3.0 ENVIRONMENTAL ANALYSIS

3.1 GENERAL DESCRIPTION OF THE AREA

The project is located in west-central Idaho and northeastern Oregon on the Snake River, which forms a part of the Idaho-Oregon border. Landscape characteristics vary greatly throughout the region. Upstream of Brownlee reservoir, the river is low gradient, with several island complexes. This reach is surrounded by farmland and rural development on flat to gentle topography. Brownlee reservoir is a steep-sided reservoir with a maximum depth approaching 300 feet near the dam. Large rock outcrops occur along the entire length of the reservoir, and the transition from riverine habitat to lacustrine habitat is evident. Oxbow reservoir is surrounded by moderate to steep topography (20 to 75 percent slopes). The shorelines are primarily basalt outcrops and talus, except where small tributaries have created alluvial fans. Similarly, the shoreline of Hells Canyon reservoir is generally very steep, with substrates consisting primarily of basalt outcrops and talus slopes.

The Snake River downstream of Hells Canyon dam is a high-gradient river with a wide diversity of aquatic habitat, including numerous large rapids, shallow riffles, and deep pools. Substrates are highly diverse, ranging from large basalt outcrops and boulders to cobble/sandbars. This unimpounded reach of Hells Canyon, considered the deepest gorge in North America, is surrounded at the upstream end by nearly vertical cliff faces. At the mouth of Granite Creek, about 7 miles below Hells Canyon dam, the river elevation is 1,480 feet msl and the canyon depth is 7,913 feet. The canyon becomes somewhat wider near Johnson Bar (RM 230), with moderate to steep topography continuing to the confluence with the Salmon River.

The current climate in the Snake River basin is influenced primarily by Pacific maritime polar air masses that travel eastward over the continent. Hells Canyon itself is primarily affected by the rain shadow of mountain ranges to the west. Data from four regional weather stations indicate that the average annual precipitation ranges from about 11 to 18 inches, depending on elevation. It is lowest at the southern (upstream) end of the region, equaling 11.3 inches at the Weiser, Idaho weather station. It increases northward through the project area (11.7 inches at Richland, Oregon), peaks near Brownlee dam (17.5 inches), and declines north (downstream) of the project area, equaling 12.8 inches near Lewiston, Idaho. Nearly 45 percent of the average annual precipitation at the Brownlee weather station falls between November and January, while just 9 percent falls between July and September, the hottest months of the summer.

Mean annual temperatures are similar among the four weather stations, although the climate tends to become drier and warmer downstream of Brownlee reservoir. At Brownlee dam, mean temperatures above 6,562 feet range from 16 degrees Fahrenheit (°F) in January to 55°F in July. In contrast, mean temperatures below 3,281 feet range from 32°F in January to between 82°F and 91°F in July. The canyon bottom area is dry, with seasonal temperatures ranging from about 23°F in January to about 95°F in July. As a general rule, winters in the canyon are mild, while summers on the canyon floor are hot.

Climate exerts the strongest influence on the vegetation in the area. The relatively mild winters below the canyon rim have allowed the development of species not normally found in this part of the country, including species such as netleaf hackberry (*Celtis reticulata*), which most often occurs in the southwestern states. Within the context of the regional climate, topography is a major influence on the development and distribution of vegetation. Grassland, shrubland, riparian, and coniferous forest communities occur near one another. Interfingering of grassland and forest occurs at a number of sites throughout the canyon because of variations in aspect (Tisdale, 1979, as cited by Idaho Power, 2003a, exhibit E.1).

Vegetative cover adjacent to the project reflects the low level of precipitation in the area and the definitive shoreline edges of the reservoirs. Riparian vegetation occurs intermittently along the margins of the Snake River and its tributaries. Many shoreline sections have no riparian vegetation; instead

upland vegetation of steep canyon slopes meets the rocky shoreline. The dry climate and typically stony, shallow soils of the canyon have favored the development of grassland steppe communities at lower and middle elevations. Coniferous forest communities generally occur at higher elevations of steep canyon slopes, although they reach down to the river at certain locations.

3.2 CUMULATIVELY AFFECTED RESOURCES

According to the Council on Environmental Quality's regulations for implementing NEPA (§ 1508.7), a cumulative effect is the effect on the environment that results from the incremental effect of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over time to include hydropower and other land and water development activities.

Based on information in the license application, agency comments, other filings, comments from the scoping process, and preliminary staff analysis, we identified sediment transport, water quality, anadromous fish, resident fish, federally listed aquatic mollusks, riparian/wetland habitat, native grasslands and shrublands, noxious weeds and invasive exotic plants, MacFarlane's four-o'clock, bald eagles, peregrine falcons, and recreation use patterns as resources that could be cumulatively affected by the continued operation of the Hells Canyon Project in combination with other activities on the Snake River. Cumulative effects of the Hells Canyon Project, along with those of seven Idaho Power-owned projects, were included in our cumulative analysis of all eight projects presented in our final environmental impact statement (final EIS) for the four mid-Snake River projects (FERC, 2002). The evaluation of cumulative effects on anadromous fish (Snake River spring/summer and fall Chinook, Snake River steelhead, and Pacific lamprey), MacFarlane's four-o'clock, and noxious weeds and invasive exotic plants was deferred to this document. This EIS for the Hells Canyon Project tiers off the mid-Snake final EIS, as necessary, to assess the cumulative effects of the Hells Canyon Project in a basin-wide context.

3.2.1 Geographic Scope

3.2.1.1 Sediment Transport

The supply and movement of sediment upstream, within, and downstream of the project area shape the geomorphic features of the Snake River that provide habitat for aquatic life, support recreational activities, and protect important cultural resources. Initial development of the basin involved many activities that increased the rate and volume of sediments delivered to the project area. These included widespread trapping and eradication of beavers and the eventual release of sediments stored behind beaver dams in low gradient reaches of many tributaries, extensive hydraulic and dredge mining for gold throughout the basin, logging and road construction in timber production areas, widespread livestock grazing and the use of flood irrigation techniques, and an increase in the frequency of high-intensity wildfires due to many years of fire suppression efforts. The construction of 13 mainstem dams on the Snake River upstream of the project between 1901 and 1957 and the construction of many smaller dams in tributary basins between Brownlee and Swan Falls dams served to trap the majority of both coarse and fine sediments that originated from sources upstream of the project. In addition, the three project dams retain the sediment that enters the Snake River between the Swan Falls and Hells Canyon dams, reducing the amount of sediment that is delivered to the free-flowing reach downstream of Hells Canyon dam. Changes in the seasonal flow regime due to flood control storage in Brownlee reservoir and daily flow fluctuations associated with load following operations also affect the sediment transport regime downstream of Hells Canyon dam. To encompass the effects of upstream activities on sediment transport into the project area and the effects of project dams on the sediment regime downstream of Hells Canyon dam, we have defined the geographic scope of our analysis to include the entire Snake River basin upstream of Lower Granite reservoir, the first impoundment downstream of Hells Canyon dam.

3.2.1.2 Water Quality

Snake River water temperature and water quality determines the level of support for numerous beneficial uses including anadromous and resident fishes; wildlife; recreation; and domestic, industrial, and irrigation water supplies. Much of the Snake River has been listed as water-quality limited due to excessive levels of sediments, nutrients, mercury, pesticides (e.g., DDT metabolites, dieldrin, and chlordane), temperature; and low DO levels (IDEQ, 2005a; ODEQ, 2005; WDOE, 2005a). Several water-resource and land use management practices conducted in the Snake River basin influence the river's water temperature and water quality in and downstream of the project area. Both ongoing and historical mining activities increase the potential for metal loadings. Management of cropland and range affects loadings of sediments, nutrients, pesticides, and metals. Discharges from aquaculture facilities and wastewater treatment plants also supply the river with sediments and nutrients.

Dams, located throughout the basin, cause localized deposition of sediments/nutrients, which can affect growth of macrophytes and algae and subsequently result in hypoxic/anaerobic conditions. These low DO conditions can result in fish kills and increased releases of toxic contaminants from sediments that can lead to bioaccumulation of these contaminants. Operation of hydropower projects, withdrawal of surface waters for irrigation, and pumping of groundwater for irrigation can alter the flow regime throughout the Snake River and its tributaries and, thus, can influence water temperatures in the project area and further downstream. Operation of Dworshak dam, which is located on the North Fork Clearwater River, can alter the flow and thermal regimes in the Clearwater River along with the lower Snake and Columbia rivers (Ecovista et al., 2003).

To address these potential effects on water temperature and water quality, the geographic scope of our cumulative analysis includes the entire Snake River basin.

3.2.1.3 Anadromous Fish

Snake River stocks of anadromous fish must migrate through more than 300 miles of the lower Columbia River during their upstream and downstream migrations, including passage through four mainstem federal dams and their associated reservoirs: Bonneville, The Dalles, John Day, and McNary. Most Snake River stocks must also pass through another four federal dams and reservoirs on the lower Snake River: Ice Harbor, Lower Monumental, Little Goose, and Lower Granite. Although each of these dams is equipped with fish passage facilities, cumulative losses during passage through these dams and reservoirs has contributed to a reduction in the abundance of the Snake River stocks. Similarly, operation of Brownlee reservoir and the Bureau of Reclamation's (BOR's) storage reservoirs in the upper Snake River basin and operation of Dworshak reservoir on the North Fork Clearwater River can alter river flows and water temperatures in ways that may have beneficial or adverse effects on juvenile and adult anadromous fish as they migrate through the lower Snake and Columbia rivers.

The nine Idaho Power dams on the Snake River also contribute to water quality effects that may extend downstream into the lower Snake and Columbia rivers and have the potential to affect the rearing and migration of anadromous fish stocks in both rivers. All of these factors may have a cumulative effect on the abundance of anadromous fish species and affect the prospects for restoring anadromous fish runs to historical habitat upstream of Hells Canyon dam. The location of mainstem dams on the Snake and Columbia rivers is shown on figure 1, and information on the ownership, date of construction and reservoir length associated with each dam is provided in table 3.

Table 3. Mainstem hydroelectric projects on the Snake River from Shoshone Falls downstream and on the lower Columbia River. (Source: Idaho Power, 2003b, as modified by staff)

Online Date	Project	Current Ownership	River Mile[a]	Reservoir Length (miles)
1907	Shoshone Falls	Idaho Power	SR 614.7	1.8
1947	Upper Salmon Falls B	Idaho Power	SR 580.8	4.7
1937	Upper Salmon Falls A	Idaho Power	SR 579.6	0
1910	Lower Salmon Falls	Idaho Power	SR 573.0	7.2
1950	Bliss	Idaho Power	SR 560.0	5
1952	C.J. Strike	Idaho Power	SR 494.0	24
1901	Swan Falls	Idaho Power	SR 458.0	10.8
1958	Hells Canyon (Brownlee development)	Idaho Power	SR 284.6	55
1961	Hells Canyon (Oxbow development)	Idaho Power	SR 273.0	12
1967	Hells Canyon (Hells Canyon development)	Idaho Power	SR 247.6	22.3
1975	Lower Granite	Corps	SR 107.5	37
1970	Little Goose	Corps	SR 70.3	37.2
1969	Lower Monumental	Corps	SR 41.6	28.7
1962	Ice Harbor	Corps	SR 9.7	31.9
1957	McNary	Corps	CR 292	62
1971	John Day	Corps	CR 215.6	76
1960	The Dalles	Corps	CR 191.5	24
1938	Bonneville	Corps	CR 146.1	45

Notes: CR – Columbia River
SR – Snake River

To encompass these potential effects on anadromous fish, the geographic scope of our cumulative effects analysis includes the entire Snake River basin, and the mainstem lower Columbia River extending from its confluence with the Snake River to downstream of Bonneville dam.

3.2.1.4 Resident Fish

Changes in water quantity and water quality and impediments to fish migration can also affect resident fish populations in a cumulative manner. Mainstem dams on the Snake River block the upstream movement of white sturgeon, which historically were able to migrate throughout much of the Snake and Columbia rivers and their major tributaries to access suitable spawning habitats and to take advantage of seasonally abundant food resources. Project peaking operations may affect resident fish habitat extending downstream to Lower Granite reservoir, including bull trout and redband trout that use tributary habitats for spawning and summer rearing. Water quality conditions in the middle and lower Snake River that may affect the reproductive success of white sturgeon and the distribution of native resident salmonids are affected by nutrient loads and elevated water temperatures in tributaries, as well as irrigation return flows,

which occur primarily from Milner dam (RM 639) downstream. Considering these factors, the geographic scope for our cumulative effects analysis on resident fish includes the Snake River extending from Milner dam to the upstream limit of Lower Granite reservoir, as well as the tributaries that enter this section of the river.

3.2.1.5 Federally Listed Aquatic Mollusks

In Scoping Document 2, we stated that we would analyze project effects on macroinvertebrates, including federally listed mollusks, and we noted that we had requested additional surveys to evaluate the presence or absence of listed, rare, or sensitive mollusks. Idaho Power filed the results of these additional surveys on February 3, 2005. Idaho Power's surveys did not identify any federally listed mollusks within the section of the Snake River that may be affected by operation of the project, so we do not assess cumulative effects on federally listed mollusks. We do, however, summarize the results of Idaho Power's invertebrate surveys and project effects on invertebrates, including mollusks, in section 3.6, *Aquatic Resources*.

3.2.1.6 Riparian/Wetland Habitat

Riparian and wetland habitats in the semi-arid west have high ecological value because they support unique microclimates and plant communities; provide foraging, cover, and movement corridors for wildlife; and contribute to landscape diversity. The characteristics of geology, soils, and climate in the region limit the extent of these habitat types, and in both Idaho and Oregon, they comprise only about 2 percent of the landscape (Scott et al., 2001; USGS, 2005a).

The most dramatic effects on Snake River riparian and wetland habitats occurred in the late 1800s and early 1900s when homesteaders first settled in the Snake River basin. Cattle and sheep congregated along streams and rivers, trampling banks and destroying vegetation. Mining, irrigation withdrawals, and the near-total eradication of beavers compounded these adverse effects. The first dam on the Snake River was constructed in 1904, and since that time 25 other dams have been constructed in the Snake River System upstream of Hells Canyon dam. The dams inundated upstream riparian and wetland habitats and altered hydrologic support for downstream habitats.

Under current conditions, many of the same factors continue to affect riparian and wetland habitats, but trends are more positive. Management of grazing and mining on federal lands has improved, and several federal and state programs now provide incentives for protection of riparian habitat on private lands. New licenses for the mid-Snake hydroelectric projects contain provisions designed to reduce or mitigate the effects of reservoir fluctuation and peaking operations on riparian and wetland habitats.

The effects of relicensing the Hells Canyon Project on riparian and wetland habitats may overlap geographically with the effects of the actions described above. For this reason, we consider the Snake River basin as the geographic area for our cumulative effects analysis.

3.2.1.7 Native Grasslands and Shrublands

Compared to riparian and wetland habitats, native grasslands and shrublands support relatively few plant and animal species. However, they provide critical habitat for a number of species that are found nowhere else (Vander Haegen et al., 2001). Although native grasslands and shrublands remain abundant in Idaho and Oregon, several factors have reduced the quantity and quality of these cover types since European settlement. These include conversion to agricultural land uses, overgrazing, urbanization, fragmentation, inundation as a result of dam construction, invasion by exotic invasive plants, and an altered fire disturbance regime.

The effects of relicensing the Hells Canyon Project on native grasslands and shrublands may overlap with the effects of past, current, and reasonably foreseeable future actions described above. For this reason, we consider the Snake River basin as the geographic area for our cumulative effects analysis.

3.2.1.8 Noxious Weeds and Invasive Exotic Plants

Noxious weeds and invasive exotic plants are a growing problem throughout the western states, including Idaho and Oregon (ODA, 2001; IWCC, 2005). Estimates for Idaho indicate that more than 8 million acres are severely infested with at least 1 of the 36 state-designated weeds (IWCC, 2005). In Oregon, three species alone infest more than 5.4 million acres (ODA, 2001). Noxious weeds and invasive exotic plants degrade native plant communities, out-compete rare species, and reduce wildlife habitat values.

Several factors contribute to the establishment and spread of weeds, including soil and vegetation disturbance resulting from construction, timber harvest, offroad vehicle use, fire, flooding, erosion, and overgrazing. Vehicles, heavy equipment, domestic animals, and human beings then serve as vectors for the spread of weeds. As weed populations expand, they alter the environments they occupy, which promotes further spread.

The effects of actions taken in the Hells Canyon Project area may overlap with the effects of action taken on adjacent ownerships because weeds tend to spread across property boundaries. For this reason, we use the Snake River basin as the geographic extent of our cumulative effects analysis.

3.2.1.9 MacFarlane's Four-o'clock

MacFarlane's four-o'clock (*Mirabilis macfarlanei*) is federally listed as an endangered species (44 FR 209). It is known only from the Snake River downstream of Hells Canyon dam and a few sites in the Imnaha River and Salmon River basins (61 FR 52). Past, present, and future actions that could affect habitat for this species include instream flow regulation; conversion of native plant communities to agricultural, ranching, or residential use; trespass grazing; and construction, maintenance, and traffic on roads and trails.

Project-related actions that may affect MacFarlane's four-o'clock occurrences in the Snake River could affect a large proportion of the total population. For this reason, we evaluate cumulative effects on MacFarlane's four-o'clock within the species' range.

3.2.1.10 Bald Eagles and Peregrine Falcons

For the bald eagle (*Haliaeetus leucocephalus*) and peregrine falcon (*Falco peregrinus anatum*), we evaluate cumulative effects using the same geographic extent selected during relicensing of the mid-Snake projects, i.e., the Snake River basin. Although the range of both species extends far beyond the Snake River basin, this area is adequate to allow for a comparison of potential project effects with the effects of past, current, and reasonably foreseeable future actions on the bald eagle and peregrine falcon.

Bald eagle populations throughout the United States have been increasing during the past 25 years as a result of habitat protection and restrictions on the use of DDT and other pesticides (FWS, 2005a). Surveys in Idaho recently documented the largest number of occupied nests and the highest levels of productivity on record for the state (Sallabanks, 2005). Although the number of nests in some zones is below the recovery goal identified in 1986 (FWS, 1986), the overall goals for the state have been met and exceeded. With the discovery of four new nests since 2003, Zone 14 (which encompasses the Hells Canyon Project area) has met the recovery target of six active nesting territories (Carpenter and Holthuijzen, 2006). The number of wintering bald eagles in the state is also increasing (Steenhof et al., 2004).

Peregrine populations in the United States are also increasing (FWS, 2003a). Restrictions on organochlorine pesticides improved the reproductive rate of surviving wild pairs, and an aggressive re-introduction program led to successful recolonization of many historical and several new sites (64 FR 164). As of 2006, Idaho supported 34 occupied territories (Sallabanks, 2006), and Oregon reported 124 in 2005 (Peterson, 2006), well above recovery goals of 30 and 17, respectively (63 FR 165). Idaho Power documented an occupied eyrie near Hells Canyon dam in 1996 (Akenson, 2000). One young fledged from the nest in 1996. Although surveyors observed adult peregrines in the vicinity from 1997 through 2000, Idaho Power reports that nest success could not be confirmed.

3.2.1.11 Recreational Resources

Flows from the Hells Canyon Project influence boating, angling, and other recreational use of the Snake River downstream of the Hells Canyon dam and outside of the project boundary. Flows from the project may affect the amount, timing, type, location, and quality of recreational use in the Hells Canyon National Recreation Area (HCNRA). For example, boaters accessing the upper portion of the Hells Canyon require certain minimum flows to navigate Granite Creek and Wild Sheep rapids. Also, demand for riverine recreational opportunities is typically associated with summer and fall months. Changes in the timing and magnitude of releases from the project as a result of relicensing could limit or enhance recreational opportunities for different types of boaters accessing this portion of the canyon.

Increased recreational use of the canyon resulting from changes in project operations could also have secondary effects on the quality of the recreational experience in the HCNRA. For example, increased boating activity may result in user conflicts between power and float boaters trying to access limited camping sites or run congested rapids. In addition, additional recreational use of the HCNRA could affect cultural sites and sensitive riparian habitats associated with more visitors accessing these areas.

In contrast, it is possible that changes in project operations could reduce recreational opportunities in the HCNRA by altering flows in a manner that may not support current demand for the timing and type of recreational use in the HCNRA. Such changes could result in displaced demand for boating and angling opportunities to other western rivers. A reduction in recreational opportunities could result in a decline in commercial boater and angler revenues that could adversely affect communities surround the project that receive economic benefits from supporting recreational use of the HCNRA.

These positive or negative effects could be incrementally small, but could accrue over the term of any new license for the project. To consider these potential cumulative effects on recreational use downstream and outside of the project boundary, the geographic scope of our cumulative effects analysis includes the Snake River from the Hells Canyon dam downstream to the northern end of the HCNRA.

3.2.2 Temporal Scope

The temporal scope of our cumulative analysis in this environmental document includes past, present, and future actions and their possible cumulative effects on each resource. Based on the license term, the temporal scope will look 30 to 50 years into the future, concentrating on the effects on the resources from reasonably foreseeable future actions. The historical discussion will, by necessity, be limited to the amount of available information for each resource.

3.3 WATER QUANTITY

3.3.1 Affected Environment

The Hells Canyon Project covers more than 96 river miles of the Snake River from RM[29] 343 just above the upstream margin of Brownlee reservoir to RM 247 just downstream of Hells Canyon dam. Points of reference relevant to water quantity issues include upstream dams, project features, Snake River tributaries, stream gages, and other key locations (table 4, figure 8).

Table 4. Key features along the main stem of the Snake River. (Source: Idaho Power, 2003a; USGS, 2005b)

Location	Snake River Mile	Drainage Area (square miles) (if available)
Swan Falls dam	458	
USGS Gage No. 13172500, Snake River near Murphy	453.5	41,900
Walters Ferry	444	
Boise River	394	
USGS Gage No. 13213100, Snake River at Nyssa	385.2	58,700
Payette River	365.5	
Weiser River	351.8	
USGS Gage No. 13269000, Snake River at Weiser	351.3	69,200
Brownlee reservoir upstream end	339.2	
Huntington/Marsing	328	
Burnt River	327	
Powder River	296	
USGS Gage No. 13289700, Brownlee reservoir at Brownlee dam	285	72,590
Brownlee dam	284.6	
Oxbow reservoir upstream end	284.6	
Wildhorse River	283.3	
Oxbow dam	272.5	
Hells Canyon reservoir upstream end	272.5	
Indian Creek	271.3	
Pine Creek	271	
Hells Canyon dam	247.6	
USGS Gage No. 13290450, Snake River at Hells Canyon dam	247	73,300
Johnson Bar	230	

[29] River miles are measured moving upstream from the mouth of the Snake River at its confluence with the Columbia River in Washington.

Location	Snake River Mile	Drainage Area (square miles) (if available)
USGS Gage No. 13290460, Snake River at Johnson Bar	229.9	73,400
Pittsburg Landing	215	
Imnaha River	191.6	
Salmon River	188.2	
USGS Gage No. 13317660, Snake River below McDuff Rapids, at China Gardens, Idaho	175.7	
Lime Point	172	
Grande Ronde River	168.7	
USGS Gage No.13334300, Snake River near Anatone	167.2	92,960

In this section, we describe inflows to the project, the three project reservoirs, and flows downstream of Hells Canyon dam. Additionally, we discuss navigation, flood control, and water rights.

3.3.1.1 Surface Water

In estimating the quantity of water entering the Hells Canyon Project, Idaho Power starts with the flows passing the Snake River at the Weiser Gage (U.S. Geological Survey [USGS] Gage No. 13269000) located at RM 351 (USGS, 2005c), and then makes adjustments to account for accretion flows downstream of the Weiser Gage based on flows from the Wildhorse River at Brownlee dam (USGS Gage No. 13289960), Pine Creek near Oxbow, Oregon (USGS Gage No. 13290190), and the Snake River at Hells Canyon dam (USGS Gage No. 13290450). In making inflow estimates, Idaho Power also takes into account any changes in reservoir content.

Brownlee Inflows

Idaho Power uses the inflow estimates to evaluate current conditions and potential alternative operations. Since hydrologic conditions vary greatly from one year to the next, Idaho Power selected five representative years spanning a variety of water conditions. The five representative calendar years and the corresponding hydrologic conditions are 1992 (extremely low); 1994 (medium-low); 1995 (medium); 1999 (medium-high); and 1997 (extremely high). For each representative water condition, figure 9 displays the seasonal variability of inflows to the project. Average daily inflows to Brownlee reservoir during the five representative years ranged from a low of 4,712 cfs to a high of 93,029 cfs and averaged 19,681 cfs.

To provide the reader with an estimate of the frequency of each of these years[30] we plotted inflows on the flow duration curve and obtained an estimate of the percent exceedance associated with each inflow value. The percent exceedances for each representative condition are summarized in table 5.

[30] Page 146 of Idaho Power's January 31, 2007, section 401 application includes table 6.1-4, which provides the latest information on Brownlee inflows from Idaho Power's modeling efforts. Additionally, figure B-3 on page B-33 of the final license application includes a flow duration curve. This information was used to develop frequency estimates.

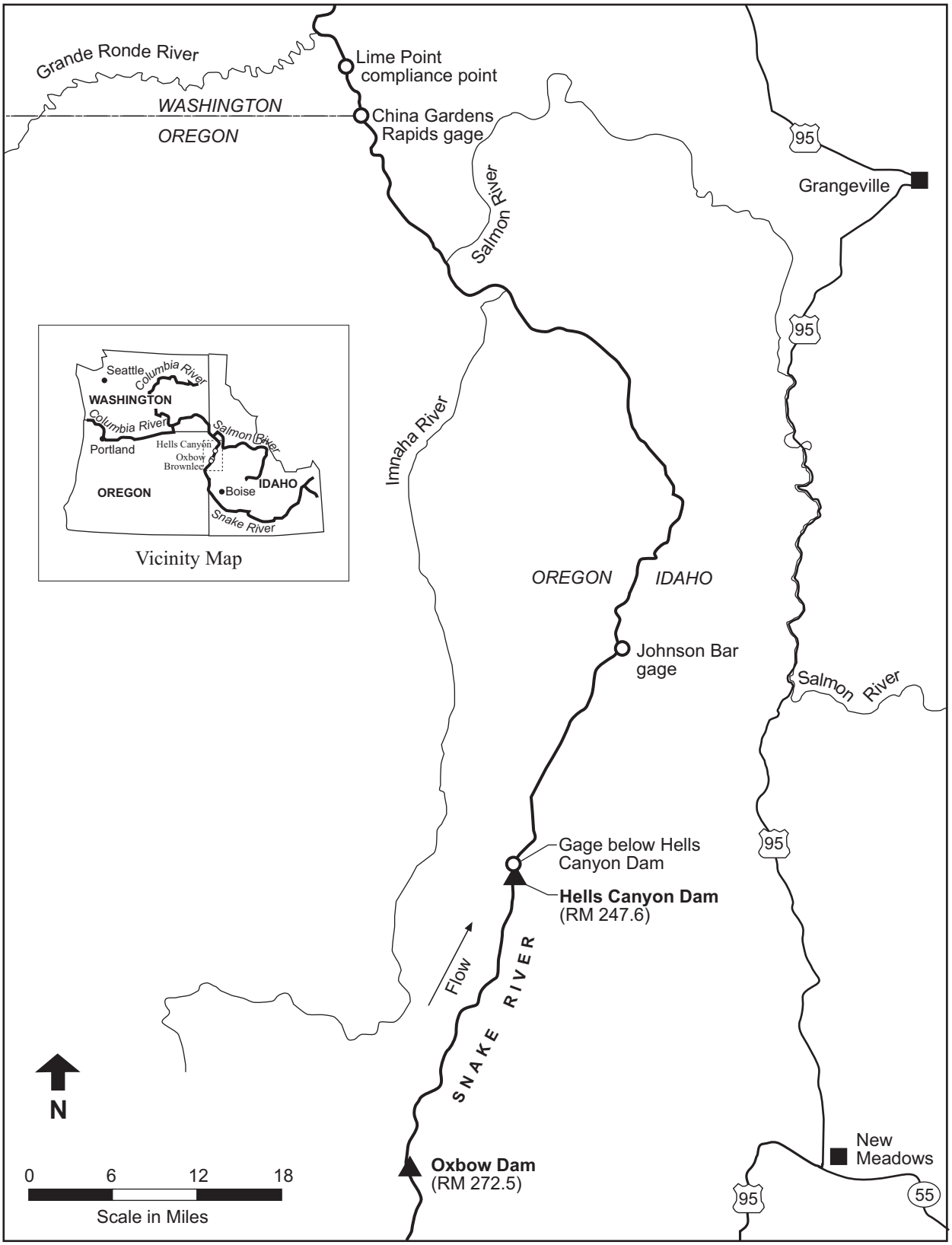
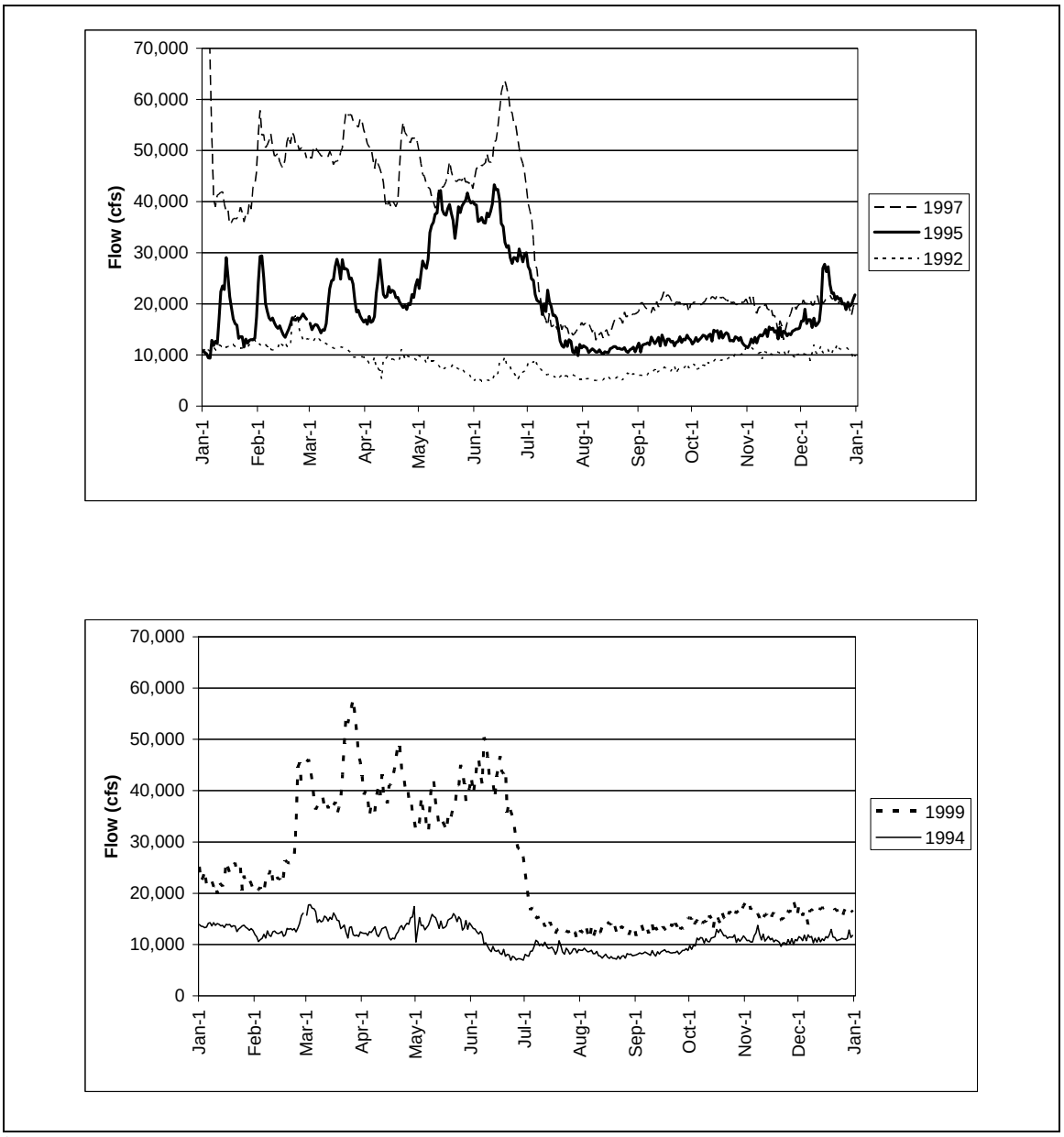


Figure 8. Selected USGS gage locations downstream from Hells Canyon dam. (Source: Staff)



[a] Prior to issuance of the draft EIS, 1994 was identified as a representative medium-low flow year, based on analysis of the 1928 to 1999 flow record. However, Idaho Power's (2007a) subsequent analysis of the 1911 to 2005 flow record resulted in reclassifying 1994 to a low flow year.

Figure 9. Comparison of Brownlee reservoir inflows under extremely high (1997), medium (1995), extremely low (1992), medium-high (1999) and medium-low (1994)[a] water conditions. (Source: Idaho Power, 2004)

Table 5. Frequency of annual inflows to Brownlee reservoir for five representative years. (Source: Idaho Power as modified by staff)

Year	Water Condition	Average Annual Inflow (cfs)	Percent Exceedance
1992	Extremely low	8,400	18
1994	Medium low	10,800	28
1995	Medium	17,500	42
1999	Medium high	22,900	85
1997	Extremely high	31,300	97

As shown here, only about 18 years in 100 would be as dry or drier than 1992. Only about 3 years in 100 would be expected to be as wet or wetter than 1997

Tributaries

Several major tributaries flow into the Snake River and project reservoirs within the project boundary; these are the Burnt River, Powder River, Brownlee Creek, Wildhorse River, Indian Creek, and Pine Creek (refer to table 18). The Weiser River flows into the Snake River just above Brownlee reservoir, and Granite Creek enters the Snake River 8.6 miles downstream of Hells Canyon dam. Deep Creek is the first perennial tributary downstream of Hells Canyon dam, entering the river just downstream of the dam on the Idaho side of the river. We characterize the drainage areas and key flow parameters for major tributaries in table 18 (see section 3.5.1.2, *Temperature*).

Reservoirs

The physical characteristics of the three project reservoirs are described in table 6. Brownlee reservoir is the dominant storage feature, accounting for more than 86 percent of the project's total water storage.

Table 6. Physical characteristics of Brownlee, Oxbow, and Hells Canyon reservoirs. (Source: Idaho Power, 2003a)

Characteristics	Brownlee Reservoir	Oxbow Reservoir	Hells Canyon Reservoir
Drainage basin area (square miles)	72,590	72,800	73,300
Surface area (acres)	15,000	1,150	2,412
Length (river miles)	58	12	25
Shoreline perimeter (miles)	193	26	56
Total volume (acre-feet)	1,420,000	57,500	170,000
Full pool (feet msl)	2,077	1,805	1,688
Minimum pool (feet msl)	1,976	1,800	1,683

Characteristics	Brownlee Reservoir	Oxbow Reservoir	Hells Canyon Reservoir
Mean depth (feet)	100	50	70
Maximum depth (feet)	300	81	245
Mean width (feet)	2,242	795	1,000
Average retention time (days)[a]	36	1.4	4
Penstock centerline elevation (feet msl)	1,948	1,750	1,571.5
Maximum powerhouse discharge (cfs)	35,000	28,000	30,500

[a] Based on a typical inflow of 20,000 cfs. For Brownlee reservoir, we computed retention time as 36 days, not the 34 days reported by Idaho Power.

Brownlee Reservoir

Brownlee reservoir fluctuates over a range of 101 feet from elevation 1,976 feet msl to 2,077 feet msl. Typically, the minimum lake elevation occurs during the late winter to early spring period as the reservoir is lowered (or, "drafted") to provide flood storage capacity (see *Flood Control* section below). Drafting to achieve this objective begins in mid-January under the Corps' direction. The Corps requires that the reservoir be no higher than elevation 2,034 feet msl[31] by March 1 each year. Additional storage to manage flooding in the Columbia River may also be required by the Corps. Over the five representative years, minimum elevations during this period ranged from 2,022.57 feet msl to 2,076.85 feet msl as shown in figure 10.

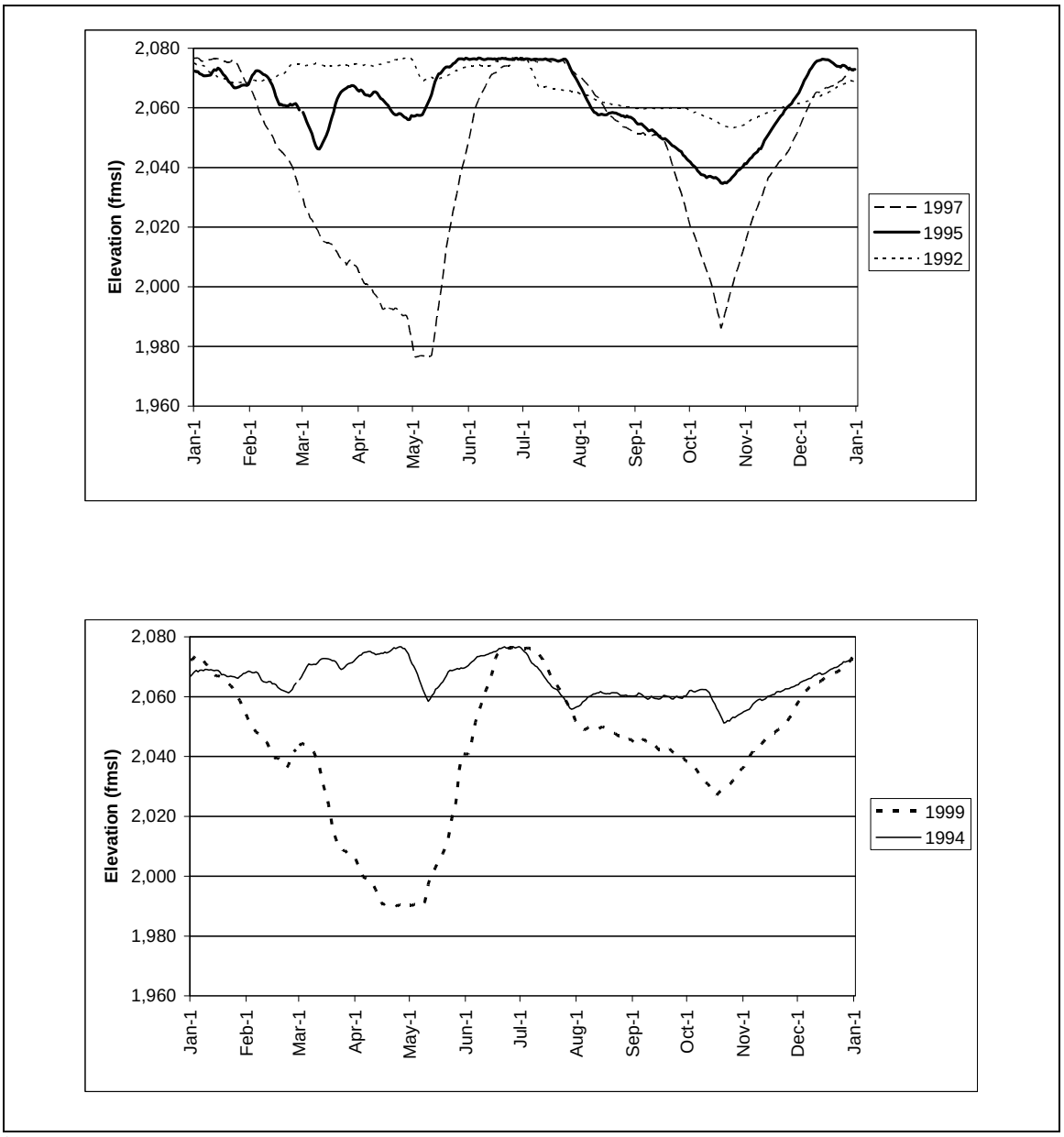
Navigation needs also enter into Idaho Power's management of outflow from Hells Canyon dam; navigation needs are discussed further in section 3.3.1.3, *Navigation*.

The project as a whole, including the water released from Hells Canyon dam, is operated such that a one-foot per hour ramping rate is maintained at Johnson Bar, located about 18 miles downstream of Hells Canyon dam at RM 230.

Refill of Brownlee reservoir occurs during the spring and summer months and varies depending on the allowable reservoir elevations required by the Corps. Typically Idaho Power attempts to refill Brownlee reservoir by the end of June. Maintenance of minimum instream flows below Hells Canyon dam may also affect refill. During the months of July and August, historical reservoir elevations ranged from 2,045.50 feet msl to 2,076.85 feet msl over the five representative years.

Over the 6-year period from 1995 through 2001, Brownlee reservoir storage was used to provide up to 237,000 acre-feet of water during the summer months for flow augmentation to assist with the outmigration of juvenile salmon and steelhead from the lower Snake River under an energy exchange agreement with the Bonneville Power Administration and cooperative agreement with federal wildlife agencies involved in the Federal Columbia River Power System (USGS, 2005d). After 2001, Idaho Power and Bonneville Power were unable to come to terms on a new energy exchange agreement and the program was discontinued. In January 2005, the Interim Agreement under the Hells Canyon

[31] This corresponds to an available storage of 500,000 acre-feet for flood control.



[a] Prior to issuance of the draft EIS, 1994 was identified as a representative medium-low flow year, based on analysis of the 1928 to 1999 flow record. However, Idaho Power's (2007a) subsequent analysis of the 1911 to 2005 flow record resulted in reclassifying 1994 to a low flow year.

Figure 10. Comparison of Brownlee reservoir average daily elevations under extremely high (1997), medium (1995), extremely low (1992), medium-high (1999) and medium-low (1994)[a] water conditions. (Source: Idaho Power, 2004)

Hydroelectric Project Settlement Process became effective. Under the terms of the Interim Agreement, Idaho Power agreed to make best efforts to hold Brownlee reservoir at or near full elevation (about 2,077 feet msl) through June 20 each year, and thereafter, subject to certain conditions, to draft Brownlee reservoir to elevation 2,059 feet msl, effectively releasing up to 237,000 acre-feet of water for flow augmentation by August 7 each year (Idaho Power, 2005a).

In September, Brownlee reservoir is once again drafted to provide storage of inflows above required releases to support the upcoming fall Chinook spawning period. A relatively constant flow, normally between 8,000 cfs and 13,000 cfs, is maintained downstream of Hells Canyon dam to ensure that fall Chinook salmon construct their redds below a certain target flow elevation. Inflows in excess of these releases are stored in Brownlee reservoir.

Once the fall Chinook spawning period ends in early December, Idaho Power attempts to maintain the Snake River downstream of Hells Canyon dam at or above the flow target selected in the preceding fall. Under moderate and higher inflow conditions, target flows are maintained without further drafting of Brownlee reservoir. Under drier conditions, Brownlee reservoir may need to be drafted to provide the minimum target flow downstream of Hells Canyon dam. The annual Brownlee reservoir operations cycle then repeats beginning in mid-January as Brownlee reservoir is drafted in preparation for the next flood control season.

Oxbow Reservoir

Oxbow reservoir fluctuates over a range of 5 feet, from elevation 1,800 feet msl to 1,805 feet msl. Reservoir fluctuations tend to be short-term, even daily, rather than seasonal. As flows are ramped up each day in response to regional demands for electricity, the Oxbow pool is drawn down. As power demand wanes in the late evening, the flow through the Oxbow powerhouse is reduced or eliminated, allowing the Oxbow reservoir to refill in preparation for the next day's heavy load period.

As required by the current license, Idaho Power maintains a minimum 100-cfs flow in the Oxbow bypassed reach, between the Oxbow dam and the powerhouse tailrace.

Hells Canyon Reservoir

Hells Canyon reservoir normally fluctuates over a range of 5 feet, from elevation 1,683 feet msl to 1,688 feet msl. It has a potential minimum operating level of 1,678 feet msl. Reservoir fluctuations tend to be short-term, often daily, rather than seasonal. During low flow periods, ramping constraints below Hells Canyon dam may limit how much powerhouse flows and reservoir pool levels fluctuate.

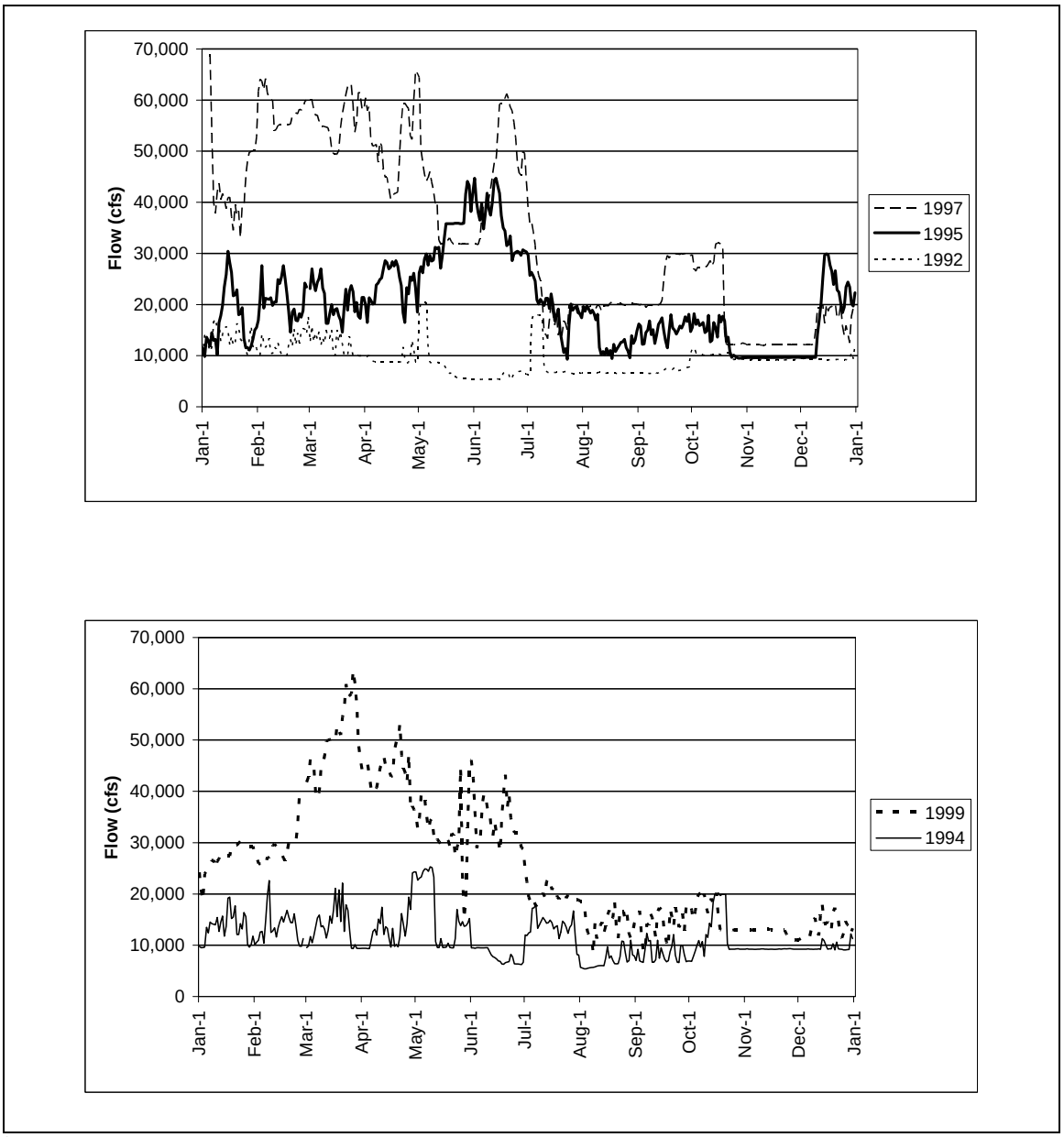
Snake River Downstream of Hells Canyon Dam

Seasonal flows downstream of Hells Canyon dam respond to operations at Brownlee reservoir, as described above. Fall Chinook salmon flow requirements, navigation flow requirements, and ramping rate restrictions have particular influence. Average daily outflows downstream of Hells Canyon dam reservoir during the 5 representative years ranged from a low of 6,960 cfs to a high of 98,100 cfs and averaged 20,741 cfs (figure11). Flows intended to benefit fall Chinook salmon, steelhead, and other fisheries are described in more detail in section 3.6, *Aquatic Resources*.

3.3.1.2 Flood Storage

Idaho Power operates Brownlee reservoir to provide springtime flood control for the lower Columbia River and, if necessary, the lower Snake River under the direction of the Corps. The goal of flood control at Brownlee reservoir is to control major floods so that flows do not exceed 600,000 cfs in the lower Columbia River at The Dalles (RM 188.9) and 400,000 cfs in the mid-Columbia near Hanford, Washington,[32] although flood control at Hanford is usually incidental to what is being targeted at The Dalles. Since Brownlee reservoir initially filled in May 1958, the highest peak flow at The Dalles was

[32] Flow into the Hanford Reach is based on USGS measured flow at Gage No. 12472800, Columbia River below Priest Rapids Dam at RM 394.5.



[a] Prior to issuance of the draft EIS, 1994 was identified as a representative medium-low flow year, based on analysis of the 1928 to 1999 flow record. However, Idaho Power's (2007a) subsequent analysis of the 1911 to 2005 flow record resulted in reclassifying 1994 to a low flow year.

Figure 11. Comparison of Hells Canyon outflows (USGS Gage No. 13290450, Snake River at Hells Canyon dam, Idaho-Oregon state line) under extremely high (1997), medium (1995), extremely low (1992), medium-high (1999) and medium-low (1994)[a] water conditions. (Source: Idaho Power, 2004)

699,000 cfs on June 8, 1961.[33] This flood would be lower under today's conditions owing to construction of additional flood control storage under the Columbia River Treaty. The Hells Canyon gage, activated in July 1965, recorded a peak flow of 103,000 cfs on January 2, 1997. The peak inflow to the project (Snake River at Weiser) during this event was 84,100 cfs on January 3, 1997 (USGS, 2005b).

Under the current FERC license, Brownlee reservoir is drawn down to elevation 2,034 feet msl or below in order to provide 500,000 acre-feet of storage space for flood control. By March 31 each year, up to an additional 500,000 acre-feet may be required by the Corps if necessary. Following a period of analysis and revision to flood control rule curves in the 1980s, the Corps implemented a modified rule curve procedure in 1998. Table 7 summarizes the required flood control storage space at Brownlee reservoir as a function of inflow volume forecast at The Dalles and inflow forecast into Brownlee reservoir. Values are interpolated between the various points in the table in accordance with the procedures outlined in Idaho Power (2003a). Flood control requirements for Brownlee reservoir can extend through June, and Idaho Power may have to spill at any or all three project developments (Brownlee, Oxford, and Hells Canyon) to achieve flood control storage objectives.

Table 7. Required flood control draft at Brownlee reservoir based on November 1998 rule curve. (Source: Idaho Power, 2003a)

	Inflow Volume Forecast[a]			
Date	**The Dalles <=75 MAF**			
Storage Space Required	**Brownlee Inflow (≤ 3 MAF)**	**Brownlee Inflow (= 4 MAF)**	**Brownlee Inflow (= 5 MAF)**	**Brownlee Inflow (≥ 6 MAF)**
February 28	0	200	300	400
March 31	0	100	200	350
April 15	0	50	150	250
April 30	0	0	50	150
	The Dalles = 85 MAF			
Storage Space Required	**Brownlee Inflow (≤ 3 MAF)**	**Brownlee Inflow (= 4 MAF)**	**Brownlee Inflow (= 5 MAF)**	**Brownlee Inflow (≥ 6 MAF)**
February 28	150	300	350	400
March 31	100	300	400	450
April 15	50	250	400	500
April 30	0	250	400	500
	The Dalles = 95 MAF			

[33] This flood event was not particularly severe on the Snake River because the maximum flow of the Snake River near Anatone was 84,900 cfs on June 3, 1961, compared to the record flow of 195,000 cfs on June 18, 1974.

	Inflow Volume Forecast[a]			
Storage Space Required	**Brownlee Inflow (≤ 3 MAF)**	**Brownlee Inflow (= 4 MAF)**	**Brownlee Inflow (= 5 MAF)**	**Brownlee Inflow (≥ 6 MAF)**
February 28	200	300	350	400
March 31	150	300	400	500
April 15	100	300	425	550
April 30	50	300	450	600
	The Dalles = 105 MAF			
Storage Space Required	**Brownlee Inflow (≤ 3 MAF)**	**Brownlee Inflow (= 4 MAF)**	**Brownlee Inflow (= 5 MAF)**	**Brownlee Inflow (≥ 6 MAF)**
February 28	300	400	400	400
March 31	200	425	475	500
April 15	150	450	525	600
April 30	100	450	550	700
	The Dalles ≥ 115 MAF			
Storage Space Required	**Brownlee Inflow (≤ 3 MAF)**	**Brownlee Inflow (= 4 MAF)**	**Brownlee Inflow (= 5 MAF)**	**Brownlee Inflow (≥ 6 MAF)**
February 28	300	400	500	500
March 31	250	450	600	750
April 15	200	500	650	850
April 30	150	550	750	980

Note: MAF – million acre-feet

[a] The inflow forecast period is April through July. The inflow forecast is partially based on observed flows on April 15 and 30.

3.3.1.3 Navigation

Article 43 of the current license states that the project is to be operated in the interest of navigation downstream of Hells Canyon dam to maintain a flow of 13,000 cfs in the Snake River at Lime Point (RM 172) at least 95 percent of the time, when determined by the Corps to be necessary for navigation. Regulated flows of less than 13,000 cfs are limited to the months of July, August, and September, during which time the project is to be operated in the best interest of power and navigation, as mutually agreed to by Idaho Power and the Corps. The minimum flow during periods of low flow or normal minimum plant operations is to be 5,000 cfs at Johnson Bar (RM 230), at which point the maximum variation in river stage is not to exceed 1 foot per hour. In September 1988, the Corps and Idaho Power agreed to maintain a higher minimum of 6,500 cfs downstream of Hells Canyon dam. Brownlee reservoir is not drafted to meet either the 6,500 or 13,000 cfs flow targets. Inflow is passed when flows are below 6,500 cfs.

In 2001, under a voluntary agreement with the Corps and the Northwest Professional Power Vessel Association (NPPVA), Idaho Power began providing timed releases of 8,500 cfs below Hells Canyon dam, while maintaining a floor of 6,500 cfs. The timed-release schedule was refined for the

summer of 2002, and Idaho Power generally followed it through July of 2006. Timed releases, or pulses, for boating purposes are complicated by the travel time of the pulses from the point of release at the Hells Canyon dam to the various rapids downstream. Releases arrive sooner and are more effective at locations closer to the dam. For example, it takes about 3 hours for a release to arrive at Wild Sheep Rapids, but as many as 16 hours to arrive at McDuff Rapid. At Wild Sheep Rapids the flow is almost identical to the pulsed release, while at McDuff, the pulse is attenuated, or flattened, due to the distance traveled and the intervening flow contribution by tributaries.

Additional information about recreational boating use downstream of Hells Canyon dam is provided in section 3.10.1.1, *Regional Recreational Setting*.

3.3.1.4 Water Rights

Idaho Power operates the project under water rights from both the state of Idaho and the State of Oregon. Table 8 summarizes the water rights for the project. Idaho Power (2003a) provides detailed information about non-project related water rights within the project boundary.

Table 8. Project-related water rights for the Hells Canyon Project. (Source: Idaho Power, 2003a)

No.	Expiration Date (If Applicable)[b] or Priority Date	Development or Location Description	Description	Use(s)
Oregon License No. HE 161	Expires December 31, 2011	Oxbow	26,500 cfs	Hydroelectric generation
Oregon License No. HE 188	Expires December 31, 2010	Brownlee	24,500 cfs and storage up to 1,500,000 acre-feet of which 1,000,000 acre-feet are useable.	Hydroelectric generation
Oregon License No. HE 189	December 31, 2017	Hells Canyon	27,000 cfs and storage up to 183,000 acre-feet of which 12,000 acre-feet are useable.	Hydroelectric generation
Oregon Water Right 50644	December 9, 1988	Overall project boundary	0.22 cfs	Irrigation
Oregon Water Right 50570	February 24, 1986	Overall project boundary	0.20 cfs	Domestic
Oregon Water Right 30551	March 10, 1960	Overall project boundary	0.20 cfs	Domestic/ irrigation
Oregon Water Right Bake 242	May 29, 1987	Overall project boundary	0.77 cfs	Domestic
Oregon Water Right Bake 243	June 1, 1987	Overall project boundary	0.35 cfs	Domestic
Oregon Water Right 72198	1878	Overall project boundary	0.69 cfs	Irrigation

No.	Expiration Date (If Applicable)[b] or Priority Date	Development or Location Description	Description	Use(s)
Oregon Water Right 72611	May 31, 1947	Overall project boundary	1.29 cfs	Irrigation
Oregon Water Right 63298	August 13, 1981	Overall project boundary	130.0 cfs	Fish ladder and attraction for trapping
Oregon Water Right 12778	April 22, 1992	Overall project boundary	0.29 cfs	Fish propagation
Oregon Water Right 15318	November 6, 2000	Overall project boundary	1.80 cfs	Fish propagation
Idaho Water Right 03-10162	May 20, 1960	Overall project boundary	0.086 cfs from Snake River	Irrigation
Idaho Water Right 03-10168	December 31, 1959	Overall project boundary	0.12 cfs from Snake River	Irrigation
Idaho Water Right 69-07098	June 12, 1989	Overall project boundary	0.50 cfs from groundwater	Domestic
Idaho Water Right 69-11490	December 10, 1974	Overall project boundary	0.04 cfs from groundwater	Domestic
Idaho Water Right 03-7063	September 23, 1996	Overall project boundary	0.06 cfs from Snake River	Irrigation
Idaho Water Right 03-10167	December 1, 1967	Overall project boundary	0.20 cfs from Snake River	Irrigation
Idaho Water Right 79-13952	December 1, 1967	Overall project boundary	0.02 cfs from spring	Irrigation
Idaho Water Right 79-13953	December 1, 1967	Overall project boundary	0.04 cfs from groundwater	Domestic

[a] The Idaho Power response to OWRD1 is used in particular.

[b] Idaho Power is in the process of re-applying for the Oregon water rights under the State's Hydropower Application Review Team (HART) Process and is providing updated information on the description of those rights via that process.

Additionally, two important regional processes affect water rights in the project vicinity. Under the Swan Falls Agreement.[34] signed in October 1984, Idaho Power agreed to subordinate its Swan Falls water rights along with the water rights of its other projects located along the Milner-to-King Hill reach of the Snake River to specific flow levels that would allow for some continued and future development of water resources upstream of Swan Falls (Law Offices of Rosholt, Robertson and Tucker, 1997). The agreement is relevant to the Hells Canyon Project because flows into the project are affected by the minimum instream flows of 3,900 cfs from April 1 to October 31 and 5,600 cfs from November 1 to March 31 that are required by the agreement, as measured at Murphy (RM 453.5 near Swan Falls). Inflows to the Hells Canyon Project may be higher than would occur in the absence of the agreement.

The Swan Falls Agreement includes the following elements:

[34] Named for the Idaho Power Swan Falls Hydroelectric Project, FERC No. 503, located upstream of the Hells Canyon Project.

1. the State of Idaho will enforce the State Water Plan and assert that the Snake River is fully appropriated as necessary to enforce that plan;
2. the flows above the established minimums were placed in trust with the State of Idaho and are only to be allocated to other uses upon findings that the proposed appropriations would comply with specific regulatory provisions intended to protect Idaho Power's generation potential;
3. the State of Idaho would initiate a general adjudication of the Snake River basin; and
4. the State of Idaho would support the establishment of an effective water marketing system and recognize Idaho Power's ability to lease, purchase or otherwise acquire water from sources upstream for power generation purposes.

The second major process, which is described in item 3 above, is the Snake River Basin Adjudication (SRBA). Under the terms of the agreement there are three principal components. The Nez Perce Tribal Component quantifies the Tribe's on-reservation consumptive use reserved water right at 50,000 acre-feet per year and provides the Tribe with $60.1 million for water and fisheries purposes, including funds for land acquisition, cultural preservation, and fish related projects, and $23 million for water supply and sewer systems. It provides the Tribe with management authority of the Kooskia National Fish Hatchery and ownership of more than 11,000 acres of BLM-administered land within the reservation valued at $7 million. The second component is the Salmon/Clearwater Habitat Management and Restoration Initiative that provides for the Idaho Water Resource Board (State of Idaho) to hold minimum instream flow water rights on selected streams of importance to the Tribe. Finally, the Snake River Flow Component provides a 30-year agreement to allow the BOR to lease up to 427,000 acre feet of water per year for flow augmentation[35] and provides that the Bureau may acquire up to 60,000 acre-feet of consumptive natural flow water rights from the Snake River. Additionally, the settlement provides the Tribe with the use of 200,000 acre-feet of stored water in Dworshak reservoir for use as temperature control and flow augmentation. Finally, it includes a $12.7 million dollar fish habitat improvement fund for use in improving habitat in the Salmon and Clearwater River basins.

The SRBA District Court partially decreed federal reserved water rights for the Hells Canyon National Recreation Area and quantified the rights based on identified flows and lake levels on 32 streams and lakes. These rights are subject to subordinations to certain existing and future rights. The Court also entered a partial decree for the federal reserved water rights on six Wild and Scenic rivers and quantified the rights for each of the six rivers[36] as an instream flow amount.

3.3.2 Environmental Effects

In this section, we assess the effects of project operations on flood storage, reservoir levels, outflows from Hells Canyon dam, downstream river locations important to navigation and recreation, daily flow fluctuations downstream of Hells Canyon dam, and water rights. In our assessment, we rely on results of Idaho Power's computer simulation of the project (Bowling and Whittaker, 2005; Bowling, 2005a,b; Parkinson et al., 2005a; Idaho Power, 2005b,c; Brink and Chandler, 2005; Parkinson and Bowling, 2005).

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[35] Flow augmentation occurred throughout the middle and later 1990s on an interim basis. A nominal amount of 427,000 acre-feet per year was provided. The agreement makes this a more permanent arrangement.

[36] The six rivers include the Salmon River, Middle Fork Salmon River, Rapid River, Selway River, Lochsa River and Middle Fork Clearwater River. All are tributaries to the Snake River downstream of Hells Canyon dam.

In simulating project operations, Idaho Power used CHEOPS, a simulation model for evaluating physical and operational changes at multiple-development hydroelectric projects. CHEOPS preserves the coordination that characterizes Idaho Power's operation of the three developments. The model is driven by a calculated daily average Snake River inflow to Brownlee reservoir. Brownlee development discharges, combined with Wildhorse River flow, become inflows to the Oxbow development. Oxbow discharges combine with the Oxbow bypassed flow and Pine Creek flow to become inflows to the Hells Canyon development. The CHEOPS model consists of two separate, but linked, modules: a rule curve module and an energy module. The rule curve module uses daily average inflow, along with user-established target reservoir elevations, plant capacity, and minimum flow requirements, to calculate daily average project outflows. These daily average outflow calculations are then input into the energy module, which uses an energy load shape to produce 15-minute water releases responsive to the variation in energy demands during the course of the typical day. Further details of the model can be found in Parkinson (2003).

Idaho Power used five typical annual hydrologic conditions (or pentiles) to capture the range of operations that would occur over the term of a new license. Actual Brownlee reservoir inflows for 5 recent years were used as proxies for the five hydrologic conditions: extremely low—1992; medium-low—1994; medium—1995; medium-high—1999; and extremely high—1997 (see section 3.3.1.1, *Surface Water*).

3.3.2.1 Proposed Operations

With one exception, Idaho Power proposes to operate all three developments under the same constraints as those that characterize current operations (section 2.2.2, *Proposed Project Operations)*. The exception relates to winter flood control requirements, whereby Idaho Power would provide flood storage at Brownlee reservoir equivalent to a maximum draft rate without spill of 3 feet per day over a 2- or 3-day period, not to exceed a total of 9 feet. This provision would apply only in December and January, and it would occur only on a case-by-case request from the Corps. In light of the occasional nature of this operational constraint, it is not separately modeled in CHEOPS. Refer to this document's appendix D, *Modeled Constraints for Idaho Power Company's Proposed Operations and Operational Alternatives*, for the constraints used in simulating Idaho Power's Proposed Operations.

At the request of Commission staff, Idaho Power evaluated differences between modeled Proposed Operations and actual historical flow and reservoir data reflective of Current Operations (Bowling, 2004). Because of the complex nature of simulation modeling of a multi-development hydroelectric project, there will always be differences between simulated operations and actual historical operations, since modeling constraints cannot replicate the real-time decisions of the project operators. Although there are some differences between simulated and historical operations, we conclude that such differences result from the limitations of modeling, not from any substantive differences between Proposed and Current Operations. Accordingly, we consider the effects of Idaho Power's Proposed Operations to be indistinguishable from the ongoing effects of Current Operations.

3.3.2.2 Operational Recommendations and Alternative Evaluation Scenarios

In response to Commission staff's Ready for Environmental Analysis notice, we received 40 operation-related recommendations from resource agencies, tribes and other interested parties (table 9). The recommendations fall into several categories as to their primary purpose: flood control; flow augmentation/shaping; navigation; recreational access; warmwater fish spawning; fall Chinook flow program flows; Oxbow minimum flows; ramping rates; and fish stranding. Because these recommendations are directed at project operations, they could potentially affect reservoir levels and river flows.

Table 9. Operational recommendations. (Source: Staff)

Recommending Entity[a]	Recommendation Category	Recommendation
Corps-1	Flood control	The flood control draft for Brownlee in preparation of the spring runoff should be determined consistent with the November 1998 Procedure for Determining Flood Control Draft at Brownlee reservoir.
Corps-2	Flood control	For winter flood control operations, the Corps and Idaho Power would handle future winter flood control operations for Brownlee reservoir on a case-by-case basis. In the event flood control operations are necessary to control winter flood events, Idaho Power would comply with a Corps' request for storage at Brownlee reservoir equivalent to a maximum draft rate without spill of 3 feet per day over a 2- or 3-day period, not to exceed a total of 9 feet, for the months of December and January only.
CTUIR-8, NPT-6	Flood control	Idaho Power, in consultation and collaboration with the Corps, other appropriate agencies, and interested tribes, should revise flood control operations so as to shift a minimum of 110,000 acre-feet in flood control space from Brownlee reservoir to Lake Roosevelt reservoir in March-through-May period during low to average flow years, defined as water years when the January-through-July unregulated runoff is less than or equal to 28 million acre-feet at Lower Granite dam.
NMFS-18	Flood control	Idaho Power should provide shifts in flood control from Brownlee reservoir to Grand Coulee reservoir if requested by the Corps based on a determination that flood control will not be compromised. The Corps would determine the appropriate timing and amount of flood control space to accommodate the shift.
NMFS-8	Flow augmentation	Idaho Power should refill Brownlee reservoir to within 1 foot of the April 15 and April 30 minimum elevations necessary to meet the Corps' flood control requirements. After April 30, Idaho Power should coordinate the refill of Brownlee reservoir with NMFS to ensure that the refill of Brownlee reservoir does not result in any drastic reductions of spring flows as measured at Lower Granite dam.
NMFS-9	Flow augmentation	Idaho Power should refill Brownlee reservoir to full pool (elevation 2077 feet msl) by June 20 of each year, unless otherwise initially agreed to by NMFS, and subsequently agreed to by the Commission. Idaho Power should, to enhance migration conditions for juvenile fall Chinook salmon, release 237 kaf (1,000 cfs) of stored water from Brownlee reservoir (draft to elevation 2,059 feet msl) between June 21 and July 31. Idaho Power should release at least 150 kaf (draft to elevation 2,066 feet msl) of this water no later than July 15 of each year, but may maintain Brownlee elevations through the three-day Fourth of July weekend to enhance recreational use of the reservoir. Idaho Power should not refill Brownlee reservoir at any time between June 21 and August 31. Deviations from these operations may be allowed with the written consent of NMFS and subsequent approval by the Commission, or in emergency situations (e.g., regional energy related emergency or the need to protect human life).

Recommending Entity[a]	Recommendation Category	Recommendation
CTUIR-9	Flow augmentation/ fall Chinook flow program	Idaho Power, in consultation with tribal, state, and federal fisheries agencies, should investigate and implement actions to make the most efficient use of Brownlee reservoir storage to meet anadromous fish needs on an annual basis. Specifically, Idaho Power should: (1) manage Brownlee operations to draft Brownlee reservoir by May 15 for spring flows; (2) refill Brownlee reservoir by June 15 to elevation 2077 feet msl for summer flow storage for fish flows and pass remaining inflows during this period; and (3) draft Brownlee reservoir for summer flow augmentation by August 1 and then refill to a level necessary to provide minimum flows of 9,000 cfs for fall Chinook spawning and incubation downstream of the project. Such Brownlee reservoir operations should be managed annually based on a sliding scale determined by the National Weather Service's January to July runoff forecast at Lower Granite dam to provide flow augmentation for downstream anadromous fish spawning, incubation, rearing, and migration.
NPT-7	Flow augmentation/ fall Chinook flow program	Idaho Power, in consultation with state and federal fisheries agencies and tribes, should investigate and make the most efficient use of Brownlee storage to meet anadromous fish needs on an annual basis. Specifically, Idaho Power should (1) manage Brownlee reservoir operations to draft Brownlee reservoir by May 15 for spring flows; (2) refill Brownlee reservoir by June 15 to elevation 2077 feet msl for summer flow storage for fish flows and pass remaining inflows during this period; and (3) draft Brownlee for summer flow augmentation by August 1 and then refill to a level necessary to provide minimum flow of 8,500 cfs for fall Chinook spawning and incubation downstream of the project. These Brownlee reservoir operations should be managed annually based on a sliding scale determined by the National Weather Services' January-to-July runoff forecast at Lower Granite dam to provide flow augmentation for downstream anadromous fish spawning, incubation, rearing, and migration.
CTUIR-7, NPT-5	Flow augmentation	Idaho Power should maintain Brownlee reservoir at its upper flood control rule curve elevation from February 28 through April 15 each year so as to accrue additional storage to assist in meeting spring target flows for anadromous fish required by Biological Opinions for the Federal Columbia River Power System. The new license should reflect the modified flood control requirements in the most recent Corps' review of flood control and should allow for future modification of flood control requirements as determined by subsequent flood control reviews and the ongoing effects of global warming and climate change.

Recommending Entity[a]	Recommendation Category	Recommendation
AR/IRU-22	Flow augmentation/ shaping	Idaho Power should pass and shape flushing flows to aid anadromous fish outmigration. This includes the following measures: 1. Cooperate with BOR in leasing water rights for flow augmentation purposes. 2. Timely pass all upper Snake River water through the project to provide benefits to fisheries resources downstream of the project. Such pass through should take place in consultation with and subject to the approval of the appropriate tribes and state and federal agencies. 3. Use best efforts to hold Brownlee reservoir at or near full elevation through June 20, and, thereafter, draft Brownlee reservoir to elevation 2059 feet msl, releasing up to 237,000 acre-feet by August 7. 4. Cooperate with the BOR in shaping BOR storage water releases from upstream of Milner dam that cannot be delivered to Brownlee reservoir by August 31 by releasing up to 100,000 acre-feet of storage water from Brownlee reservoir from June 21 to August 31.
ODFW-32	Flow augmentation/ shaping	Idaho Power should cooperate with the BOR in leasing water rights, funded by the BOR, for flow augmentation purposes. Idaho Power should also make appropriate arrangements for passing of BOR flow augmentation water through the project. Idaho Power should shape BOR flow augmentation storage water releases from upstream of Milner dam that cannot be delivered to Brownlee reservoir by August 31, by releasing up to 100 kaf of storage water from Brownlee reservoir from June 21 to August 31 and refilling Brownlee reservoir with an equivalent amount of BOR water released for flow augmentation when that water reaches Brownlee reservoir. Idaho Power should attempt to hold Brownlee reservoir full through July 4 and thereafter coordinate releases from Brownlee reservoir, up to 237 kaf, by August 7. Idaho Power should consult with the Corps for a Brownlee reservoir target refill date of June 20, once the project is released from flood control requirements.
CTUIR-6	Flow shaping	Idaho Power should timely pass all Upper Snake River water through the project to provide benefits to fisheries resources downstream of the project, in consultation with, and subject to the approval of, the Umatilla Tribes and other appropriate tribes and state and federal agencies.
Interior-22	Flow shaping	Idaho Power should pass BOR flow augmentation water releases that reach Brownlee reservoir prior to August 29 (which assumes a 2-day routing time to Lower Granite reservoir) and shape all BOR flow augmentation water releases that do not reach Brownlee reservoir prior to August 29 (which assumes a 2-day routing time to Lower Granite reservoir).
NPT-2	Flow shaping	Idaho Power should provide timely pass through of all water released from BOR reservoirs for flow augmentation for salmon downstream of the Hells Canyon Complex (up to 427,000 acre-feet) and all natural flow rights acquired (up to 60,000 acre-feet) in the upper Snake River water through the Hells Canyon Complex by August 31 of each year. If any portion of the upper Snake River water dedicated for flow augmentation for salmon downstream of the Hells Canyon Complex in any given year is not passed through the Hells Canyon Complex, Idaho Power should release the amount not delivered in July.

Recommending Entity[a]	Recommendation Category	Recommendation
Interior-26	Recreation	Idaho Power, to the maximum extent practical, should maximize use of recreation access sites by holding Brownlee reservoir, at or near full elevation (approximately 2,077 feet msl) through June 20. The flow augmentation draft from Brownlee should stop during the Fourth of July holiday or begin after the Fourth of July holiday, if at all possible.
ODFW-51	Warmwater fish spawning	Idaho Power should operate the project for a Brownlee reservoir target refill date of June 30. Beginning on May 21, a 30-day period should be protected, during which time Brownlee reservoir should not be drafted more than 1 foot from the highest elevation reached during the 30-day period. From the end of the 30-day period through July 4, the Brownlee reservoir may be drafted more than 1 foot, but an elevation of at least 2,069 feet above mean sea level should be maintained through July 4, unless initiation of flow augmentation occurs before July 4.
NMFS-1	Fall Chinook flow program	Idaho Power should provide stable flows (i.e., no load following) downstream of Hells Canyon dam of between 8,500 and 13,500 cfs (dependent upon runoff forecasts) throughout the spawning season to ensure that spawning fall Chinook salmon redds are created at elevations that are protected during the winter peak load period. These flow restrictions should commence after the weekly spawning surveys in early October indicate that fall Chinook salmon are spawning between RM 146.8 (head of Lower Granite reservoir) and RM 247.6 (Hells Canyon dam) and continue until spawning surveys indicate that spawning is complete (typically early December). Idaho Power should monitor redds weekly and coordinate redd monitoring and project operations with NMFS and FWS to ensure that this operation remains effective for fish protection for the duration of the new license.
NMFS-2	Fall Chinook flow program	Idaho Power should provide instantaneous minimum flows downstream of Hells Canyon dam that are equal to or greater than the stable flows provided during the preceding fall Chinook salmon spawning period throughout the incubation period to protect fall Chinook salmon redds, unless NMFS agrees that shallow water redds, as identified by weekly spawning surveys and ground truthing, can be fully protected with a lower minimum flow. These flow restrictions should commence after weekly spawning surveys indicate that fall Chinook salmon spawning is complete (typically by early December) and continue through the winter and spring until the end of fry emergence, typically mid- to late May in the upper Hells Canyon reach. Idaho Power should coordinate redd monitoring and project operations with NMFS and FWS to ensure that this operation remains effective for the duration of the new license.
NPT-1	Fall Chinook flow program	Idaho Power should continue its fall Chinook flow program operation over the term of the license. This includes providing stable flows between 8,500 cfs and 13,000 cfs from Hells Canyon dam during the fall Chinook spawning period (October 1 through December 31) to protect redds from becoming dewatered. During the spawning season, Idaho Power should monitor the shallowest redds to ensure they do not become dewatered. In the event that spawning flows need to be altered, Idaho Power should report to tribal, federal, and state fisheries managers of any operational change necessary to protect redds.

Recommending Entity[a]	Recommendation Category	Recommendation
CTUIR-14, NPT-14	Flow augmentation	Idaho Power should maintain a minimum flow of 6,500 cfs immediately downstream of Hells Canyon dam and 13,000 cfs at Lime Point.
Corps-3, NPPVA-1	Navigation	Idaho Power should operate the project in the interest of navigation to maintain the following flow targets continuously throughout the year: (1) an instantaneous minimum of 8,500 cfs upstream of the mouth of the Salmon River, as measured at the Hells Canyon dam gaging station (RM 247.0); and (2) an instantaneous minimum of 11,500 cfs downstream of the mouth of the Salmon River as measured at the Snake River below McDuff Rapids gaging station (RM 175.5). If daily inflows into Brownlee reservoir drop below 8,500 cfs, Idaho Power should not be required to meet these minimum flows. When the 3-day moving average for Brownlee reservoir inflow is less than 8,500 cfs, the instantaneous minimum release required from Hells Canyon dam for the current day will be equal to the previous 3-day moving average for Brownlee reservoir inflow. When the 3-day moving average for Brownlee reservoir inflow is less than 8,500 cfs between July 1 and September 30, Idaho Power can seek a temporary variance from the Corps for the flow requirements.
FS-29	Navigation	Idaho Power should maintain a year-round minimum flow downstream of Hells Canyon dam of 8,500 cfs or project inflow (whichever is less) to provide for safe navigation for the duration of the license.
Interior-43	Oxbow minimum flows	Idaho Power should provide a conservation flow in the Oxbow bypass reach sufficient to meet state water quality standards and life history requirements for bull trout. The determination of the flow should employ state-of-the-art methodologies to determine the duration, timing, and quantity of the flow necessary to protect bull trout and provide for the movement, foraging, and rearing of adult and sub-adult bull trout in the Oxbow bypass reach between Hells Canyon reservoir and Oxbow dam, including unrestricted access to Pine and Indian creeks.
Interior-63	Oxbow minimum flows	Idaho Power should provide adequate flows and oxygen supplementation to maintain water quality parameters in the Oxbow bypass reach.
NMFS-15	Flow measurement location	Idaho Power should measure flows and ramping rates (stage height) within 1 mile downstream of Hells Canyon dam, or at the first location downstream where consistent and accurate information can be collected. At a minimum, this information should be collected at 15-minute intervals. Idaho Power should provide access to this information (both "real-time" and historical information) via the Internet.
FS-30	Ramping rate adaptive management plan	Implement a 12-year adaptive management plan to determine ramping rates based on monitoring sequential modification of: (1) the minimum flow monitoring location; (2) DO augmentation; and (3) seasonal run-of-river operation.

Recommending Entity[a]	Recommendation Category	Recommendation
Interior-66	Ramping rate adaptive management plan	Idaho Power should work with FWS to determine what operations support conservation of aquatic species downstream of the Hells Canyon dam. Toward that objective, Idaho Power should modify the operation of Hells Canyon dam to include experimental periods of various operating regimes and seasonal enhancement of DO, while assessing the effects of these changes on the lotic ecosystem and sensitive species in the Snake River of Hells Canyon. Idaho Power should, in cooperation with FWS, design and conduct monitoring programs for selected species and ecosystem processes under the current peak-loading mode of operation. Operations would be modified sequentially to assess changes in the benthic community and aquatic habitats in the Snake River downstream of Hells Canyon dam. Study design would be based on an adaptive approach where study results of the first scenario provide the basis for whether and how to evaluate the next operational scenario.
AR/IRU-25	Ramping rates	Idaho Power, in coordination with a Technical Advisory Committee, should identify and implement restrictions on a range of changes in daily maximum discharge to protect biological and other resource values in the Snake River downstream of Hells Canyon dam. The studies should be designed and evaluated by the Technical Advisory Committee. Based on the study results and the recommendation of the Technical Advisory Committee, Idaho Power should modify project operations with respect to maximum daily change in discharge at Hells Canyon dam to provide an optimal range of benefits and effects across resource values.
Corps-6	Ramping rates	The maximum variation in river stage should not exceed 1 foot per hour as measured at the Snake River at Johnson Bar gaging station (RM 230).
NPT-4	Ramping rates/effects on fish migration through Lower Granite reservoir due to Seiche (wave effect on velocities)	If flows at Lower Granite dam fall below 30,000 cfs at anytime during the juvenile fall Chinook salmon outmigration through Lower Granite dam, including fall Chinook salmon outmigrating from Clearwater River, Idaho Power should minimize ramping rates to 2 inches per hour to prevent flow fluctuations from backflow effects caused by power peaking.
AR/IRU-24	Ramping rates/fish stranding	Idaho Power, in coordination with the Technical Advisory Committee, should identify and implement a minimum flow that maintains connection to main river flow for most of the important entrapment pools identified in Idaho Power's analysis. This flow would be implemented during the fall Chinook rearing/outmigration period, which extends from late winter into the early summer.
CTUIR-10	Ramping rates/fish stranding	Idaho Power, in consultation with tribal, state, and federal fish and wildlife agencies, should restrict load following (i.e., "power peaking") during fall Chinook spawning and emergence and early rearing and when flows reach 30,000 cfs and below at Lower Granite dam. Flow fluctuations (ramping rate) from the project during these periods should vary by no more than 2 inches per hour. Idaho Power, in consultation with tribal, state, and federal fish and wildlife agencies, should establish critical flow levels for the protection of juvenile fall Chinook salmon downstream of the project to protect them from stranding and entrapment.

Recommending Entity[a]	Recommendation Category	Recommendation
AR/IRU-23	Ramping rates/fish stranding/measurement location	Idaho Power should operate under the following requirements for ramping rates in the Snake River downstream of Hells Canyon dam: 1. From October 20 to December 7, Idaho Power should continue the fall Chinook flow program (no ramping). 2. From December 8 to October 19, ramping rates should vary by no more than 2 inches per hour. 3. From March 1 to May 31, Idaho Power should monitor and identify potential stranding sites in the Snake River downstream of the project to the confluence with the Salmon River and operate the project, and/or take such other measures as may be necessary, to minimize the potential for stranding of juvenile fall Chinook salmon. Idaho Power should work with the Technical Advisory Committee to craft and implement operations to minimize stranding, including identifying and implementing minimum flows. 4. Ramping rate compliance should be measured at Hells Canyon dam, rather than 17.6 miles downstream at Johnson Bar. 5. Idaho Power, in cooperation with the Technical Advisory Committee, should develop and implement a monitoring and reporting protocol.
ODFW-33	Ramping rates/flow measurement location	Idaho Power should implement the ramping rates and minimum flows as described below. The ramping rate should be enforced below each of the three dams and apply to load following operations, as well as to project start-up and planned project shutdowns. – From December 12 through March 20, Idaho Power should use a 6-inches-per-hour ramping rate. – From March 21 through June 21, Idaho Power should use a ramping rate of 4 inches per hour and maintain a minimum flow of 11,500 cfs. – From June 22 through September 30, Idaho Power should use a 6-inches-per-hour ramping rate with a 10,000 cfs daily flow change limit. – From October 1 through October 20, Idaho Power should use a 6-inches-per-hour ramping rate. – From October 21 through December 11, Idaho Power should implement the fall Chinook flow program including no ramping. – Idaho Power should measure compliance of project operations within 1 mile of Hells Canyon dam.

Recommending Entity[a]	Recommendation Category	Recommendation
NMFS-6	Ramping rates/stranding	Idaho Power should release flows sufficient to ensure that the largest juvenile entrapment areas are reconnected with the mainstem Snake River for at least 2 hours on a daily basis, to the extent that spring flow conditions allow. In addition, when the daily average temperature in any entrapment pool exceeds 16°C for more than 3 days or when peak water temperatures in any entrapment pool exceed 18°C for more than 4 hours, Idaho Power should release stable flows of at least 11,500 cfs (unless otherwise agreed to by NMFS, and subsequently by the Commission) through the remainder of the rearing period to ensure that fish in the largest entrapment pools can readily move to the main river channel and avoid these stressful temperatures. These measures may be modified after NMFS initially approves, and the Commission subsequently approves, new operations to protect juvenile fall Chinook salmon rearing in shallow water areas downstream of the project.
NPT-3	Ramping rates/stranding	During fall Chinook rearing (April to May), Idaho Power should limit load following operations to no more than 2 inches per hour to minimize or eliminate stranding and entrapment by project operations. Idaho Power should monitor the formation of entrapment pools under this operation and if the sites form, and stranding occurs under the 2-inches-per-hour ramping rate operation, Idaho Power should reconnect the entrapment sites to the river channel twice in a 24-hour period through releases of water at Hells Canyon dam.

Notes: AR/IRU – American Rivers and Idaho Rivers United
BOR – Bureau of Reclamation
cfs – cubic feet per second
C – Celsius
Corps – U.S. Army Corps of Engineers
CTUIR – Confederated Tribes of the Umatilla Indian Reservation
DO – dissolved oxygen
FS – U.S. Forest Service
FWS – U.S. Fish and Wildlife Service
Interior – U.S. Department of the Interior
kaf – thousand acre-feet
msl – mean sea level
NMFS – National Marine Fisheries Service
NPPVA – Northwest Professional Power Vessel Association
NPT – Nez Perce Tribe
ODFW – Oregon Department of Fish and Wildlife
RM – river mile

[a] Appendix A provides a crosswalk between the alpha-numeric identifiers used throughout the EIS and the identifying numbers used by the recommending parties to identify their terms, conditions, recommendations, and prescriptions.

At the direction of Commission staff, Idaho Power simulated a set of operational scenarios, upon which the staff relied in assessing the effects of the various operation-related recommendations. We developed these scenarios based on our evaluation of comments received during the scoping process. In this final EIS, we make use of 3 alternative operational scenarios, which are as follows:

- **Scenario 1, Stabilized Hells Canyon Release**—This scenario uses the Hells Canyon reservoir to reregulate the load-following operations of the two upstream developments, thereby stabilizing the project's downstream releases. Operational flexibility to meet fluctuating load demands would be maintained at the Brownlee and Oxbow developments. We examine a range of potential downstream release stabilization levels under this scenario:
    - (a) instantaneous outflow from Hells Canyon dam equals the average inflow to the Hells Canyon reservoir during the previous 24 hours;
    - (b) maximum ramping rate of 2 inches per hour (year-round) with compliance measured at the Hells Canyon gage, located 0.6 mile downstream of Hells Canyon dam; and
    - (c) maximum ramping rate of 6 inches per hour (year-round) with compliance measured at the Hells Canyon gage, located 0.6 mile downstream of Hells Canyon dam.
- **Scenario 2, Flow Augmentation with Stabilized Release**—This scenario involves the augmentation of downstream flows using 350,000 acre-feet of Brownlee reservoir storage between June 21 and July 31 each year. The intent of this scenario is to improve anadromous fish smolt outmigration in the lower Snake River. The Brownlee reservoir target elevation would be 2,049 feet msl, and no additional water would be stored (i.e., the water surface elevation would not be raised) prior to August 31. This scenario also includes a maximum ramping rate of 2 inches per hour from March 1 through May 31) with compliance measured at the Hells Canyon gage, located 0.6 mile downstream of Hells Canyon dam. [37]
- **Scenario 3, Navigation Target Flow**—Under this scenario, Idaho Power would operate the project to maintain downstream flow targets helpful to boating. It includes: (1) an instantaneous year-round minimum flow of 8,500 cfs above the mouth of the Salmon River measured at RM 247.0, and (2) an instantaneous year-round minimum flow of 11,500 cfs downstream of the mouth of the Salmon River measured at RM 175.5. When daily flows into Brownlee reservoir drop below 8,500 cfs, the instantaneous minimum release required from Hells Canyon dam for the current day would equal the previous 3-day moving average for Brownlee reservoir inflow. At all times, the maximum variation in river stage at RM 230 would not exceed 1 foot per hour.

For further detail on how these operating scenarios were specified for evaluation purposes, refer to appendix D.

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[37] In response to our additional information request, Idaho Power submitted three related scenarios to the Commission on March 30, 2007. Scenario 7 evaluates the effect of a maximum ramping rate of 4 inches per hour from March 15 through June 15 with compliance measured at Johnson Bar. Scenario 8 evaluates the effect of downstream flow augmentation using 237,000 acre-feet of Brownlee reservoir storage. Scenario 9 combines scenarios 7 and 8. Idaho Power filed revisions to this response on April 25, 2007. The information provided by Idaho Power was primarily related to economic effects; water resources effects would be expected to follow trends similar to earlier scenarios. See appendix D for a description of all scenarios.

3.3.2.3 Flood Storage

Starting in January and through the spring, Brownlee reservoir is operated under the direction of the Corps to provide storage space for springtime flood waters. The Corps recommends that Brownlee reservoir continue to be operated in accordance with the Corps' November 1998 *Procedure for Determining Flood Control Draft at Brownlee Reservoir* (table 9, recommendation Corps-1), which requires a drawdown sufficient to provide up to 1 million acre-feet of flood storage. In addition, the Corps recommends handling winter flood control operations on a case-by-case basis, subject to certain specified maximum draft rates (table 9, Corps-2). Idaho Power's Proposed Operations incorporates these two recommendations from the Corps. The only effect relative to current operations would be occasional drawdown associated with the winter flood control operation. When requested by the Corps, Idaho Power would draft Brownlee reservoir to create flood storage. The maximum draft rate would be 3 feet per day over a 2- or 3-day period, not to exceed a total of 9 feet. This request would occur only during the months of December and January, and Idaho Power would not be required to spill to meet the Corps request. During these months, Brownlee is normally at, or near, full reservoir level (2077 feet msl). The drawdown, when requested, would lower the reservoir up to 9 feet. There are no competing reservoir uses at this time of year that would be affected by this occasional mid-winter drawdown.

NMFS (table 9, NMFS-8) recommends that Idaho Power control the level of Brownlee reservoir so as to be within 1 foot of the Corps' April 15 and April 30 target flood control elevations and then, after April 30, coordinate the refill of Brownlee reservoir with NMFS to ensure that the refill does not result in any drastic reductions of spring flows as measured at Lower Granite dam. Similarly, the Umatilla Tribes and the Nez Perce Tribe (table 9, CTUIR-7 and NPT-5, respectively) recommend that Idaho Power maintain Brownlee reservoir at its upper flood control rule curve elevation from February 28 through April 15 each year, so as to accrue additional storage to assist in meeting spring target flows for anadromous fish. The effect of these recommendations would be to somewhat limit Idaho Power's operational flexibility by requiring that Idaho Power not provide more storage capacity in Brownlee reservoir than that required by the Corps.

We address these recommendations and other recommendations that are directed at meeting spring and summer target flows for anadromous fish more fully in *Anadromous Fish Migration* in section 3.6.2.1, but we note here that a certain degree of operational flexibility is required by Idaho Power operators to ensure that the Corps' target flood control elevations are met. Further, during medium to high flow years, Brownlee reservoir is typically filling after April 30, capturing inflows as part of the springtime flood control operation. Under these circumstances, the Corps controls the rate of Brownlee reservoir's refill.

The Umatilla Tribes and the Nez Perce Tribe recommend that Idaho Power, in consultation with the Corps, interested tribes, and other appropriate agencies, revise flood control operations so as to shift a minimum of 110,000 acre-feet of flood storage space from Brownlee reservoir to Lake Roosevelt reservoir on the Columbia River in the March-through-May period during low to average flow years (table 9, CTUIR-8 and NPT-6). NMFS (table 9, NMFS-18) makes a similar recommendation but specifies that the timing and amount of the flood storage shift be determined by the Corps. In section 5.2.2.1, *Flood Storage*, we discuss the issue of agency jurisdiction over flood control operations.

3.3.2.4 Brownlee Reservoir Levels

Operational constraints imposed on the Hells Canyon Project result in substantial seasonal variation in modeled Brownlee reservoir levels. The modeled reservoir levels are also greatly affected by hydrologic conditions. Refer to figures 12 through 16 for simulated daily average Brownlee reservoir levels.

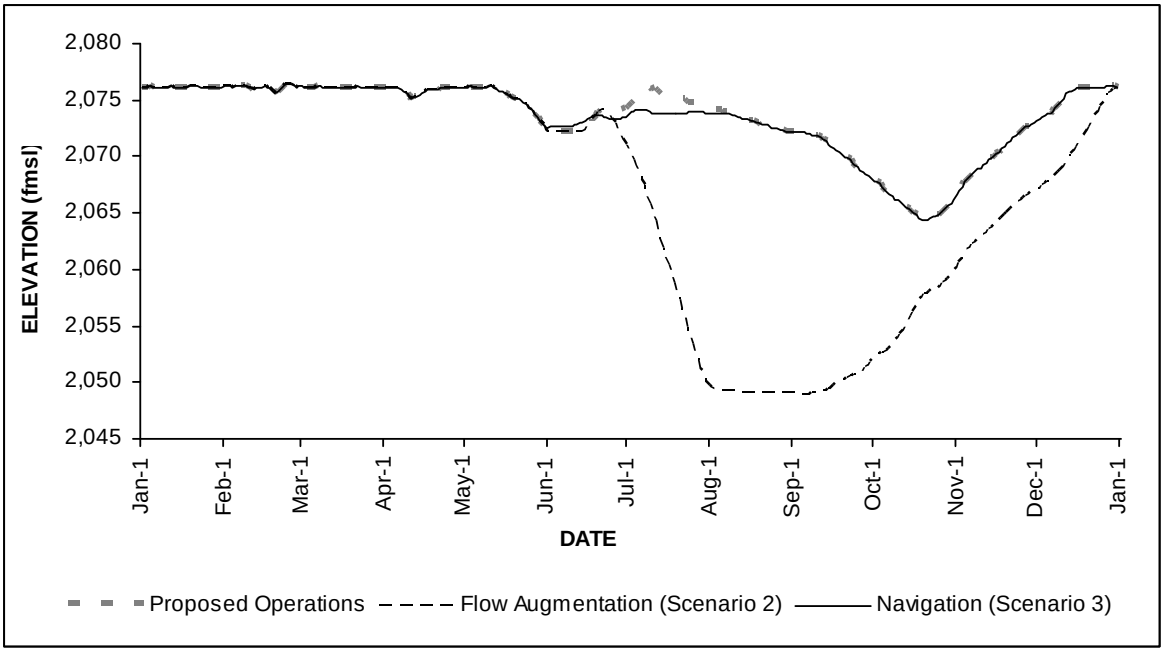
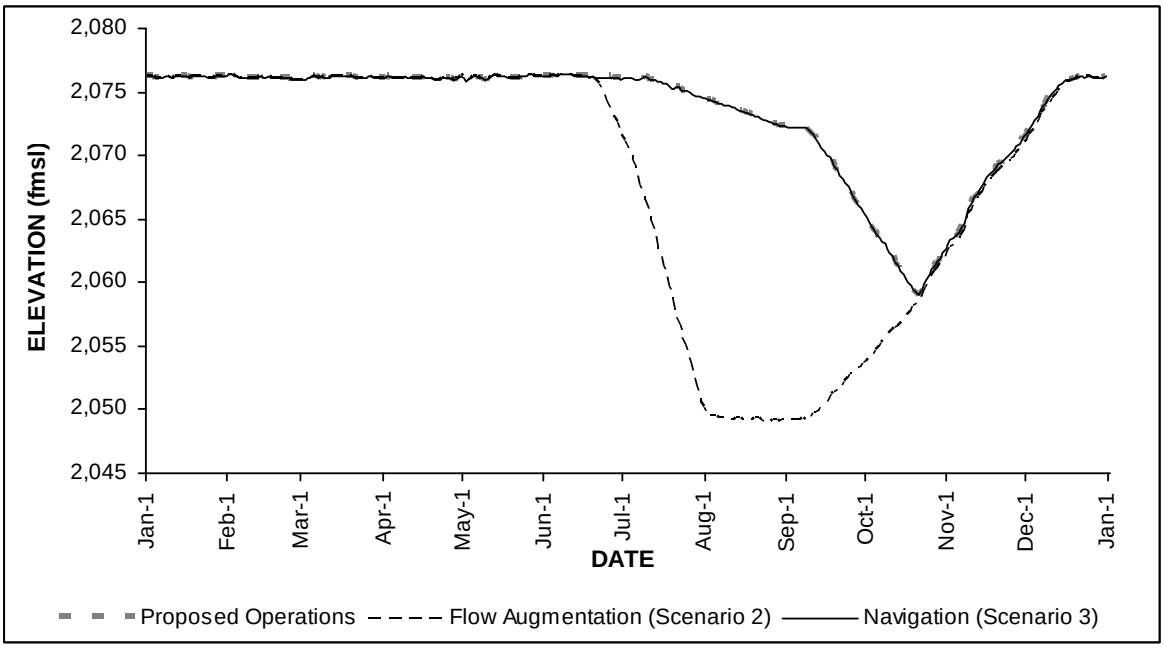


Figure 12. Simulated Brownlee reservoir levels for extremely low water conditions. (Source: Bowling and Whittaker, 2005, as modified by staff)



[a] Simulation based on 1994. Prior to issuance of the draft EIS, 1994 was identified as a representative medium-low flow year, based on analysis of the 1928 to 1999 flow record. However, Idaho Power's (2007a) subsequent analysis of the 1911 to 2005 flow record resulted in reclassifying 1994 to a low flow year.

Figure 13. Simulated Brownlee reservoir levels for medium-low water conditions.[a] (Source: Bowling and Whittaker, 2005, as modified by staff

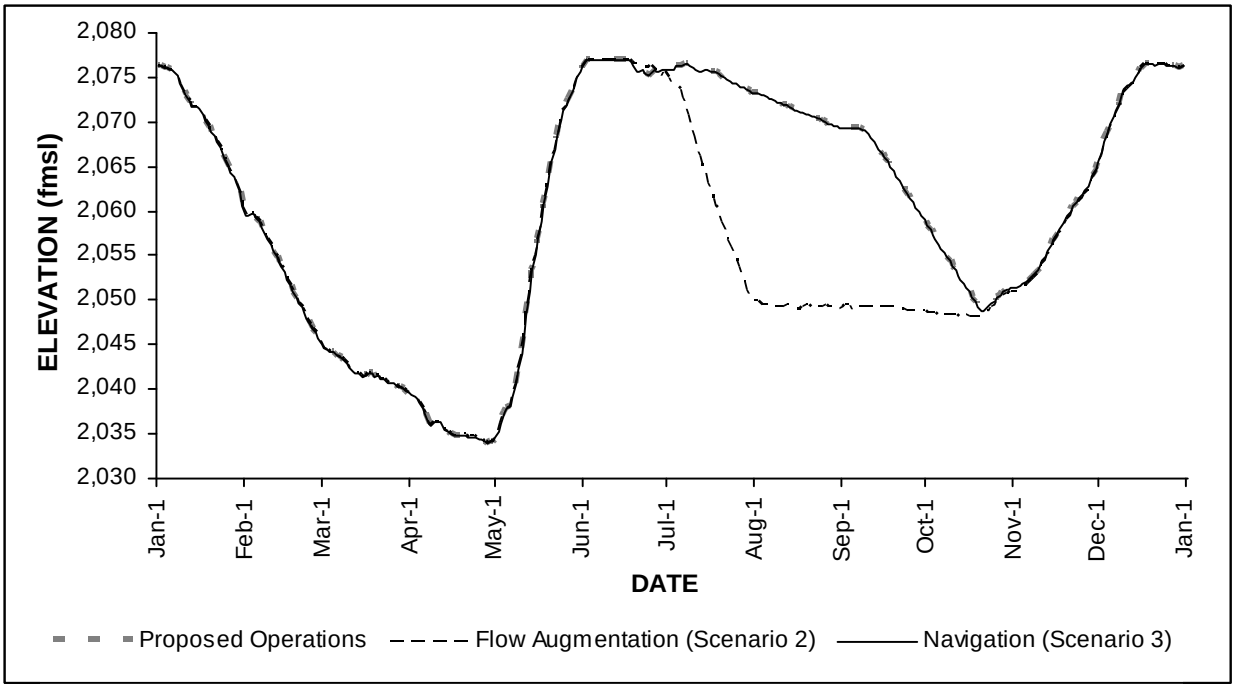


Figure 14. Simulated Brownlee reservoir levels for medium water conditions. (Source: Bowling and Whittaker, 2005, as modified by staff)

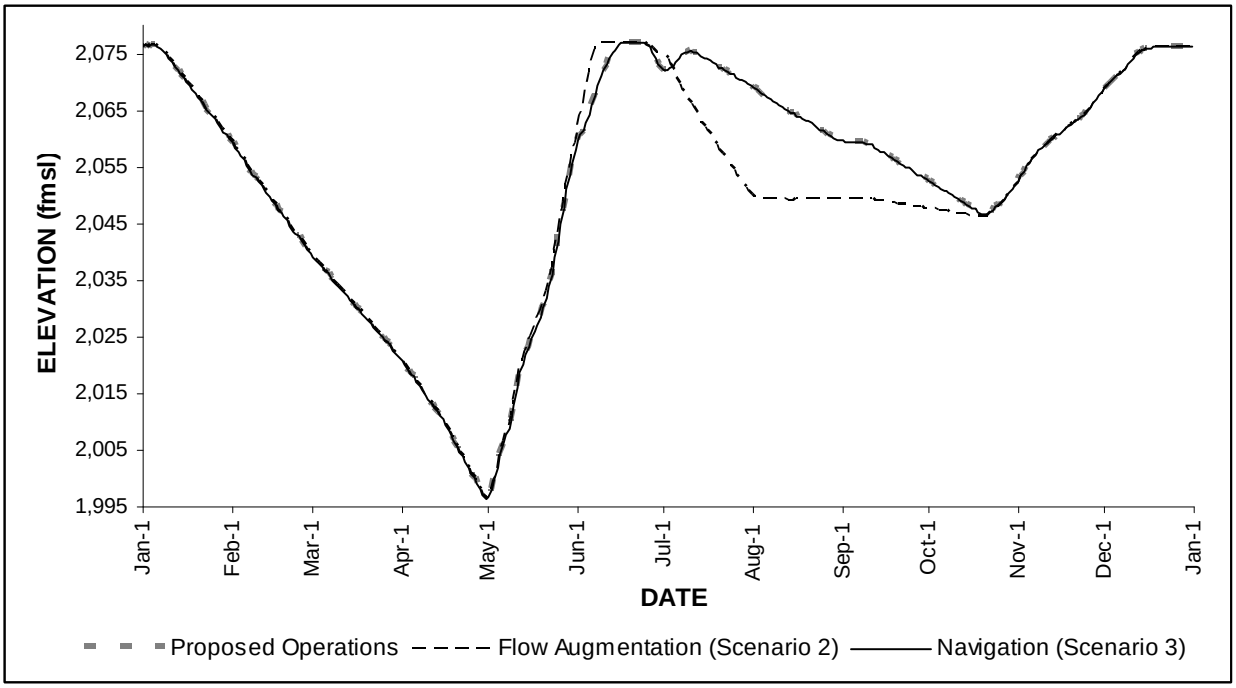


Figure 15. Simulated Brownlee reservoir levels for medium-high water conditions. (Source: Bowling and Whittaker, 2005, as modified by staff)

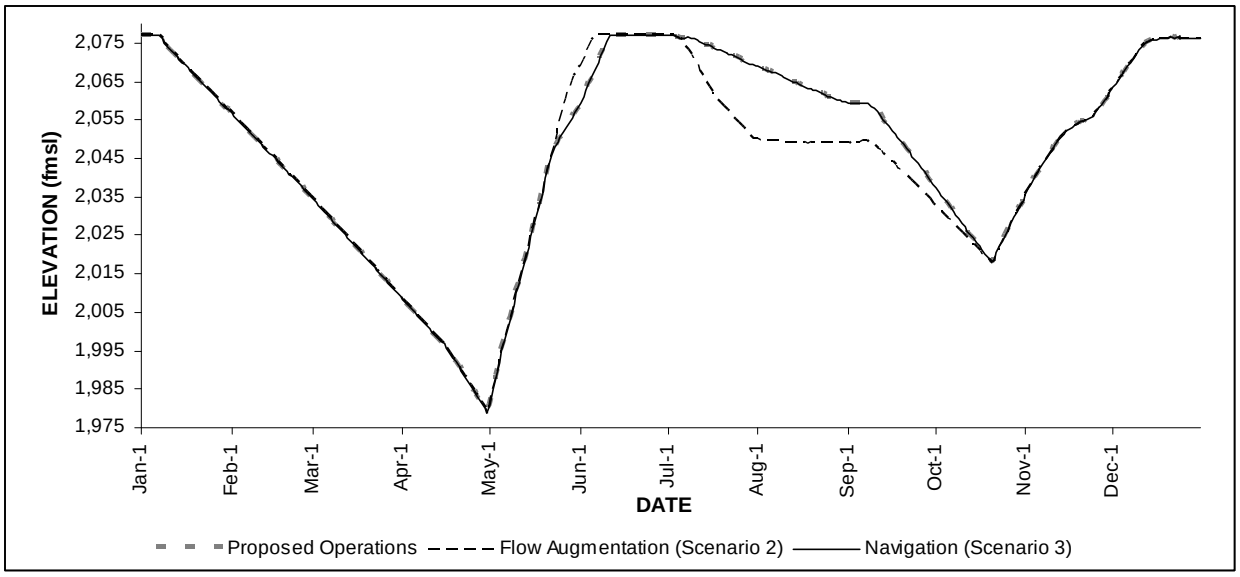


Figure 16. Simulated Brownlee reservoir levels for extremely high water conditions. (Source: Bowling and Whittaker, 2005, as modified by staff)

Under Idaho Power's Proposed Operations, the modeled Brownlee reservoir level in a medium hydrologic year (figure 14) begins to fall in early January as the reservoir is drafted to meet target elevations for flood storage purposes. The reservoir elevation falls from an elevation of 2,077 feet msl (full reservoir) in the first week of January to about 2,035 feet msl by April 30. Starting May 1, the reservoir begins to refill to reach a target elevation of 2,069 feet msl by the first week of June and is full by the latter part of June. Under medium-high or extremely high water conditions (figures 15 and 16), greater flood storage capacity is required and the April 30 reservoir level falls to about 2,000 feet and 1,980 feet, respectively. Under extremely low or medium-to-low water conditions (figures 12 and 13), the flood storage capacity of Brownlee reservoir is not needed, and the reservoir level remains at or near full through May.

After the Fourth of July holiday, under Idaho Power's Proposed Operations, modeled reservoir levels gradually fall as Idaho Power operates to meet system power needs during July and August. During late August and through September, under all hydrologic conditions, Idaho Power continues to draft Brownlee reservoir so as to be in a position to implement the fall Chinook flow program of stable downstream spawning flows. Beginning in mid-October and lasting through early December, Brownlee reservoir refills so as to maintain a constant outflow downstream of Hells Canyon dam. The reservoir returns to full by the first week of December under all modeled conditions and remains full until any flood control drawdown is again called for in early January.

Operational recommendations directed at flow augmentation and flow shaping have the greatest potential for affecting seasonal reservoir levels at Brownlee. For a listing of these recommendations, refer to table 9. Our Scenario 2, Flow Augmentation, (described above) is representative of the recommendations calling for flow augmentation and flow shaping, and we graphically display the effects of the Flow Augmentation Scenario on Brownlee reservoir levels in figures 12 through 16.

Under the Flow Augmentation Scenario, modeled Brownlee reservoir levels are unchanged during the first half of the year compared to Proposed Operations, since the Corps' flood control rule curve is common to both scenarios. Beginning in late June, however, the modeled reservoir levels differ substantially as the flow augmentation program is implemented. In all hydrologic year types, the Flow Augmentation Scenario results in an earlier and more rapid drafting of Brownlee reservoir. In the

medium water year, for example, the 2,050-foot-msl reservoir elevation is reached by the end of July under the Flow Augmentation Scenario, in contrast to mid-October for Proposed Operations (figure 14).

Operational recommendations related to navigation target flow levels also can affect Brownlee reservoir levels, but only under extremely low water conditions. Refer to table 9 for a listing of navigation-related recommendations. Our Scenario 3 (Navigation, described above) is consistent with the navigation recommendations (Corps-3, NPPVA-1, and FS-29).

For extremely low water conditions, modeled Brownlee reservoir levels during June and July under the Navigation Scenario differ from those under the Proposed Operations (figure 12). Whereas the reservoir refills under Proposed Operations as inflow spikes are captured and stored, under the Navigation Scenario most of the inflow spikes are passed through the project to meet the navigation target flows. As a result, little reservoir refill occurs. For the other hydrologic conditions, there are no distinguishable differences between these scenarios.

3.3.2.5 Oxbow and Hells Canyon Reservoir Levels

Under current conditions, both Oxbow and Hells Canyon reservoirs fluctuate within a 5-foot band from maximum reservoir levels year-round (section 3.3.1.1, *Surface Water*, above). Idaho Power's Proposed Operations would maintain this same regime under normal operating conditions, but would allow fluctuation up to 10 feet under certain atypical conditions. As defined by Idaho Power, atypical conditions would be conditions when Idaho Power determines that operation of the project (which operation may occur automatically or manually) is needed to: (1) protect the performance, integrity, reliability, or stability of Idaho Power's electrical system or any electrical system with which it is interconnected; (2) compensate for any unscheduled loss of generation; (3) provide generation during severe weather or extreme market conditions; (4) inspect, maintain, repair, replace, or improve Idaho Power's electrical systems or facilities related to the project; (5) prevent injury to people or damage to property; or (6) assist in search-and-rescue activities.

Commission licenses typically include a license article that allows departures from licensed operating procedures in circumstances involving potential harm to life or property. Idaho Power's proposed conditions for atypical operations include market factors, which go beyond the Commission's standard license article. Idaho Power has not specified the exact nature of these extreme market conditions nor has it explicitly modeled any such events in their CHEOPS simulations. Therefore, we cannot estimate the frequency of greater than normal reservoir drawdowns that would be associated with such market conditions.

None of the 40 operation-related recommendations made by the parties (table 9) are directed at the Oxbow and Hells Canyon reservoir levels, and Idaho Power's CHEOPS modeling shows little or no effect of the alternative operational scenarios on the levels of these reservoirs (refer to Idaho Power response to additional information request (AIR) OP-1(f), tables 1 through 117).

3.3.2.6 Project Outflows

Constraints on operation of the project affect the pattern of modeled outflows from the Hells Canyon dam. The pattern of modeled project outflows, in turn, has the potential for affecting sediment movement (section 3.4.2), aquatic resources (section 3.6.2), navigation (section 3.10.2), and other downstream resource values. Refer to figures 17 through 21 for Brownlee reservoir inflows and simulated daily average project outflows.

On a seasonal basis, under Proposed Operations, modeled outflows in a medium hydrologic year (figure 19) tend to exceed inflows during the late winter and early spring as the reservoir is being drawn down to create flood storage; be less than inflows after April 30 as the reservoir refills; closely match inflows from early June through mid-July; slightly exceed inflows from mid-July to early September;

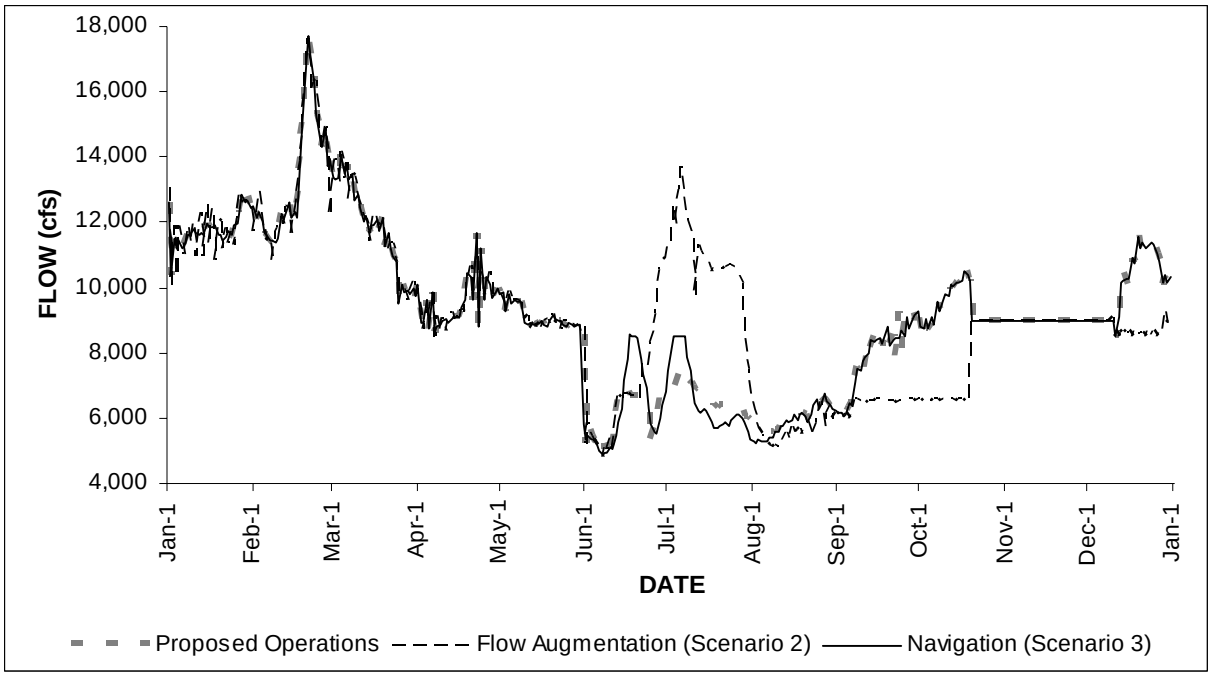
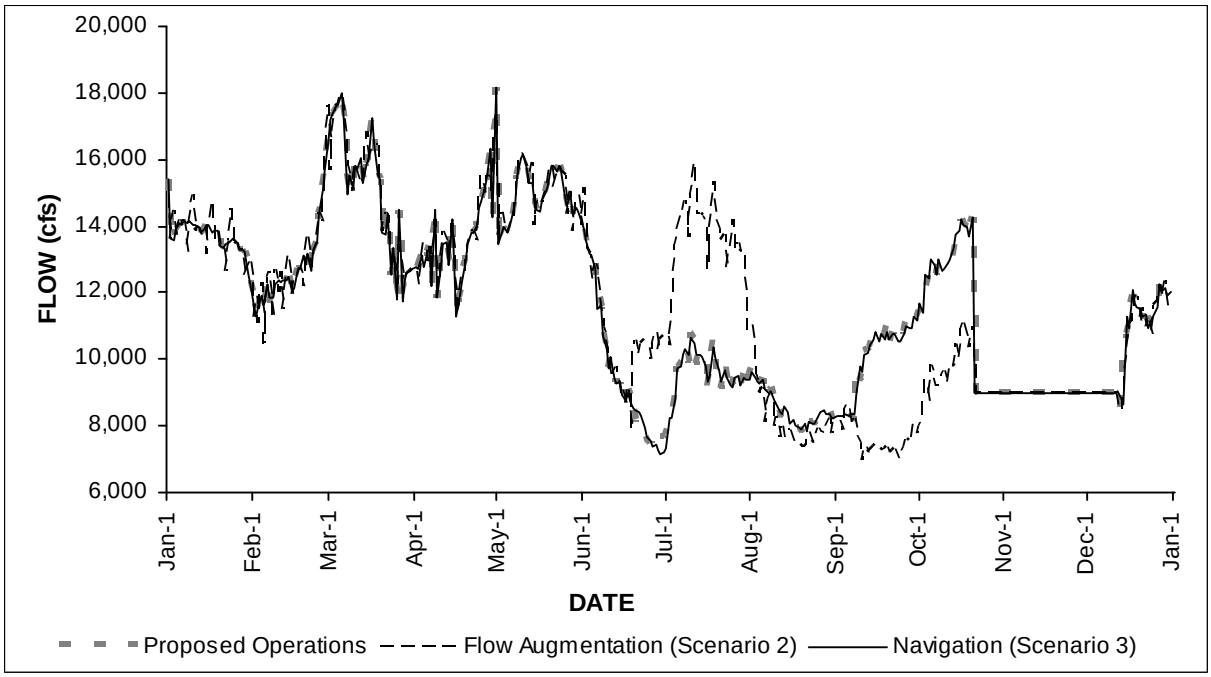


Figure 17. Simulated project outflows for extremely low water conditions. (Source: Bowling and Whittaker, 2005, as modified by staff)



[a] Simulation based on 1994. Prior to issuance of the draft EIS, 1994 was identified as a representative medium-low flow year, based on analysis of the 1928 to 1999 flow record. However, Idaho Power's (2007a) subsequent analysis of the 1911 to 2005 flow record resulted in reclassifying 1994 to a low flow year.

Figure 18. Simulated project outflows for medium-low water conditions.[a] (Source: Bowling and Whittaker, 2005, as modified by staff)

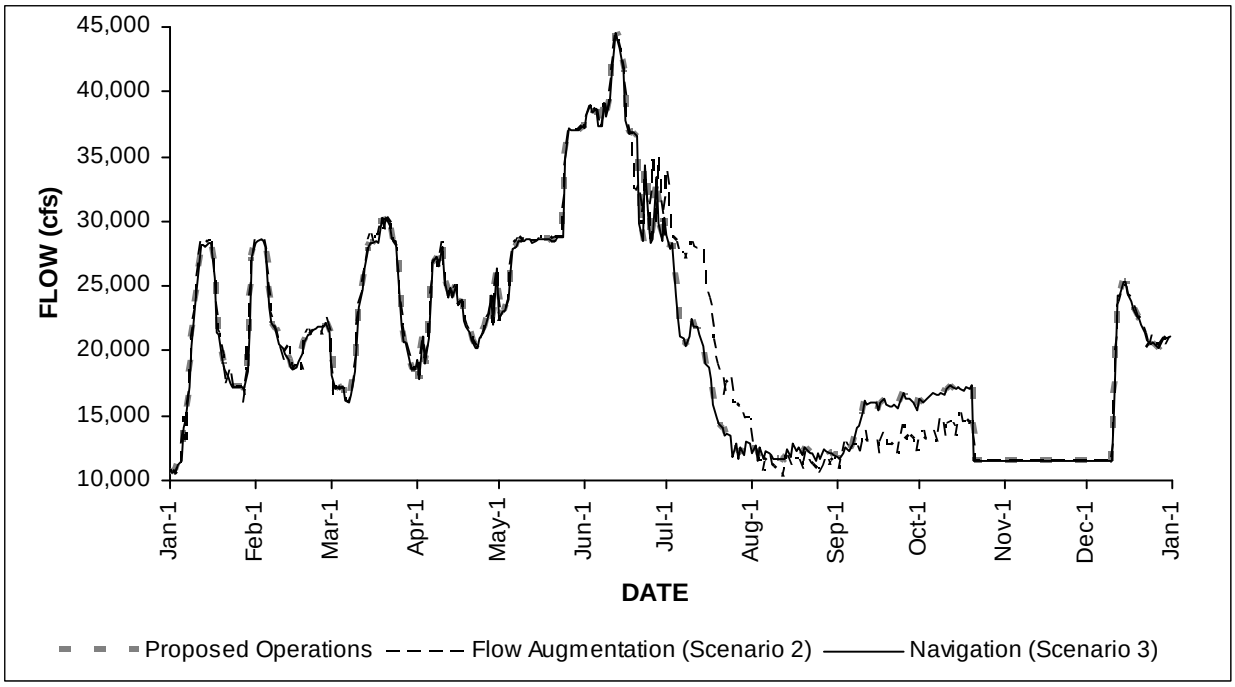


Figure 19. Simulated project outflows for medium water conditions. (Source: Bowling and Whittaker, 2005, as modified by staff)

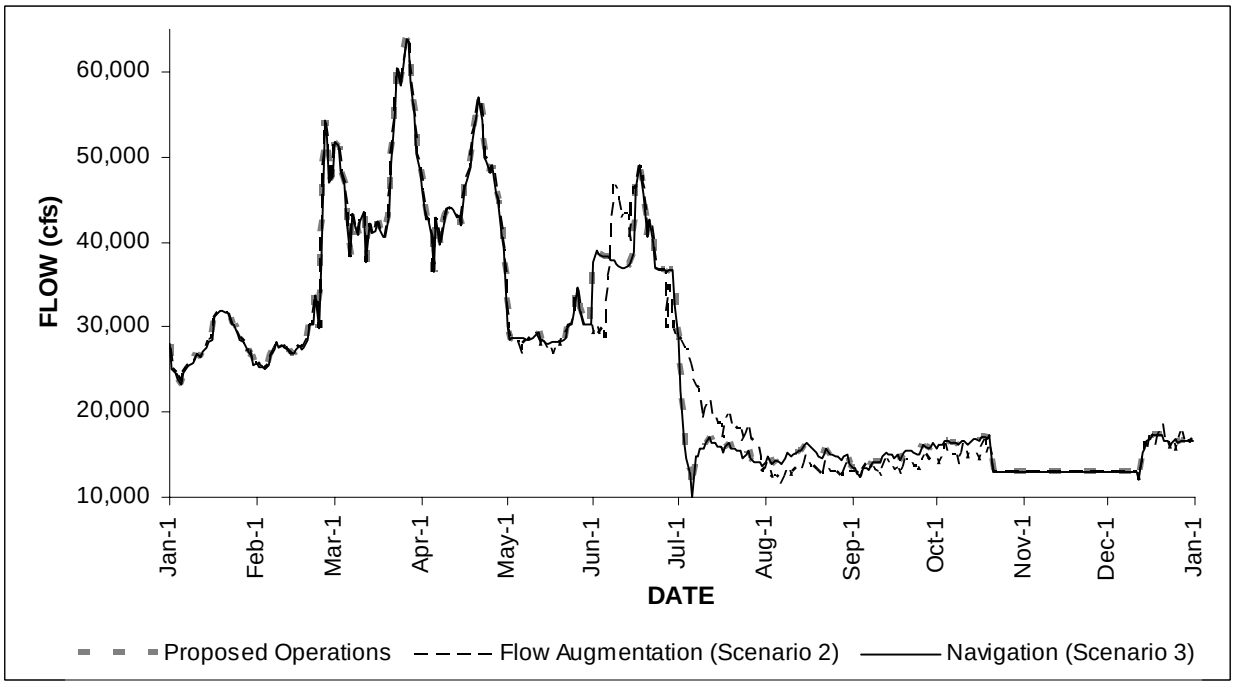


Figure 20. Simulated project outflows for medium-high water conditions. (Source: Bowling and Whittaker, 2005, as modified by staff)

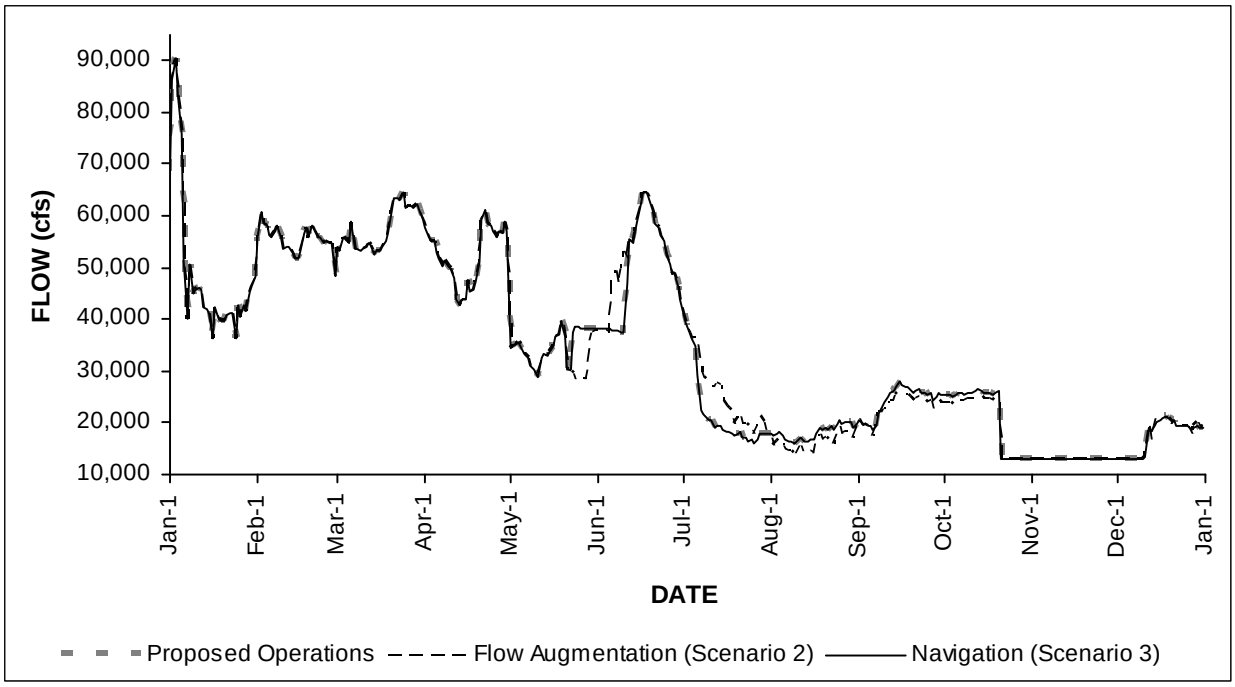


Figure 21. Simulated project outflows for extremely high water conditions. (Source: Bowling and Whittaker, 2005, as modified by staff)

appreciably exceed inflows from early September through mid-October; and then stabilize at levels below inflow during the fall Chinook salmon spawning period from mid-October to early December. The seasonal pattern is similar under other conditions, except in extremely low and medium-to-low water years when project outflows closely match inflows during the late winter and early spring because Brownlee reservoir is not being called upon to provide flood storage under these low-water conditions (figures 17, 18, 20, and 21).

Under Scenario 2 (Flow Augmentation), modeled project outflows differ from Proposed Operations during two periods (figure 19). The first is during July when project outflows exceed inflows as the project releases water for flow augmentation. The second is later in the year, from early September through mid-October, when outflows under the Flow Augmentation Scenario match inflows since Brownlee reservoir has already been drawn down due to the flow augmentation releases and no further drawdown is necessary to prepare for the fall Chinook flow program.

Under Scenario 3 (Navigation), project outflows differ from Proposed Operations during summer periods in low water conditions (figure 17). During June and July of the extremely low water year, for example, outflows rise coincident with spikes in Brownlee reservoir inflow because the Navigation Scenario calls for releasing water to meet the target whenever inflows to the project allow.

3.3.2.7 Downstream Flows Important to Navigation

Project operations affect minimum river flow levels in the Snake River downstream of Hells Canyon dam, which can affect the conditions under which boats can safely navigate this reach. Of particular importance for navigation are flows measured at the Hells Canyon dam gage and China Gardens Rapids gage (also known as the Snake River below McDuff Rapids gage; see figure 8). The latter gage is downstream of the confluence of the Snake and Salmon rivers. In the interest of navigation, the Corps identified 8,500 cfs downstream of Hells Canyon dam and 11,500 cfs downstream of the mouth of the Salmon River as minimum flow targets (Corps-3). We use the relative frequency of achieving these target levels to compare operational scenarios.

Under Proposed Operations, Idaho Power would continue to operate the project for navigation purposes by maintaining 13,000 cfs in the Snake River at Lime Point[38] at least 95 percent of the time. Flows of less than 13,000 cfs would be limited to the months of July, August, and September, and Idaho Power would not be required to use reservoir storage to meet the 13,000-cfs requirement. Idaho Power modeled this restriction for June 1 through October 20 by providing a 6,500-cfs release from the Hells Canyon dam, or project inflow if inflow was less than 6,500 cfs. The Umatilla and Nez Perce Tribes recommend that Idaho Power maintain a minimum flow of 6,500 cfs immediately downstream of Hells Canyon dam and 13,000 cfs at Lime Point (CTUIR-14 and NPT-14 in table 9). These tribes are concerned that higher minimum flows would jeopardize fish flows during low water years.

Under Proposed Operations and the 6,500-cfs minimum flow recommendations, modeled flows at the Hells Canyon dam gage routinely fall below the Corps' 8,500-cfs navigation target from early June through mid-October under the extremely low and medium-to-low water conditions. The causes of the lower flows are low inflow to Brownlee reservoir, power peaking operations at Hells Canyon dam, or a combination of the two. At the China Gardens Rapids gage, modeled flows for these low water conditions similarly fall below the 11,500-cfs target for much of the summer and fall period.[39] Under medium water conditions, modeled flows under Proposed Operations routinely fall below the navigation target for the Hells Canyon dam gage from late July through early September, while at China Gardens Rapids, Proposed Operations meet or exceed the target year-round. Modeled Proposed Operations flows below the targets occur only once for medium-to-high water conditions (a couple of days in early July at the Hells Canyon dam gage) and never for extremely high water conditions.

The Corps recommends that Idaho Power operate the project to maintain a year-round instantaneous minimum flow of 8,500 cfs, as measured at the Hells Canyon dam gage and 11,500 cfs as measured at the Snake River below McDuff Rapids (China Gardens Rapids) gage. If daily inflows to Brownlee reservoir fall below 8,500 cfs, however, Idaho Power would not have to meet these minimum flows. Instead, Idaho Power would be required to release from Hells Canyon dam a flow equal to the previous 3-day moving average Brownlee reservoir inflow. From July 1 through September 30, if the 3-day moving average Brownlee reservoir inflow drops below 8,500 cfs, Idaho Power could seek a temporary variance from the Corps for the flow requirements. NPPVA (NPPVA-1 from table 9) concurs with the Corps' recommendation. The Forest Service provides a similar recommendation for a year-round minimum flow downstream of Hells Canyon dam of 8,500 cfs, or project inflow (whichever is less), but does not include the opportunity for the variance (see table 9, FS-29). Scenario 3, Navigation, is representative of these recommendations.

Under the Navigation Scenario, the modeled flows meet the navigation target flows more frequently than under Idaho Power's Proposed Operations. In extremely low water conditions, the Navigation Scenario results in about 18 fewer days during the summer and fall when modeled flows measured at the Snake River at Hells Canyon gage fall below the 8,500-cfs target. For medium-to-low water conditions, there is a much reduced duration of flows below target; the duration of such flows decreases from longer than 4 months under Proposed Operations to about 6 weeks under the Navigation

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[38] Idaho Power does not explicitly propose 13,000 cfs at Lime Point, but this value is consistent with the flow releases from Hells Canyon dam assumed by Idaho Power for modeling purposes. In the absence of an explicit alternative proposal, we consider it part of Idaho Power's proposed operation. Idaho Power proposes that any navigation flow requirement for the Snake River reach from the Salmon River confluence to Lewiston be measured at McDuff Rapids (RM 175.5), 4 miles upstream of Lime Point.

[39] The observations in this subsection are based on staff's analysis of Idaho Power's response to AIR OP-1(c) (Bowling, 2005b).

Scenario. For modeled medium water conditions, below-target flows are eliminated, and the same is true for medium-to-high and extremely high water conditions.

Relative to Proposed Operations, the frequency with which navigation target flow levels are reached is also higher under the Flow Augmentation Scenario (350 kaf) because the augmented release during July for anadromous fish also improves Snake River navigation conditions. At the Hells Canyon dam gage, modeling shows about 25 fewer days below the 8,500-cfs target for extremely low water conditions, about 30 fewer days for medium-to-low conditions, and about 21 fewer days for medium water conditions[40].

3.3.2.8 Flow Fluctuations Downstream of Hells Canyon Dam

The extent of diurnal flow fluctuations downstream of the project can affect aquatic resources, riparian habitats, recreation usage, and other resource values. We briefly discuss flow fluctuations here, but assess their resource effects in the appropriate resource sections later in this final EIS. Refer to appendix E figures E-1 through E-15 for simulated river flows at 15-minute intervals at two locations: (1) immediately downstream of Hells Canyon dam; and (2) at Anatone, which is downstream of the confluence with the Grande Ronde River at RM 167.2.

Under Proposed Operations, Idaho Power would limit the daily range of the Hells Canyon dam release to 10,000 cfs from June 1 through September 30, and no load following would occur during late fall and early winter (approximately October 21 through December 11), in keeping with the fall Chinook flow program. Further, throughout the year, Idaho Power would continue to manage project releases to meet a 1-foot-per-hour ramping rate restriction at Johnson Bar. The effect of this operation is apparent in figures E-1, E-2, and E-3 in appendix E, for extremely low water conditions, medium water conditions, and extremely high water conditions, respectively. For extremely low water conditions, there is a substantial modeled flow fluctuation immediately downstream of Hells Canyon dam from mid-December through June, occasional periods of modest fluctuation during the summer, substantial fluctuation in the early fall, and no fluctuation during the fall Chinook salmon spawning period. For medium water conditions, the extent of flow fluctuation is similar, with two exceptions. The first is in the early summer when flows are sufficiently high that the project operates continually at full capacity. The second is during the late summer when there is sufficient flow to support a load following operation. For extremely high water conditions, there is substantially less modeled fluctuation because the project is running at full capacity for much of the year. The flow fluctuations farther downstream at Anatone (lower portion of each figure) mirror those at Hells Canyon dam, but are much reduced due to the inflow from tributaries entering the Snake River between the two locations.

The Stabilized Hells Canyon Release scenarios are specifically designed to reduce the extent of flow fluctuation. The model results for Scenario 1b (Year-round 2-Inches-Per-Hour Ramping Rate) and for Scenario 1c (Year-round 6-Inches-Per-Hour Ramping Rate) are displayed in figures E-4 through E-6 and in E-7 through E-9, respectively. These scenarios are representative of the various recommendations for ramping rate restrictions (see table 9). Both of these ramping rate restriction scenarios follow the same seasonal pattern of diurnal fluctuations as Proposed Operations, but the magnitude of fluctuation is much reduced.

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[40] In comments on the draft EIS (Idaho Power, November 23, 2006, page 19), Idaho Power provided the results of additional operational modeling based on the operational scenario included in the draft EIS Staff Alternative, specifically a 237-kaf flow augmentation scenario. The incremental effect of adding the Corps' minimum flow recommendation to the 237-kaf flow augmentation scenario would be to reduce the below-target days from 116 to 100 under extremely low water conditions, from 120 to 32 under medium-low water conditions, and from 40 to zero under medium water conditions.

Scenario 2 (Flow Augmentation [figures E-10 through E-12]) results in substantially less diurnal fluctuation than under Proposed Operations in the March 1 through May 31 period (as specified in the scenario).

Meaningful differences between modeled flow fluctuations under Scenario 3 (Navigation [figures E-13 through E-15]) and Proposed Operations occur only under extremely low water conditions (compare figures E-1 and E-13). Under the Navigation Scenario, flows would fluctuate less in June and July for extremely low water conditions, and greater fluctuations would occur during August.

3.3.2.9 Operations Compliance Measurement Location

Currently, compliance with minimum flow and ramping rate restrictions is measured at the Johnson Bar gage. This gage is downstream of Hells Canyon dam, but upstream of major tributaries such as the Imnaha, Salmon and Grande Ronde rivers (refer to table 4). Idaho Power proposes to continue using Johnson Bar as the compliance monitoring location, and the Corps concurs (table 9, Corps-6). The Corps proposes to monitor minimum navigation flows downstream of the Salmon River confluence at the Snake River below McDuff Rapid Gage. The 8,500-cfs minimum flow downstream of the Hells Canyon Project would be measured at the Hells Canyon Dam Gage (USGS Gage No. 13290450)

NMFS, with respect to biologically based flows and ramping rates, recommends that Idaho Power measure flows and stage heights within 1 mile downstream of Hells Canyon dam, or at the first location downstream where consistent and accurate information can be collected (table 9, NMFS-15). At a minimum, NMFS recommends that this information should be collected at 15-minute intervals and that Idaho Power should provide access to this information (both "real-time" and historical information) via the Internet. ODFW and AR/IRU concur with NMFS on an upstream location for compliance monitoring (ODFW-13 and AR/IRU-23, respectively, in table 9).

The various compliance locations serve different purposes. Ramping rate compliance at Johnson Bar and flow rate compliance at the Snake River below McDuff Rapids gaging station are designed to address navigation issues. Flow monitoring below Hells Canyon dam serves both a navigation and biologically based purpose. Ramping rate monitoring below Hells Canyon dam is designed to address biologically based ramping rates. Staff does not see any conflict between having different types of monitoring occurring at different locations. Idaho Power would have a greater degree of control at the base of Hells Canyon dam, since except for spill conditions, they can control the release and limit changes in release in accordance with the stage-discharge rating curve for that gage.

Ramping rates can be estimated by using the latest USGS rating curves below Hells Canyon dam and at Johnson Bar. Minimum flows at McDuff Rapids can be monitored by that USGS gage, however information from several tributary gages may provide useful information to Idaho Power in terms of regulating release from Hells Canyon dam to meet flow objectives at McDuff Rapids and ramping rate objectives at Johnson Bar. In addition to the gages on the main stem Snake River, these gages include:

- Salmon River at White Bird, Idaho (USGS Gage No. 13317000);
- Imnaha River at Imnaha, Oregon (USGS Gage No. 13292000); and
- Grande Ronde River at Troy, Oregon (USGS Gage No. 13333000).

Because Idaho Power has varying levels of control at the different monitoring locations, it would be advisable to develop a plan to measure compliance with both minimum flows and ramping rates. Such a plan would usually be developed in consultation with the USGS, fish and wildlife agencies and the Corps of Engineers. Typically minimum flow and ramping rate monitoring plans specify under which conditions compliance is enforceable and set a reasonable basis for evaluating compliance. For example if the Hells Canyon dam is spilling, Idaho Power does not have control and cannot be expected to meet ramping rate objectives. Compliance with ramping rates immediately downstream of Hells Canyon dam

would likely have a higher standard than at Johnson Bar. The basis for compliance should include the frequency of required compliance and what percentage deviation from the targeted ramping rate is permissible over what period. Such a basis should take into account the ability to measure and forecast both flow and stage.

3.3.2.10 Water Uses and Water Rights

Although operational changes have the potential to affect existing water rights, we have no information to suggest that existing water rights would be inconsistent with proposed or alternative operating regimes considered in this final EIS.

Idaho Power is in the process of reconciling discrepancies between its water rights for hydroelectric diversion in the state of Oregon via the Oregon Hydropower Application Review Team (HART) Process. The HART Process is Oregon's certification process that combines all state authorities into single entity for providing comments and includes primarily ODEQ, OWRD, and ODFW. Idaho Power would enlarge its water right to match the maximum diversion capacities of the as-built Hells Canyon Project.

Several processes are underway that could affect water rights and streamflow hydrology in the Snake River, including potential clarification of the Swan Falls Agreement, the SRBA, and the Snake River Aquifer recharge program. Idaho Power would be required to revise or supplement its water rights based on the outcome of these processes.

Lower Valley Energy (LVE) recommends that Idaho Power compensate the state of Wyoming and the Wyoming public in the upper Snake River watershed in Wyoming, as represented by LVE, for the use of Wyoming's unused allocation under the Snake River Compact. In section 5.2.2.4, *Water Rights,* we discuss the issue of agency jurisdiction over this issue.

3.3.3 Unavoidable Adverse Effects

None.

3.4 SEDIMENT SUPPLY AND TRANSPORT

3.4.1 Affected Environment

The supply and movement of sediment in the free-flowing section of the Snake River downstream of Hells Canyon dam provide habitat for aquatic life, support recreational activities, and maintain important cultural resources. For example, fall Chinook salmon depend on the availability of suitable gravel for spawning habitat, and juvenile fall Chinook favor areas with gently sloping shorelines that are often associated with beach areas. Beaches used for recreational purposes, such as camping, hiking, rafting, and boating, depend heavily on the availability and movement of sediment because sand beaches are typically preferred by recreation users over gravel or cobble beaches. Terraces located above beaches contain important archeological sites that could be affected by beach and terrace erosion.

Idaho Power's sediment studies primarily addressed the reach of the Snake River extending from Weiser, Idaho (RM 351.3) to just upstream of the confluence with the Salmon River (RM 188.2) (see figure 1). Idaho Power focused its study of sediment supply and transport on the Hells Canyon reach because it: (1) includes the majority of the Hells Canyon National Recreational Area (HCNRA) and sections of the Snake River designated as wild and scenic; (2) contains most of the spawning habitat for anadromous fish (Groves, 2001); and (3) is most sensitive to the effects of Hells Canyon Project operations because there are no major streamflow or sediment inputs to the Snake River between the project and the river's confluence with the Salmon and Grande Ronde rivers (Parkinson et al., 2003a).

The Hells Canyon reach is confined within a deep, narrow bedrock canyon, which restricts substantial floodplain development. Portions of the bedrock walls are mantled with fine- to coarse-grained sediment derived from debris flows and landslides. Incision of the canyon began about 2.5 million years ago in response to the draining of Lake Idaho (a large lake covering much of the western Snake River Plain) into the headwaters of the pre-canyon Salmon River basin at the present location of Oxbow dam (O'Connor, 2002). The catastrophic Bonneville Floods released large volumes of glacial water approximately 14,500 years ago and formed numerous terraces up to 600 feet above the current channel bed (Miller et al., 2003a).

Numerous dams constructed upstream of the project trap sediment originating from the upper Snake River basin. The nearest (and also the oldest) upstream dam on the Snake River was constructed in 1901 at Swan Falls. The Swan Falls dam was a major barrier to sediment movement on the mainstem Snake River for approximately 60 years before construction of the Hells Canyon Project and attenuated any anthropogenic sediment pulses associated with twentieth-century land development in the upper Snake River basin (Vincent and Andrews, 2002; Wilcock et al., 2002). Sediment from widespread development of irrigation farming in the basin was also trapped behind other mainstem dams and numerous tributary dams constructed during this era.

The average slope of the Snake River downstream of Hells Canyon dam varies from 0.002 to 0.0007 (10.5 to 3.7 feet per mile) and decreases in the downstream direction. Local variations in slope are associated with debris fans and bar features at tributary junctions. Between Hells Canyon dam and the Salmon River confluence, debris fans and gravel bars maintain a pool-riffle morphology in the river (Parkinson et al., 2003a). Relict debris fans at the mouths of tributaries along the river banks reflect the strong coupling between the river and the many small tributary basins that deliver sediment to the project reach.

3.4.1.1 Sediment Budget

Idaho Power completed numerous studies to quantify the components of a sediment budget for the Hells Canyon reach (Miller et al., 2003a; Parkinson et al., 2003a; Parkinson et al., 2005a,b). The sediment budget is an accounting of all sediment sources entering the project reach via the mainstem of the Snake River and sediment supplied by tributaries. The sediment budget also accounts for sediment

leaving the reach and changes in sediment storage within the reservoirs and along the banks and bed of the Snake River. The sum of all sediment inputs and outputs is balanced by the net change in storage:

$$S_i + S_t - S_o = \Delta S_r$$

where

S_i = rate of sediment entering the project reach at Weiser,

S_t = rate of tributary additions for either a single basin or a group of basins,

S_o = rate of sediment leaving a specified river segment, and

ΔS_r = rate of change in sediment storage for various storage elements.

We use these components in the following discussion to describe the transfer of sediment within individual basins, specified reaches, and various sediment storage elements (i.e., reservoirs, sandbars, and gravel bars). The sediment budget is summarized in table 10.

Sediment Supply at Weiser, S_i

Of the four terms in the sediment budget, S_i (the average rate of sediment entering the reach from upstream) is the only term for which long-term measurements of sediment transport are available. This term implicitly accounts for sediment trapped behind the 13 mainstem dams on the Snake River upstream of the project and sediment trapped behind many tributary dams in smaller basins upstream of the project. All of the sediment entering the three project reservoirs is trapped (i.e., sediment output, $S_o = 0$ at Hells Canyon dam), which simplifies the calculation of sediment storage in the three reservoirs to $\Delta S_r = S_i + S_t$, where S_t in this case is all tributary inputs to the three reservoirs below Weiser.

Idaho Power estimated S_i using sediment rating curves (relations between discharge and sediment transport rate) developed by the USGS from suspended sediment load measurements in the Snake River near Weiser. The sediment sampling technique excluded the fraction of sediment transported as bedload, which is defined as sand and gravel with a grain diameter larger than 0.063 mm. Idaho Power calculated an average sediment yield of 1.47 million tons per year for S_i, which includes approximately 220,000 tons per year of unmeasured sand and gravel estimated by assuming 15 percent of the total suspended load is transported as bedload (Parkinson et al., 2003a), a reasonable assumption based on the range of bedload (5 to 15 percent) measured for rivers of this size (Reid and Dunne, 1996). Wilcock et al. (2002) performed a similar calculation and reported 978,000 tons per year for suspended sediment, which includes 214,000 tons per year of suspended sand (22 percent of the suspended load >0.062 mm) based on sediment analyses performed by the USGS on the suspended sediment samples collected at Weiser. Wilcock et al.'s (2002) calculations do not include the unmeasured bedload component, which would bring the total sediment yield to 1.15 million tons per year using Idaho Power's bedload estimate of 15 percent. Mussetter (2006) re-interpreted the rating curves for Weiser and calculated a greater yield for sand of 384,000 tons per year. Based on the assumptions reported by Mussetter (2006), including the assumption that bedload (gravel and sand) is 15 percent of total suspended load (fine sand, silt, and clay), we calculated a total suspended load of 1.17 tons per year and a total sediment load of 1.38 million tons per year for comparison with other estimates.

Based on the foregoing interpretations of suspended sediment records at Weiser, the total sediment load entering the project reach (S_i) is estimated to range from 1.15 to 1.47 million tons per year. The sand and gravel component of S_i is estimated to range from 220,000 to 384,000 tons per year, with most of this sediment likely falling in the size range of sand. The remaining sediment at Weiser (an estimated 764,000 to 1.25 million tons per year) is classified as clay and silt.

Table 10. Sediment budget. (Source: Wilcock et al., 2002; Miller et al., 2003a; Parkinson et al., 2003a, 2005b; Mussetter, 2006; as modified by staff)

Reach Segment	Contributing Basin Area (square mile)	Estimated Sediment Yield (tons/year)		
		Total	Clay and Silt (<0.063 mm)	Sand and Gravel (>0.063 mm)
Sediment gage at Weiser (S_i)[a]	9,260	1,150,000–1,470,000	764,000–1,250,000	220,000–384,000
Tributary inputs to Brownlee reservoir (S_t)[b]	2,230	277,000–825,000	207,000–701,000	41,500–206,000
Tributary inputs to Oxbow reservoir (S_t)[b]	218	27,100–80,700	20,300–68,600	4,050–20,200
Tributary inputs to Hells Canyon reservoir (S_t)[b]	447	55,500–165,000	41,600–141,000	8,310–41,300
Total sediment yield to reservoirs (ΔS_r)[b]	12,160	1,510,000–2,540,000	1,030,000–2,160,000	274,000–652,000
Tributary inputs (S_t)				
Hells Canyon dam to Pine Bar[b]	207	25,700–76,600	19,300–65,100	3,850–19,100
Pine Bar to Tin Shed[b]	91	11,300–33,700	8,460–28,600	1,690–8,420
Tin Shed to Salmon River (excluding Imnaha River)[b]	242	30,000–89,500	22,500–76,100	4,500–22,400
Total Hells Canyon dam to Salmon River (excluding Imnaha River)	540	67,100–200,000	50,200–170,000	10,000–50,000

Notes: Values are limited to three significant figures.

[a] Sediment yield based on gage data at Weiser and various techniques. See text for explanation.

[b] Range in total sediment yield based on 124 to 370 tons per square mile per year and the contributing basin area for each tributary. Range in sediment yield for the fine and coarse fractions is based on 75 and 15 percent of the minimum total and 85 and 25 percent of the maximum total, respectively (sum of ranges may not equal totals). See text for explanation.

As part of its license application and AIR responses, Idaho Power collected deep sediment cores from the bottom of Brownlee reservoir and collected shallow sediment samples from the bottom of Oxbow and Hells Canyon reservoirs to evaluate the relative fractions of fine sediment, sand, and gravel entering the Hells Canyon Project from upstream and from tributaries draining into the reservoirs. Due to the 20-mile shift in pool extent corresponding to the operational 100-foot fluctuation in water elevation and the reworking of sediment during reservoir drawdown, the depositional environment at the inlet to Brownlee reservoir is extremely complex and heterogeneous (Wilcock et al., 2002). Consequently, the three sediment cores taken within the draw-down reach may not provide an adequate characterization of the sediment composition delivered to the reservoir.

We divided the sediment yield estimated at Weiser by the contributing basin area (9,260 square miles) for comparison with the range in sediment yield calculated for four other reservoirs in the region. Based on the range in sediment yield estimated at Weiser, S_i is estimated to range from 124 to 159 tons per square mile per year (figure 22), which is about one-half the sediment yield (240 to 370 tons per square mile per year) measured from sedimentation surveys at other reservoirs in the region (Miller et al., 2003a). The lower estimates at Weiser may reflect sediment retention behind numerous upstream dams.

Changes in Reservoir Storage, ΔS_r

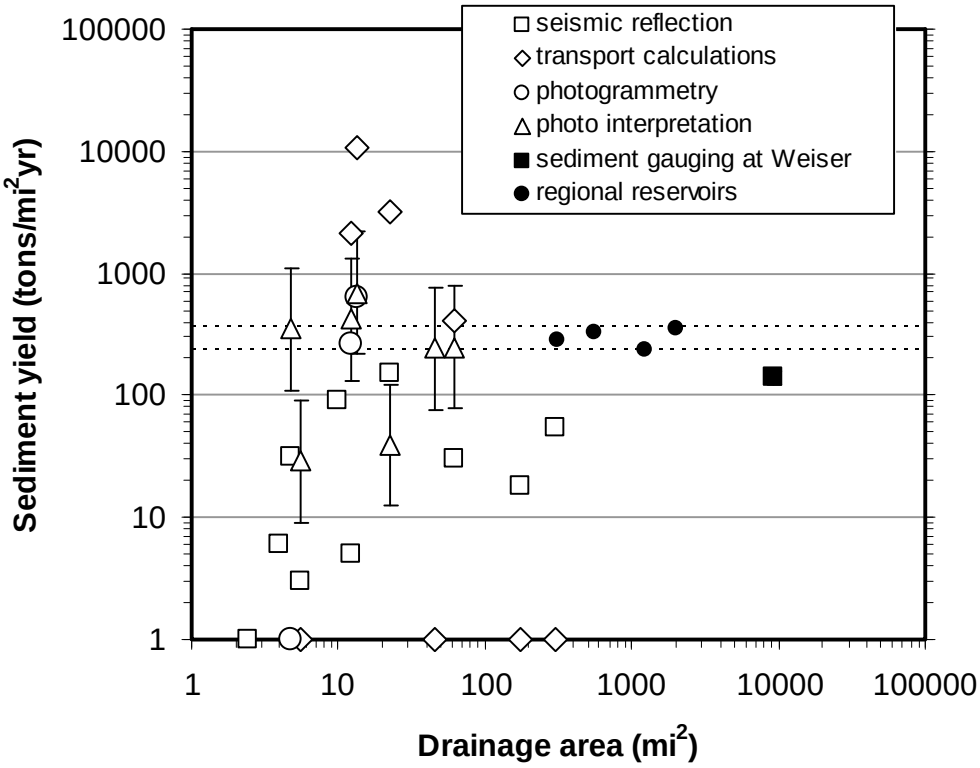
Idaho Power used a variety of techniques to evaluate the other components of the sediment budget. In its license application and AIR responses, Idaho Power attempted to estimate the volume of sediment trapped in the three reservoirs (ΔS_r) using the difference between pre-impoundment topography and recent bathymetric data. Parkinson et al. (2005b) found that the precision of the pre-impoundment topographic maps produced volumetric errors that exceeded the likely sediment volumes they set out to quantify. Therefore, reliable estimates of ΔS_r in the three reservoirs based on bathymetry are not available.

Sediment Supplied from Tributaries, S_t

In its license application, Idaho Power estimated S_t for 17 tributaries below Hells Canyon dam and 12 of the tributaries draining directly into the three reservoirs. Sediment yield for these selected tributaries was calculated using a sediment transport equation and field surveys of channel dimensions and bed material (Parkinson et al., 2003a). Results ranged from 0 to 59,000 tons per square mile per year, which Parkinson et al. (2003a) acknowledge are more than two orders of magnitude greater than regional sediment yields calculated by other methods (figure 22). The wide variability in the calculated values of S_t is likely due to the uncertainty of the assumptions used in the sediment transport model (Wilcock et al., 2002). Hence, a reasonable estimate of S_t, as measured from the transport calculations, cannot be determined for use in the sediment budget.

Idaho Power (Parkinson et al., 2005b) employed three additional techniques to quantify S_t. The methods included analyses of several tributary fans using photogrammetry, geomorphic interpretation of aerial photography and topographic maps, and geophysical profiling. For each technique, the volume of sediment stored in the tributary fans was measured at the point of entry to the reservoirs. Some tributary volumes were measured using more than one method.

Idaho Power (Parkinson et al., 2005b) used photogrammetry developed from historical aerial photographs to reconstruct the pre-impoundment topography of three tributary fans at a greater resolution than was previously available on the earlier pre-impoundment maps. The volumes of the three tributary fans were calculated from the difference between the high-resolution, pre-impoundment topography and the recent bathymetry. Measurable differences in the topography of two of the fans resulted in sediment yields of 268 and 640 tons per square mile per year (figure 22), which are two orders of magnitude lower than earlier estimates of S_t but twice the sediment yield measured at Weiser and from sediment trapping in the four regional reservoirs.



[a] Results of transport calculations are shown only for basins evaluated by other techniques. Error bars show the estimated range of values. Sediment yields from seismic reflection are minimum estimates. Calculations that did not result in a sediment yield are shown at $S_t = 1$ on the log axis. The dashed lines designate the range in sediment yield for the four regional reservoirs used in the sediment budget.

Figure 22. Summary of estimated sediment yield from tributaries using various techniques, sediment gaging at Weiser, and the four regional reservoirs.[a] (Source: Wilcock et al., 2002; Miller et al., 2003a; Parkinson et al., 2003a, 2005b; Mussetter, 2006; as modified by staff)

Idaho Power (Parkinson et al., 2005b) used the geomorphic interpretation of pre-impoundment aerial photographs, low-resolution pre-impoundment topography, and recent high-resolution bathymetry to estimate sediment volumes at the mouths of seven tributaries. Results ranged from 29 to 352 tons per square mile per year (figure 22) with an order-of-magnitude margin of error reported by Parkinson et al. (2005b). Values agree with the average sediment yield for Weiser and the four regional reservoirs to within the relatively large margin of error reported for these results.

Idaho Power (Parkinson et al., 2005b) conducted seismic reflection surveys and subbottom profiling at eleven tributary fans. Because sonar is unable to penetrate coarse sediment, only the thickness of the uppermost fine- to medium-grained sediment could be measured, and results are reported as a possible lower estimate of S_t. Additionally, bathymetry indicated that some post-impoundment sediment fans may have been deposited on pre-impoundment fans. Excluding the one tributary fan for which there was no measurable difference in topography, sediment yield ranged from 3 to 152 tons per square mile per year (figure 22).

The range in tributary sediment yield illustrated in figure 22 using the various analytical techniques shows considerable scatter over more than four orders of magnitude for the smaller basins but

encompasses the narrow range calculated from sediment gaging at Weiser and values reported by Parkinson et al. (2003a) for the four reservoirs in the region. The wide variability in sediment yield decreases in larger basins due to the averaging of widely varying sediment yields from many small basins. Since the actual sediment yield in each tributary cannot be measured accurately, we estimated an average yield from tributaries of 124 to 370 tons per square mile per year based on a consideration of the range of rates reported for Weiser and the regional reservoirs. Based on this range, the average tributary input (S_t) to the three reservoirs from the approximately 2,900-square-mile drainage area is 359,000 to 1.07 million tons per year. Adding S_i to this range yields an average of 1.51 to 3.63 million tons of sediment trapped each year in the three reservoirs, of which 274,000 to 652,000 tons per year is likely sand and gravel (table 10).

Sediment Leaving the Reach, S_o

The project reach downstream of Hells Canyon dam is ungaged for sediment, such as it is at Weiser; therefore, direct measurements of sediment leaving the downstream project reach (S_o) and the rate of change in sediment storage in beaches and gravel bars within this reach (ΔS_r) are not readily available for use in the sediment budget. Tributaries draining to the Snake River downstream of Hells Canyon dam currently provide the only substantial source of sediment input for sandbars and spawning gravel. We calculated average sediment yields for the reach segments downstream of Hells Canyon dam using the range of average sediment yields established above for the tributaries (S_t) and the contributing basin areas for each reach (table 10). The results indicate that an estimated average of 67,000 to 200,000 tons per year of sediment is supplied by tributaries to the Snake River between Hells Canyon dam and the confluence with the Salmon River, which by comparison represents only 7 percent of the annual sediment trapped in the three reservoirs. In the absence of any changes in sediment storage below Hells Canyon dam (such as from beach erosion or bed incision), S_o in this reach should be equivalent to S_t. However, substantial changes in historical sediment storage have occurred downstream of Hells Canyon dam and are addressed in the following sections.

3.4.1.2 Beaches and Terraces

Beaches

Sandbars comprised of particles between 0.062 and 2 mm and connected to the Snake River shoreline are referred to as beaches. Beaches form by deposition of suspended sand in zones of recirculating flow or eddies along the channel margin. Studies of the 1996 controlled flood on the Grand Canyon indicate that large floods that transport sediment from the bed to the channel margin and the continuous supply of sand-size sediment from upstream are both necessary to maintain river beaches (Webb et al., 1999). Beaches occupy a small proportion of the total river bank and represent an important resource in Hells Canyon for fish rearing and recreational use (e.g., camping, boating, and hiking).

Idaho Power conducted a study to evaluate potential sources of the sand and coarse sediment found upstream, within, and downstream of the Hells Canyon Project (Miller et al., 2003b; Parkinson et al., 2003b). Idaho Power collected sediment from the Snake River upstream of Weiser (RM 449), sediment trapped in the reservoirs, sediment within tributaries, and sediment in sand and gravel bars in the Snake River downstream of Hells Canyon dam to below the confluence with the Salmon River (RM 152). Visual analyses of coarse sediment (>4 mm) indicated a mixture of both local and upstream host rocks, with a trend of increasing supply from local host rocks (mostly basalt) downstream of Hells Canyon dam.

Idaho Power evaluated the source of fine sediment (<4 mm) collected from the mainstem, tributaries, and sandbars using X-ray diffraction (XRD)[41] (Miller et al., 2003b; Parkinson et al., 2003b; CH2M HILL, 2006). The analyses measured the relative fractions of three minerals: plagioclase, quartz, and potassium feldspar (or K-spar). Quartz and K-spar are common to calc-alkaline intrusive rocks (such as granite, which is most common in the Payette and Boise River basins), but they are largely absent in mafic, volcanic rocks (such as basalt, which is common in tributary basins downstream of Weiser). Plagioclase occurs both in granite and basalt, but plagioclase (predominantly calcium-rich plagioclase) is found in greater proportions in basalt. For sediment collected from the mainstem Snake River between RM 152 and RM 149, CH2M HILL (2006) reported that the river mile where each sample was taken explained 67 percent of the total variance in the fraction of plagioclase, but that river mile explained only 56 percent of the variance in the fraction of quartz and only 13 percent of the variance in the fraction of K-spar in mainstem sediment. The downstream increase in plagioclase content supports mixing with sediment derived from more mafic source rocks (basalt) located downstream of Hells Canyon dam; however, the lack of a significant downstream trend in either quartz or K-spar suggests a homogenous sediment composition consistent with a host rock that includes basalt, calc-alkaline intrusive rocks, and metamorphic rocks. These results also indicate that local sources of calc-alkaline intrusive rocks are a significant source of mainstem sediments.

Historical aerial photographs indicate that the number and size of sandbars between Hells Canyon dam and the Salmon River declined substantially during the decade immediately following construction of the Hells Canyon Project (Grams, 1991; Grams and Schmidt, 1999b; Miller et al., 2003a.). The magnitude of this reduction declined with increasing distance downstream of Hells Canyon dam (Grams and Schmidt, 1999b). For the 9 years between 1964 and 1973, Grams (1991) and Grams and Schmidt (1999b) measured a 57 percent reduction in the number and cumulative area of sandbars. In a complementary inventory compiled by Idaho Power, Miller et al. (2003a) reported a 37 percent reduction in the number of sandbars for the same time period and noted an 11 percent increase in the number of sandbars in their inventory between 1955 (prior to dam construction) and 1964.

The rate of sand loss has declined substantially since the 1970s. Grams (1991) measured a roughly 30 percent reduction in the number and cumulative area of sandbars during the nine years between 1973 and 1982. Grams (1991) reported a 2 percent reduction in the number of sandbars from 1982 to 1990 and a 4 percent decrease in the total area of sandbars for this same period, but noted these changes were within the margin of error for the analysis. In contrast, Miller et al. (2003a) calculated a 19 percent increase in the number of sandbars between 1982 and 1997. Miller et al. (2003a) did not report any change in sandbar area for comparison with the results of Grams (1991).

Based on the work of Grams (1991) and Grams and Schmidt (1999b), Wilcock et al. (2002) calculated 10,500 to 35,000 tons per year for the average annual rate of sand loss from sandbars below Hells Canyon dam between 1964 and 1990, which encompasses the decade of rapid sand export after dam construction. Based on values presented in the sediment budget, the annual rate of sand loss between 1964 and 1990 would represents 1 to 15 percent of possible sand- to gravel-size sediment sequestered in the three reservoirs each year, and is roughly equal to the estimated sand and gravel component supplied by all of the tributaries downstream of Hells Canyon dam.

In addition to analyzing aerial photographs for the sandbar inventory, Idaho Power conducted transect surveys at four sandbars between 1997 and 2000: Pine Bar, Salt Creek Bar, Fish Trap Bar, and China Bar (figure 23). In general, Parkinson et al. (2003a) reported that all monitored sandbars except Salt Creek Bar experienced both erosion and aggradation (buildup through sediment deposition) during the monitoring period. Salt Creek Bar experienced only erosion. Results of sandbar stability analyses

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[41] XRD is a laboratory method used to determine the mineralogical signature of a material by analyzing the crystalline structure at the atomic level.

conducted at Fish Trap Bar indicated instability for some transects during drawdown from load-following flows and during the recession of a major flood (Parkinson et al., 2003c). Stability analyses for Pine Bar found that all eight transects were unstable during the recession of a major flood. Idaho Power updated the stability analyses using an instantaneous drawdown from 20,000 cfs to 10,000 cfs to conservatively model a 2-hour drawdown. Results indicated a similar level of sandbar instability under load-following flows at Fish Trap Bar, some instability at Pine Bar, and marginal to stable conditions at Tin Shed Bar (Parkinson et al., 2005b).

Idaho Power (Parkinson et al., 2005a) modeled sand mobilization and measured active sand transport at the four sandbars to determine the minimum flows capable of mobilizing sand. The results indicated that sand is transported at flows lower and higher than those predicted by the model. Based on available information, there are no estimates of S_o for the reach below Hells Canyon dam, except for the volume of historical sand loss estimated by Wilcock et al. (2002).

Terraces

Terraces are generally considered ancient fluvial surfaces located at an elevation above the current floodplain sufficient to isolate them from current channel processes. Terraces may be erosional or depositional in nature and form in response to channel incision caused by a lowering of the base level (such as a drop in sea level), tectonic uplift, or a change in hydrologic regime. Two sets of terraces have been identified within the Hells Canyon reach. High terraces located 100 to 600 feet above the current channel bed are interpreted to have formed by rapid incision and high water during the Bonneville Flood and subsequent Holocene flooding (Miller et al., 2003a). Lower terraces and river bars, located approximately 10 to 15 feet above the current channel, may have been formed by natural flows prior to basin regulation (that is, more than 100 years ago) (Parkinson et al., 2003a).

Many terraces below Hells Canyon dam contain valuable archaeological resources that may be threatened by the loss of beaches (see section 3.9.2.1, *Effects of Project Operations on Cultural Resources*). Many of the remaining beaches provide a buffer against erosion of these terraces. Bank stability analyses performed by Idaho Power found that portions of terraces may become unstable when subjected to rapid water drawdown during non-operational flood events (Parkinson et al., 2003a). The pre-dam flood flows would have delivered greater quantities of sand that would have maintained sandbar buffers adjacent to some terraces. Grams and Schmidt (1999b) documented high flows reaching terrace cut banks, which could contribute to bank retreat.

3.4.1.3 Spawning Gravel

Gravel beds with sediment ranging in size from 25 to 150 mm are used for spawning by fall Chinook salmon (Groves and Chandler, 2001). Based on spawning surveys conducted by Idaho Power between 1991 and 1993, the majority of redds (salmon spawning sites) were located downstream of the Snake River confluence with the Grande Ronde River (RM 169), an area with abundant sediment supply from the Imnaha River (RM 191.7), Salmon River (RM 187.5) and the Grande Ronde River (figure 1). However, since 1994, most observed redds have been located upstream of the confluence with the Salmon River.

Bedload transport rates for gravel have not been measured and thus are unknown. Idaho Power concludes from spawning-gravel size reported by Groves and Chandler (2001), assumptions for incipient motion, and MIKE 11 hydrodynamic modeling[42] that 11 to 30 percent of the bed surface in the Snake River between Hells Canyon dam and Salmon River (primarily downstream of tributaries) is mobilized at

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[42] MIKE 11 is a one-dimensional hydrodynamic model that includes add-on modules capable of simulating unsteady flows, sediment transport, flood forecasting, and water quality in open channels.

a flow of 30,000 cfs (the lowest modeled flow) (Parkinson et al., 2003a). Scour chains installed by Idaho Power in spawning beds downstream of Hells Canyon dam showed gravel mobilization during the monitoring period that included a peak flow of 30,800 cfs (Parkinson et al., 2003a). The location of scour chains in spawning beds implies that gravel mobilization in those areas could partly be due to spawning activity. Boat wakes are unlikely to contribute to gravel mobilization because wake influence is limited to disturbance of the armor layer in the near-shore environment.

3.4.2 Environmental Effects

3.4.2.1 Effects of Project Operations on Sediment Transport

We describe Idaho Power's Proposed Operations in section 2.2.2, *Proposed Project Operations*, and we assess the effects of the proposed operation on reservoir levels and project outflows in section 3.3.2, *Effects of Project Operations on Water Quantity*. In section 3.3.2.2, we identify operation-related recommendations filed by agencies, tribes, and other parties (table 9), and we describe five alternative operational scenarios that we use to assess the effects of the various operation-related recommendations. At our request (AIR OP-1), Idaho Power simulated project operations for these representative scenarios under various hydrologic conditions. Refer to section 3.3.2.2 for additional discussion of the scenarios and the modeling process used for the simulations. We use the results of these simulations to assess the effects of the operation-related recommendations on: (1) beach erosion; (2) terrace stability; and (3) quality of spawning gravel.

Beach and Terrace Erosion

Sediment trapping within Idaho Power's mainstem reservoirs and flow fluctuations caused by project operations may contribute to the erosion of beaches and terraces downstream of Hells Canyon dam. The loss of beaches and sandbars may adversely affect aquatic resources by reducing the availability of gently sloping shorelines favored by rearing juvenile fall Chinook salmon (Kondolf, 1997; Wissmar, 2004). Because beaches add to the aesthetic appeal of the riverscape and provide locations for boat landing, swimming, and camping, beach erosion reduces the aesthetic appeal of the river and reduces the extent of beaches available for recreation. Beach and terrace erosion may also affect important archaeological sites. In this section, we evaluate the effects that proposed and alternative operations would have on beach and terrace erosion based on changes in sand mobility and terrace stability.

Our Analysis

Numerous studies in the Colorado River downstream of Glen Canyon dam have found that sediment-replenishing floods are required for the maintenance of sandbars and deposition of sand on high-stage terraces (e.g., Bennett, 1993; Schmidt, 1993; Webb et al., 1999). Investigations of the effects of flow regulation have found that lower flows and fluctuating flows with low suspended-sand concentrations can erode sandbars and redistribute sand to lower channel elevations (e.g., Schmidt and Graf, 1990; Beus and Avery, 1993; Schmidt, 1993; Melis, 1997; Webb et al., 1999). Budhu and Gobin (1994) documented seepage erosion of sandbars during downramping of load-following operations. Grams and Schmidt (1999b) observed the erosion of terraces in areas where beaches that had provided a buffer between the water and the terraces were substantially eroded or completely lost. Bauer and Schmidt (1993) demonstrated sandbar erosion by wave action. Based on an Idaho Power wave impact study performed on Hells Canyon sandbars, Mussetter (2006) found that waves created by powerboats are another important factor in mobilizing sediment from beach shorelines and may cause beach erosion during low to intermediate flow conditions.

To assess sandbar areas subject to erosion, we examined annual flow-duration curves, hydrodynamic model results of sand mobilization at four sandbars, field measurements of sand transport rates at four sandbars, and the simulated stability of three sandbars under instantaneous (conservative)

drawdown conditions (Parkinson et al., 2005a,b). Areas of sand mobilization and inundation were simulated for each hour of the year and were then summed over the entire year. Areas of sand mobilization measured in the field were both higher and lower than those predicted by the hydrodynamic model; however, the estimates are suitable for our purposes in differentiating among the relative effects of various operational scenarios. The cumulative annual area of sandbars that would be subject to inundation and sand mobilization under Proposed Operations and the five alternative scenarios are presented in tables 11 and 12. The area of sandbars that would be subject to sand mobilization is illustrated graphically in figures 23 through 25. The percent change in area of sandbars that would be subject to sand mobilization under the five alternative scenarios relative to the area of sand mobilization for Proposed Operations are presented in table 13.

Table 11. Estimated cumulative annual area of sandbars that would be subject to inundation under Proposed Operations and five alternative scenarios. (Source: Parkinson et al., 2005a, as modified by staff)

		Inundated Area of Sandbars (m^2)			
Scenario	**Water Year Type[a]**	**Pine Bar (RM 227.5)**	**Salt Creek (RM 222.4)**	**Fish Trap (RM 216.4)**	**China Bar (RM 192.3)**
Proposed Operations	Extremely low	10,795	5,120	1,828	869
	Medium	12,486	5,739	3,243	1,309
	Extremely high	13,064	5,942	3,969	1,538
Scenario 1a (Reregulating)	Extremely low	10,800	5,136	1,769	859
	Medium	12,437	5,725	3,181	1,291
	Extremely high	13,076	5,944	3,991	1,537
Scenario 1b (Year-round 2-Inches-Per-Hour Ramping Rate)	Extremely low	10,827	5,144	1,779	863
	Medium	12,484	5,739	3,215	1,300
	Extremely high	13,074	5,944	3,987	1,537
Scenario 1c (Year-round 6-Inches-Per-Hour Ramping Rate)	Extremely low	10,821	5,137	1,789	863
	Medium	12,493	5,742	3,237	1,307
	Extremely high	13,074	5,943	3,979	1,540
Scenario 2 (Flow Augmentation)	Extremely low	10,835	5,144	1,814	869
	Medium	12,446	5,729	3,249	1,311
	Extremely high	13,052	5,938	3,970	1,537
Scenario 3 (Navigation)	Extremely low	10,896	5,168	1,847	880
	Medium	12,469	5,735	3,255	1,310
	Extremely high	13,059	5,942	3,981	1,541

[a] Water year types and corresponding flow years include extremely low (1992), medium (1995), and extremely high (1997).

Table 12. Estimated cumulative annual area of sandbars that would be subject to sand mobilization under Proposed Operations and five alternative scenarios. (Source: Parkinson et al., 2005a, as modified by staff)

		Mobile Area of Sandbars (m^2)			
Scenario	**Water Year Type[a]**	**Pine Bar (RM 227.5)**	**Salt Creek (RM 222.4)**	**Fish Trap (RM 216.4)**	**China Bar (RM 192.3)**
Proposed Operations	Extremely low	147	1	49	591
	Medium	716	35	490	789
	Extremely high	1,062	74	796	861
Scenario 1a (Reregulating)	Extremely low	109	0	26	600
	Medium	649	33	464	781
	Extremely high	1,012	70	786	856
Scenario 1b (Year-round 2-Inches-Per-Hour Ramping Rate)	Extremely low	131	0	30	602
	Medium	667	33	473	783
	Extremely high	1,018	71	786	856
Scenario 1c (Year-round 6-Inches-Per-Hour Ramping Rate)	Extremely low	148	0	35	598
	Medium	683	33	481	786
	Extremely high	1,070	73	796	861
Scenario 2 (Flow Augmentation)	Extremely low	131	1	40	599
	Medium	677	38	498	787
	Extremely high	1,058	75	797	861
Scenario 3 (Navigation)	Extremely low	140	1	47	607
	Medium	671	35	491	787
	Extremely high	1,053	76	803	861

[a] Water year types and corresponding flow years include extremely low (1992), medium (1995), and extremely high (1997).

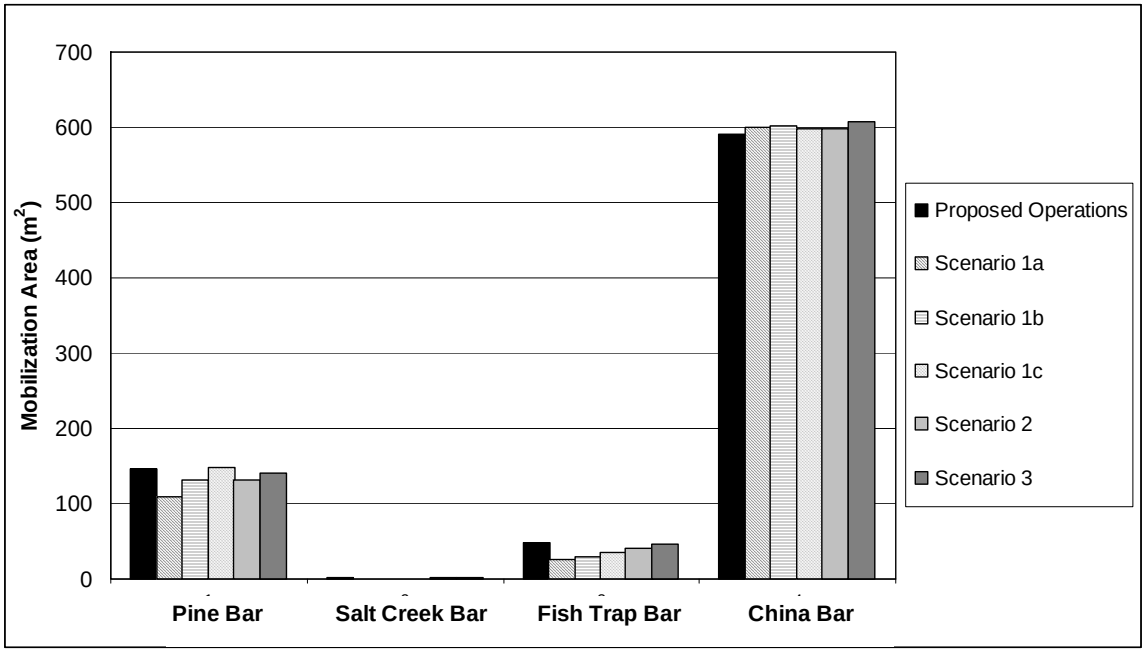

Figure 23. Estimated cumulative annual area of sandbars that would be subject to sand mobilization under Proposed Operations and five alternative scenarios for an extremely low water year. (Source: Parkinson et al., 2005a, as modified by staff)

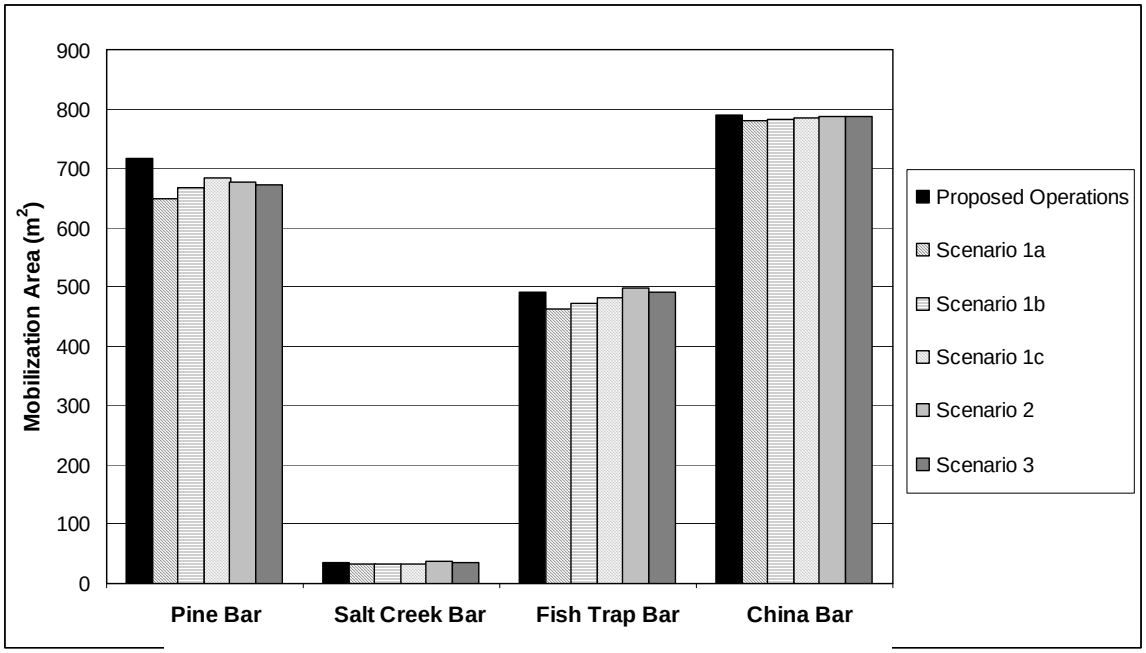

Figure 24. Estimated cumulative annual area of sandbars that would be subject to sand mobilization under Proposed Operations and five alternative scenarios for a medium water year. (Source: Parkinson et al., 2005a, as modified by staff)

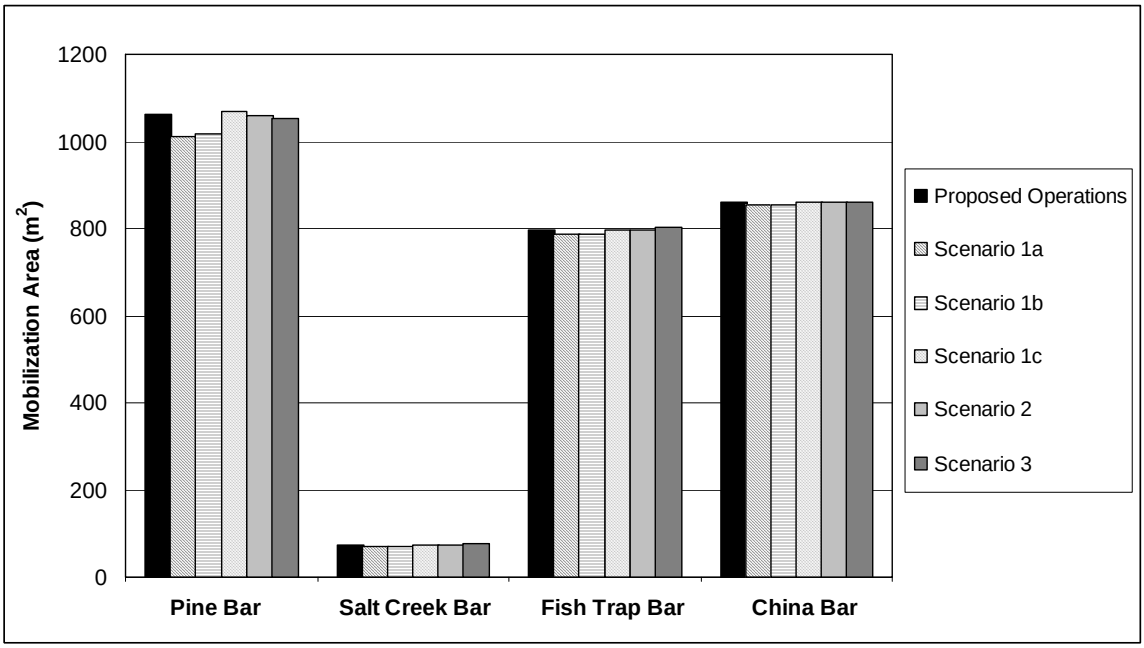

Figure 25. Estimated cumulative annual area of sandbars that would be subject to sand mobilization under Proposed Operations and five alternative scenarios for an extremely high water year. (Source: Parkinson et al., 2005a, as modified by staff)

Table 13. Estimated percent change in cumulative annual area of sandbars that would be subject to sand mobilization under five alternative scenarios. Percentages are given relative to the area of sand mobilization for Proposed Operations. (Source: Parkinson et al., 2005a, as modified by staff)

		Percent Change in Mobile Area of Sandbars Relative to Proposed Operations			
Scenario	**Water Year Type[a]**	**Pine Bar (RM 227.5)**	**Salt Creek (RM 222.4)**	**Fish Trap (RM 216.4)**	**China Bar (RM 192.3)**
Scenario 1a (Reregulating)	Extremely low	–25.9	Ind.[b]	–46.9	1.5
	Medium	–9.4	–5.7	–5.3	–1.0
	Extremely high	–4.7	–5.4	–1.3	–0.6
Scenario 1b (Year-round 2-Inches-Per-Hour Ramping Rate)	Extremely low	–10.9	Ind.	–38.8	1.9
	Medium	–6.8	–5.7	–3.5	–0.8
	Extremely high	–4.1	–4.1	–1.3	–0.6
Scenario 1c (Year-round 6-Inches-Per-Hour Ramping Rate)	Extremely low	0.7	Ind.	–28.6	1.2
	Medium	–4.6	–5.7	–1.8	–0.4
	Extremely high	0.8	–1.4	0.0	0.0

Scenario	Water Year Type[a]	Percent Change in Mobile Area of Sandbars Relative to Proposed Operations			
		Pine Bar (RM 227.5)	Salt Creek (RM 222.4)	Fish Trap (RM 216.4)	China Bar (RM 192.3)
Scenario 2 (Flow Augmentation)	Extremely low	–10.9	Ind.	–18.4	1.4
	Medium	–5.4	8.6	1.6	–0.3
	Extremely high	–0.4	1.4	0.1	0.0
Scenario 3 (Navigation)	Extremely low	–4.8	Ind.	–4.1	2.7
	Medium	–6.3	0.0	0.2	–0.3
	Extremely high	–0.8	2.7	0.9	0.0

[a] Water year types and corresponding flow years include extremely low (1992), medium (1995), and extremely high (1997).

[b] Ind. = indeterminate change due to the relatively small area for Proposed Operations (see table 12).

Results show that the estimated area of sandbar inundation varies more among sandbar locations and water year types than among Proposed Operations and the alternative scenarios. For instance, the area of sandbars subject to inundation varies by more than one order of magnitude between Pine Bar and China Bar (table 11), whereas the total area of sandbars that would be subject to inundation under any one of the five alternative scenarios differs by no more than about ±2 percent of the area inundated under Proposed Operations. Based on results of the analysis, the alternative scenarios would not cause a measurable change in the area of annual sandbar inundation.

The estimated area of sandbar mobilization also exhibits the greatest variability among sandbar locations and water year types, but in this case, the factor does vary considerably among flow scenarios and is correlated with ramping rate (table 12). The area of sand mobilization could be reduced by 26 to 47 percent for the extremely low water year under alternative Scenario 1a (Reregulating) for some sandbars (i.e., Pine Bar and Fish Trap Bar) but could increase modestly by 1.5 percent for other sandbars (i.e., China Bar). With the exception of China Bar, the 2-inches-per-hour ramping rate restriction would also yield a measurable reduction in the area of sandbar mobilization, and the other scenarios would provide little or no reduction.

The influence of drawdown rate on the stability of sloping portions of sandbars during load-following operations has not been evaluated. Nonetheless, slopes would be more prone to failure if the drawdown rate exceeds the rate at which the slope is able to drain. Under this condition, failure risk by seepage would increase as the range of fluctuation increases, the period in which peak discharge is held constant decreases, and the ramping rate increases (Parkinson et al., 2005b, appendix C). Based solely on ramping rates, the alternative scenarios with a 2-inches-per-hour ramping rate (Scenarios 1b, 1d, and 1f) or less (i.e., Reregulating) would carry the greatest reduction in risk of beach failure, followed by scenarios with a year-round 6-inches-per-hour ramping rate.

The results of these comparisons indicate that, in general, the area of sand mobilization would decline under the alternative scenarios compared to Proposed Operations, and the degree of reduction would vary considerably between sandbar locations. The area of beach inundation, which is causally linked to beach and terrace erosion, would not change measurably under the alternative scenarios; however, based on slope stability analyses, implementing the Year-round 6-Inches-Per-Hour Ramping Rate Scenario would cause greater seepage failure of sandbar slopes during drawdown than the other alternatives compared to Proposed Operations. Model results show that the area of sand mobilization at all of the model locations except China Bar would decline under alternative Scenario 1a (Reregulating). The area of sand mobilization would decline the least under the Year-round 6-Inches-Per-Hour Ramping

Rate and Navigation scenarios, with minor increases in mobilization area depending on sandbar location and water year type.

Spawning Gravel

Trapping of sand and gravel within the project's mainstem reservoirs and flow fluctuations caused by project operations may contribute to a reduction in the quality and quantity of spawning habitat downstream of Hells Canyon dam that is available for fall Chinook salmon. In this section, we evaluate the effects that proposed and alternative operations would have on the quality and quantity of spawning gravel.

Our Analysis

Numerous studies of the effects of dams show that the combination of a reduced sediment supply from sediment trapping in reservoirs and the elimination of large-magnitude floods that typically mobilize gravel can cause scouring and armoring of the stream bed downstream of dams (e.g., Gilbert, 1917; Leopold and Maddock, 1953; Galay, 1983). Armoring and the associated increase in roughness can diminish the quality of spawning habitat by increasing the threshold shear stress necessary for the transport and supply of gravel to spawning sites (Buffington and Montgomery, 1999). This increased stability can result in greater retention of finer sediments and reduce the permeability of spawning substrates (Wilcock, 1998; Wilcock et al., 2001; Wilcock and Kenworthy, 2002), which can lead to reductions in the survival of incubating salmon and steelhead eggs.

To assess the potential for gravel mobilization, we examined annual flow-duration curves and the minimum discharge required for gravel mobilization. As discussed in section 3.4.1.3, flows less than 30,000 cfs are sufficient to mobilize a portion of the bed containing sediment within the size range of spawning gravel (Parkinson et al., 2003a). Therefore, we used the percent exceedance reported for 22,200 cfs (the maximum peak flow in the historical period of record with an annual recurrence) to compare the change in potential for gravel mobilization under Proposed Operations, under Reregulating, Year-round 2-Inches-Per-Hour and Year-round 6-Inches-Per-Hour Ramping Rate restrictions, and under the Flow Augmentation and Navigation scenarios. Table 14 presents the percent exceedance for selected flows based on flow-duration curves for Proposed Operations and the five alternative scenarios.

Table 14. Percent exceedance for selected flows based on flow-duration curves for Proposed Operations and five alternative scenarios. (Source: Parkinson et al., 2005a, as modified by staff)

		Percent Exceedance for the Indicated Flow[b]		
Scenario	**Water Year Type[a]**	**10,000 cfs**	**22,200 cfs**	**39,621 cfs**
Proposed Operations	Extremely low	23	1	0
	Medium	95	39	3
	Extremely high	100	65	38
Scenario 1a (Reregulating)	Extremely low	35	0	0
	Medium	100	35	3
	Extremely high	100	63	38

Scenario	Water Year Type[a]	Percent Exceedance for the Indicated Flow[b]		
		10,000 cfs	22,200 cfs	39,621 cfs
Scenario 1b (Year-round 2-Inches-Per-Hour Ramping Rate)	Extremely low	34	0	0
	Medium	100	35	2
	Extremely high	100	63	37
Scenario 1c (Year-round 6-Inches-Per-Hour Ramping Rate)	Extremely low	31	0	0
	Medium	99	36	2
	Extremely high	100	65	37
Scenario 2 (Flow Augmentation)	Extremely low	28	1	0
	Medium	93	40	2
	Extremely high	100	65	38
Scenario 3 (Navigation)	Extremely low	24	1	0
	Medium	95	40	2
	Extremely high	100	65	38

[a] Water year types and corresponding flow years include extremely low (1992), medium (1995), and extremely high (1997).

[b] Indicated flows correspond to the simulated flow for incipient motion of 1 mm sand (10,000 cfs), the maximum peak flow with an annual recurrence (22,200 cfs), and the flow with a 1.5-year recurrence (39,621 cfs), as indicated in the AIRs.

Results of these comparisons indicate that the occurrence of potential gravel-mobilizing flows of 22,200 cfs would be reduced by as much as 4 percent under alternative Scenarios 1a, 1b, and 1c during medium water years. Gravel mobilization at 22,200 cfs would remain about the same or increase slightly under the Flow Augmentation and Navigation scenarios.

3.4.2.2 Sediment Augmentation and Monitoring

Idaho Power proposes to stabilize terraces containing culturally important sites and has also agreed to implement Forest Service condition no. FS-4, which includes measures to stabilize or restore sandbars. Idaho Power also proposes to implement a gravel monitoring plan, which it describes in appendix B of its comments on the draft EIS. The monitoring plan would include the following measures downstream of Hells Canyon dam: (1) continuation of aerial redd surveys from Asotin, WA (RM 145) to Hells Canyon dam and deep-water redd surveys at approximately 35 sites; (2) high resolution bathymetry monitoring to estimate bed scour or deposition at selected reaches every 3 to 5 years; (3) ground surveys in shallow areas where bathymetric monitoring is infeasible; (4) reach-scale mapping of spawning substrate in potential high-use spawning index sites upstream of the Salmon River every 5 years; (5) substrate classification by photography at approximately 650 locations between Hells Canyon dam and the Salmon River every 3 to 5 years and after high runoff events; (6) assessment of gravel quality by monitoring incubation and emergence at four sites between Hells Canyon dam and the Salmon River at 5-year intervals; and (7) the use of scour chains or sliding bead monitors to assess bed scour or gravel deposition at selected known and potential spawning areas. Idaho Power also states in its comments on the draft EIS that if monitoring indicates that gravel augmentation may be necessary or appropriate, the Commission could then instruct Idaho Power to develop a plan to address the issue.

Resource agencies, tribes, and other parties recommend measures for sediment augmentation and monitoring to address beach erosion, terrace instability, and the effects on spawning gravel as a result of ongoing project effects. We evaluate the effectiveness of the various measures below.

Forest Service condition FS-4 specifies that Idaho Power fund a sandbar maintenance and restoration program consisting of sand augmentation and monitoring. To fund the program, Idaho Power would establish and maintain an interest-bearing account, with the Forest Service as the beneficiary. Under this condition, the Forest Service would use the fund to restore 14 acres of sandbars on or adjacent to National Forest System lands. Sand would be placed at restoration sites between the levels of the 50,000 cfs and 100,000 cfs flows, which is equivalent to flows with recurrence frequencies of approximately 2.3 and 30 years, respectively, as measured immediately downstream of Hells Canyon dam.

Under measure AR/IRU-21, Idaho Power would be required to replenish an appropriate portion of the sediments (sand and gravel) to the Snake River downstream of Hells Canyon dam that have been diminished due to project operations. The quantity and composition of the sediment to be added would be determined based on specific habitat needs of anadromous and resident fish species and benthic organisms affected by the disruption of fine sediment and gravel supplies. Idaho Power would be required to develop a plan to identify a source and means of material excavation, propose methods and costs for sediment delivery, estimate sediment volumes and water energy available for sediment transport, address monitoring and reporting, and develop an adaptive management protocol for sediment augmentation.

The Forest Service (FS-31) recommends that Idaho Power prepare a gravel monitoring plan. The plan would include weekly aerial redd surveys, mapping of reach-scale spawning substrate, identification of representative reaches for intensive annual substrate monitoring (riverbed elevations, bed scour and deposition, and bedload sampling), and provide the Forest Service with an annual report of results.

Under Interior-68, Interior recommends that Idaho Power monitor selected beaches and gravel bars to determine rates of sediment depletion on exposed and submerged sediment deposits. Under Interior-69, Interior also recommends that Idaho Power monitor the quantity and quality of gravel material used by aquatic species in the Snake River below Hells Canyon dam. NMFS-6 recommends that Idaho Power, in cooperation with various resource agencies, design and carry out monitoring of fall Chinook salmon spawning gravel between Hells Canyon dam and its confluence with the Salmon River. The recommendation calls for the study to be repeated every 5 years and to employ high-resolution, multi-beam bathymetry, reach-scale substrate mapping using the Idaho Power's GIS database, and substrate monitoring using scour chains or sliding bead monitors. NMFS-7 recommends the evaluation of fall Chinook salmon egg-to-fry survival in at least two representative spawning areas in the Snake River downstream of Hells Canyon dam in 2015 and every 5 years thereafter. NMFS further recommends that the location of these specific monitoring locations be approved by NMFS and that Idaho Power provide a report of Chinook salmon egg-to-fry survival to NMFS and file it with FERC by December 31 of the same year.

The Nez Perce Tribe (NPT-20) recommends that Idaho Power be required to monitor the movement of sand, silt, and gravel from above, through, and downstream of the Hells Canyon Project to accurately quantify the composition and rate of movement of sediment. The Nez Perce Tribe (NPT-21) also recommends that Idaho Power be required to restore sandbars to their pre-project number and size through the use of sand augmentation practices to be developed in consultation with resource agencies. The purpose of sand augmentation would be to protect tribal cultural sites at risk of degradation from the erosion of sandbars and terraces.

ODFW-53 recommends that Idaho Power implement a gravel monitoring program to assess spawning gravel for fall Chinook salmon downstream of Hells Canyon dam. ODFW-53 also

recommends that Idaho Power develop a bedload augmentation program if monitoring indicates project operations are adversely affecting the quantity and quality of spawning gravel.

Our Analysis

Based on the unit costs for sand procurement, trucking, transport by barge, and placement, we estimate that the funding specified by the Forest Service (FS-4; $937,000 per year for 10 years) would provide sand augmentation at selected beaches of about 2,500 cubic yards per year, which is roughly 7 to 24 percent of the average annual rate of sand loss estimated by Wilcock et al. (2002) for all sandbars below Hells Canyon dam between 1964 and 1990. The sand augmentation program, which would involve material placement above the annual flow level, would help maintain some current beaches and provide a buffer against terrace erosion. This could help reduce the loss of cultural resources, provide recreational benefits, and help maintain the scenic and recreational values of the Hells Canyon wild and scenic river. Restoring sandbars would also provide some benefits to aquatic resources because the augmented sand would be engaged and redistributed by flows with recurrence frequencies ranging from approximately 2.3 to 30 years. Such a program would also have some adverse environmental effects, due to the quantity of sand required and the effects of sediment procurement and delivery. Barges delivering sediment could interfere with recreation traffic and possibly disturb wildlife, particularly eagles.

Sand augmentation to restore beaches to their pre-dam number and size, as recommended by the Nez Perce Tribe (NPT-21) and AR/IRU-21, could restore rearing habitat for juvenile fall Chinook salmon by increasing the availability of near-shore habitat, maintain beaches used for recreation, and reduce potential losses to archaeological resources from beach erosion. However, the volumes of sand required to restore beaches to their pre-dam condition would be considerably larger than the amounts needed for partial restoration of selected sandbars, as called for in FS-4. Consequently, there would be a proportionate increase in adverse environmental effects associated with sediment procurement and delivery to restore beaches to their pre-dam number and size.

Monitoring the movement of sand and gravel and changes in the volume of sand and gravel bars, as recommended by Interior-68 and NPT-20, along with monitoring the use of sand and gravel by Chinook salmon, as recommended under FS-31, Interior-69, ODFW-53, and NMFS-6 would help quantify any changes in sediment storage (ΔS) downstream of Hells Canyon dam, a critical component currently missing from the sediment budget and necessary for the assessment of the effects of ongoing project operations on the spawning and rearing habitat of fall Chinook salmon. Monitoring salmon egg-to-fry survival, as described in NMFS-7, would help to determine whether the quality of incubation habitat has declined and thereby guide any corrective measures in a manner consistent with Idaho Power's proposed gravel monitoring plan. Results from sandbar monitoring would establish current conditions, provide an evaluation of the effectiveness of ramping rate restrictions on the stability of beaches, allow assessment of near-shore beach erosion from boat wakes relative to other recreational, project-related, and natural processes, and help determine if the documented increase in the use of floodplains and culturally significant terraces by recreation users is linked to a decline in sandbars. If significant changes in the number and volume of sandbars are detected, monitoring results could be used to test reasonable alternatives for sand augmentation. Our analysis indicates that conventional sand procurement and delivery methods are not economically or environmentally feasible at this time; however, adaptive measures other than sand augmentation could be proposed to maintain baseline sandbar conditions and protect aquatic habitat. Adaptive measures could include the restriction of various recreational activities (such as powerboat use, camping, and beach access) that are linked to beach and terrace erosion and the loss of fall Chinook rearing habitat.

Substrate monitoring with the use of scour chains and the sampling of bedload over a range of flows would help calibrate future sediment transport models for both sand and gravel. Bedload sampling may not be feasible in some remote locations. Results would fill data gaps in the current sediment budget and quantify the supply rate of sand and gravel from tributary sources to sandbars and spawning sites.

Gravel monitoring, in conjunction with spawning surveys, could determine whether spawning gravel is limiting fall Chinook production. The potential benefits of augmenting spawning gravel could be evaluated by conducting a pilot study consisting of adding gravel and monitoring any effects on the quantity of available spawning habitat. We provide further analysis of a pilot spawning gravel augmentation study in Aquatic Resources section 3.6.2.14, *Sediment Augmentation*.

3.4.3 Cumulative Effects

Alteration of the processes and conditions influencing sediment supply and transport contribute to cumulative effects that can adversely affect ecological, cultural, and recreational resources. The dramatic reduction in sediment supply downstream of dams directly affects the morphology and substrate of the river by reducing the number and size of sand and gravel bars and coarsening the river bed. These effects can be further compounded by flow regulation associated with impoundments.

Historical land use and water resource management have resulted in substantial changes to the sediment budget of the Snake River basin. Land use practices such as deforestation, grazing, land cultivation and irrigation, hydraulic and dredge mining, road construction, land development, channel clearing, and channel straightening, as well as the increased frequency of wildfires, all contributed to higher erosion rates and sediment yield to the drainage network. During the same period of historical development, numerous small and large dams were constructed throughout the drainage network. Between 1901 and 1957, 13 dams were constructed on the main stem Snake River upstream of the Hells Canyon Project. Swan Falls dam, the first dam on the mainstem Snake River upstream of Brownlee dam, was constructed in 1901 and would have trapped much of the increased sediment resulting from historical land use practices upstream of Swan Falls. Mainstem and tributary dams upstream of Brownlee dam have effectively trapped most of the sediment entering the Hells Canyon reach of the Snake River, dramatically reducing the amount of sediment delivered to the free-flowing Hells Canyon Reach downstream of Hells Canyon dam. With respect to sediment supply to the Snake River downstream of Hells Canyon dam, sediment retention by dams has more than offset any increase in sediment supply from land development.

Dam operations reducing the frequency of large magnitude floods can lead to downstream bed armoring, which diminishes the extent and quality of spawning sites and increases the flow threshold necessary to transport gravel. The downstream effects of a dam on sediment supply increase with time because of the cumulative effects of trapping sediment. The impact of sediment trapping by dams is most pronounced immediately downstream of the dams, diminishing with increasing distance downstream as the number of tributary inputs increases.

Cumulative adverse effects on the Snake River downstream of Hells Canyon dam will continue as a result of additional sediment trapping by the Hells Canyon Project. Most of the coarse sediment trapped by the dams is sand. The loss of sand increases the threshold flow for mobilizing gravel, decreasing the frequency of flow events capable of moving spawning gravels.

Idaho Power proposes to address the project's cumulative effects on sediment transport by implementing FS-4, which includes measures to stabilize or restore sandbars.

3.4.4 Unavoidable Adverse Effects

The Snake River annually delivers between 220,000 and 384,000 tons of coarse sediment (>0.063 mm) to Brownlee reservoir. Tributaries deliver an additional 54,000 to 268,000 tons per year of coarse sediment to the Brownlee, Oxbow and Hells Canyon reservoirs. The total load of coarse sediment trapped above Hells Canyon dam is estimated to be 274,000 to 652,500 tons per year. Based on these estimates, the three reservoirs would trap between 13,700,000 and 32,600,000 tons of sand and gravel over the next 50 years that would otherwise be delivered downstream of Hells Canyon dam. This would equate to 274,000 to 652,000 tons of sand and gravel annually. The coarse sediment delivered to the Hells Canyon Reach increases from zero at Hells Canyon dam to 3,850–19,100 tons per year at Pine Bar,

to 5,540–27,520 tons per year at Tin Shed, to 10,000–49,900 tons per year at the Salmon River confluence (excluding the Imnaha River). The total flux of coarse sediment within the Snake River at its confluence with the Salmon River is between 3 and 7 percent of what it would be without the three dams of the Hells Canyon Project. This assumes the Swan Falls dam and upstream tributary dams remain intact. Without augmentation of coarse grained sediment downstream of Hells Canyon dam, the loss of sand and gravel bars would continue to adversely affect aquatic and riparian habitat.

3.5 WATER QUALITY

3.5.1 Affected Environment

3.5.1.1 Water Quality Standards

The Snake River within the project area is an interstate water body with the Idaho/Oregon State boundary described as the centerline of the river. Since the waters from each side of the Snake River can mix with the other side, waters of the entire river cross-section must be of a quality to protect the beneficial uses designated by the states of Idaho and Oregon. Beneficial uses designated by Idaho and Oregon for Snake River reaches in the project area are presented in tables 15 and 16, respectively.

As required under section 303(d) of the federal CWA, Idaho and Oregon periodically review the status of water quality and develop a list of water-quality limited waterbodies referred to as the 303(d) list. Both states have listed segments of the Snake River in the project area on their respective 303(d) list. The most recent U.S. Environmental Protection Agency (EPA)-approved 303(d) listings are presented in tables 15 and 16. IDEQ and ODEQ have cooperatively developed a total maximum daily load (TMDL) to address these listings.

Table 15. Idaho designated beneficial uses and most recent EPA-approved 303(d) listings for the Snake River. (Sources: IDEQ, 2005a; IDEQ and ODEQ, 2004, as modified by staff)

Segment	Designated Beneficial Uses[a]	303(d) Listed Pollutants
Brownlee reservoir, Scott Creek to Brownlee dam (RM 347–285)	Coldwater aquatic life, primary contact recreation, domestic water supply, special resource water[b]	DO, mercury, nutrients, pH,[c] sediment
Oxbow reservoir (RM 285–272.5)	Coldwater aquatic life, primary contact recreation, domestic water supply, special resource water[b]	Nutrients, sediment, pesticides,
Hells Canyon reservoir (RM 272.5–247)	Coldwater aquatic life, primary contact recreation, domestic water supply, special resource water[b]	Not listed
Downstream Snake River, Hells Canyon dam to Salmon River inflow (RM 247–188)	Coldwater aquatic life, salmonid spawning, primary contact recreation, domestic water supply, special resource water[b]	Temperature

Notes: DO – dissolved oxygen
EPA – Environmental Protection Agency
IDEQ – Idaho Department of Environmental Quality
ODEQ – Oregon Department of Environmental Quality
pH – potential hydrogen
RM – river mile
TMDL – total maximum daily load

[a] The designation of salmonid spawning for both Idaho and Oregon specifies that this designation applies only when and where salmonids are present and spawning.

[b] Idaho's designation of special resource water is applied where there are unique or outstanding characteristics or where intensive protection of water quality is needed to maintain a current designated beneficial use.

[c] Based on results of analyzing pH values for the TMDL process, IDEQ and ODEQ (2004) recommended that the state of Idaho delist Brownlee reservoir for pH.

Table 16. Oregon designated beneficial uses and most recent EPA-approved 303(d) listings for the Snake River. (Sources: IDEQ and ODEQ, 2004; ODEQ, 2005, as modified by staff)

Segment	Designated Beneficial Uses	303(d) Listed Pollutants
Upstream Snake River to Farewell bend (RM 395–335)	Public/private domestic water supply, industrial water supply, irrigation water, livestock watering, salmonid rearing and spawning[a] (trout), resident fish (warm water) and aquatic life, water-contact recreation, wildlife and hunting, fishing, boating, aesthetics	Mercury, temperature
Brownlee reservoir, Oxbow reservoir, and upper half of Hells Canyon reservoir (RM 335–260)	Public/private domestic water supply, industrial water supply, irrigation water, livestock watering, salmonid rearing and spawning,[a] resident fish and aquatic life, water-contact recreation, wildlife and hunting, fishing, boating, aesthetics, hydropower	Mercury, temperature
Lower half of Hells Canyon reservoir and downstream Snake River (RM 260–188)	Public/private domestic water supply, industrial water supply, irrigation water, livestock watering, salmonid rearing and spawning[a] (downstream), resident fish and aquatic life, water-contact recreation, wildlife and hunting, fishing, boating, aesthetics, anadromous fish passage, commercial navigation and transport	Mercury, temperature

Note: RM – river mile

[a] The designation of salmonid spawning for both Idaho and Oregon specifies that this designation applies only when and where salmonids are present and spawning.

Each state has its own water quality criteria developed specifically to protect the designated beneficial uses. Idaho's criteria are in the Idaho Administrative Code (IDAPA 58.01.02) and Oregon's criteria are in the Oregon Administrative Rules (OAR 340-41). The interstate nature of the Snake River in the project area requires that the more stringent of the two states' water quality criteria be applied to the river. Because Idaho and Oregon use different methods to establish water quality criteria, it is not immediately obvious which state's criteria are most stringent. Therefore, IDEQ and ODEQ conducted a direct calculation of the criteria to determine which state's criteria were most stringent (Glass et al., 2001) prior to development of the TMDL. The resulting water quality targets are listed in table 17.

Table 17. TMDL water quality targets for the Snake River–Hells Canyon and applicable Idaho and Oregon water quality criteria. (Source: IDEQ and ODEQ, 2004; Idaho Administrative Procedures Act 58 Title 01 Chapter 02; OAR Chapter 340, Division 041, as modified by staff)

Parameter	TMDL Selected Target	Water Quality Criteria [a]
Temperature		
Full Snake River to Hells Canyon reach (RM 409 to 188), year-round	For coldwater aquatic life and salmonid rearing, a maximum 7-day average maximum temperature of 17.8ºC if and when the site potential is less than a 7-day average maximum temperature of 17.8ºC. If and when the site potential is greater than a 7-day average maximum temperature of 17.8ºC, the target is no more than a 0.14ºC increase from anthropogenic sources. When aquatic species listed under the ESA are present, and if a temperature increase would impair the biological integrity of the threatened or endangered species' population, the target is no greater than a 0.14ºC increase from anthropogenic sources.	Idaho: For aquatic life, 22°C or less with a maximum daily average of no greater than 19°C. Oregon: For salmon/steelhead migration corridor, a 7-day average maximum temperature of 20ºC at times and places where the salmonid spawning standard does not apply. Where the department determines that the natural thermal potential of all or a portion of a waterbody exceeds this, the natural thermal potential temperatures supersede the biologically-based criteria, and are deemed to be the applicable temperature criteria for that water body. [b]
Downstream Snake River (RM 247 to 188), October 23 to April 15	For salmonid spawning, when and where it occurs, a maximum weekly maximum temperature of 13ºC (when and where salmonid spawning occurs) if and when the site potential is less than a weekly maximum temperature of 13ºC. If and when the site potential is greater than a weekly maximum temperature of 13ºC, the target is no more than a 0.14ºC increase from anthropogenic sources. When aquatic species listed under the ESA are present, and if a temperature increase would impair the biological integrity of the threatened or endangered species' population, the target is no greater than a 0.14ºC increase from anthropogenic sources. These targets apply only to from October 23 to April 15 for fall Chinook salmon and from November 1 to March 30 for mountain whitefish.	Idaho: For salmonid spawning and incubation, 13°C or less with a maximum daily average of no greater than 9°C. Oregon: For salmon/steelhead spawning to fry emergence, a 7-day average maximum temperature of 13ºC from October 23 to April 15. Where ODEQ determines that the natural thermal potential of all or a portion of a water body exceeds this, the natural thermal potential temperatures supersede the biologically-based criteria, and are deemed to be the applicable temperature criteria for that water body.[b]

Parameter	TMDL Selected Target	Water Quality Criteria [a]
Dissolved Oxygen		
Downstream Snake River (RM 247 to 188), year-round	For coldwater aquatic life and salmonid rearing, 8 mg/L water column DO as an absolute minimum, or (where conditions of barometric pressure, altitude, and temperature preclude attainment of 8 mg/L) DO levels not less than 90% of saturation; unless adequate (i.e., continuous monitoring) data are collected to allow assessment of the multiple criteria section in the standards.	Idaho: For aquatic life, greater than 6.0 mg/L at all times with the exceptions of the bottom 20% of reservoir water depths that are 35 meters or less, bottom 7 meters of reservoir water depths that are greater than 35 meters, and the hypolimnion in stratified reservoirs. [c] Oregon: For cold water aquatic life, 8 mg/L water column DO as an absolute minimum, or (where conditions of barometric pressure, altitude, and temperature preclude attainment of 8 mg/L) DO levels not less than 90% of saturation; unless the Department determines that adequate information exists to use 8.0 mg/L as a 30-day mean minimum, 6.5 mg/L as a 7-day minimum mean, and 6.0 mg/L as an absolute minimum. Applicable at times and places in the Snake River where the salmonid spawning standard does not apply.
Downstream Snake River (RM 247 to 188), October 23 to April 15	For salmonid spawning, when and where it occurs: 11 mg/L water column DO as an absolute minimum or (where conditions of barometric pressure, altitude, and temperature preclude attainment of 11 mg/L) DO levels not less than 95% of saturation; with intergravel DO not lower than 8 mg/L, unless adequate (i.e., continuous monitoring) data are collected to allow assessment of the multiple criteria section in the standards. These targets will apply only to that portion of the Snake River to Hells Canyon TMDL reach downstream of Hells Canyon dam (RM 247–188) from October 23 to April 15 for fall Chinook salmon and from November 1 to March 30 for mountain whitefish.	Idaho: For salmonid spawning and incubation, intergravel DO of not less than 5.0 mg/L or 7-day average mean of less than 6.0 mg/L. Water column DO of not less than 6.0 mg/L or 90% of saturation, whichever is greater. [c] Oregon: For active salmonid spawning through fry emergence use, water column DO of 11.0 mg/L as an absolute minimum unless minimum intergravel DO measured as a spatial median is 8.0 mg/L or greater, then the water column DO criterion is 9.0 mg/L. Where conditions of barometric pressure, altitude, and temperature preclude attainment of 11 or 9 mg/L, DO levels must not be less than 95% of saturation. Spatial median intergravel DO must not fall below 8.0 mg/L. Applicable October 23 to April 15 from Hells Canyon dam to Oregon/Washington border.

Parameter	TMDL Selected Target	Water Quality Criteria [a]
Full Snake River to Hells Canyon reach (RM 409 to 188), year-round	For coolwater aquatic life, 6.5 mg/L water column DO as an absolute minimum, unless adequate (i.e., continuous monitoring) data are collected to allow assessment of the multiple criteria section in the standards.	Idaho: For aquatic life, greater than 6.0 mg/L at all times with the exceptions of the bottom 20% of reservoir water depths that are 35 meters or less, bottom 7 meters of reservoir water depths that are greater than 35 meters, and the hypolimnion in stratified reservoirs. [c] Oregon: For cold water aquatic life, 8 mg/L water column DO as an absolute minimum, or (where conditions of barometric pressure, altitude, and temperature preclude attainment of 8 mg/L) DO levels not less than 90% of saturation; unless the Department determines that adequate information exists to use 8.0 mg/L as a 30-day mean minimum, 6.5 mg/L as a 7-day minimum mean, and 6.0 mg/L as an absolute minimum. Applicable at times and places in the Snake River where the salmonid spawning standard does not apply.
Total dissolved gas, Oxbow reservoir to the Salmon River inflow (RM 285 to 188)	Less than 110% of saturation, except when stream flow exceeds the 10-year, 7-day average flood flow.	Idaho: Less than 110% of saturation. Oregon: Except when streamflow exceeds the 10-year, 7-day average flood flow, 105% of saturation or less in hatchery-receiving waters or waters less than 2 feet deep, 110% of saturation or less elsewhere.
Nutrients, Full Snake River to Hells Canyon reach (RM 409 to 188), May through September	Less than or equal to 0.07 mg/L total phosphorus.	Idaho: No phosphorus criteria specified. Oregon: No phosphorus criteria specified.
Nuisance algae, Full Snake River to Hells Canyon reach (RM 409 to 188)	14 μg/L mean growing season limit (nuisance threshold of 30 μg/L with exceedance threshold of no greater than 25%). [d]	Idaho: None specified. Oregon: 15 μg/L as average chlorophyll-a concentration used to identify reservoirs and rivers where phytoplankton may impair the recognized beneficial uses.
Bacteria, Full Snake River to Hells Canyon reach (RM 409 to 188)	Less than 126 *E. coli* organisms per 100 mL as a 30 day log mean with a minimum of 5 samples and no sample greater than 406 *E. coli* organisms per 100 mL.	Idaho: Same as TMDL target with addition of 235 *E. coli* organisms per 100 mL for public swimming areas. Oregon: Same as TMDL target.
pH, Full Snake River to Hells Canyon TMDL reach (RM 409 to 188)	7 to 9 pH units.	Idaho: 6.5 to 9.0 units. Oregon: 7.0 to 9.0 units from RM 260 to 335, 6.5 to 8.5 elsewhere.

Parameter	TMDL Selected Target	Water Quality Criteria [a]
Sediment (turbidity), Full Snake River to Hells Canyon TMDL reach (RM 409 to 188)	Less than or equal to 80 mg TSS/L for acute events lasting no more than 14 days, and less than or equal to 50 mg TSS/L monthly average.	Idaho: Shall not exceed background turbidity by more than 50 NTU instantaneously or more than 25 NTU for more than 10 consecutive days. Oregon: No more than 10% cumulative increase in natural stream turbidity.
Mercury, Full Snake River to Hells Canyon reach (RM 409 to 188)	Less than 0.012 μg/L water column concentration (total). Less than 0.35 mg/kg in fish tissue.	Idaho: Less than water column concentration of 0.14 μg/L for drinking water, 2.1 μg/L as a criterion maximum concentration and 0.012 μg/L as a criterion continuous concentration. Oregon: Not to exceed 2.4 µg/L for acute protection of aquatic life, 0.012 µg/L for chronic protection of aquatic life, 0.144 μg/L for protection of human health from ingestion of water and fish, 0.146 μg/L for protection of human health from ingestion of fish, and 2.0 µg/L for drinking water..
Pesticides, Oxbow reservoir segment and upstream waters (RM 409 to 272.5)	Less than 0.024 ng/L water column concentration DDT. Less than 0.83 ng/L water column concentration DDD. Less than 0.59 ng/L water column concentration DDE. Less than 0.07 ng/L water column concentration dieldrin.	Idaho: Less than water column DDT of 0.59 ng/L, DDD of 0.83 ng, DDE of 0.59 ng/L, and dieldrin of 0.14 ng/L. Oregon: For acute protection of aquatic life, not to exceed 1.1 μg/L as DDT and 2.5 μg/L as dieldrin. For chronic protection of aquatic life, not to exceed 1.0 ng/L as DDT and 1.9 ng/L as dieldrin. For human protection from ingestion of water and fish, not to exceed 0.24 ng/L as DDT and 0.071 ng/L as dieldrin. For human protection from ingestion of fish, not to exceed 0.24 ng/L as DDT and 0.076 ng/L as dieldrin.

Notes:
C – Celsius
DO – dissolved oxygen
ESA – Endangered Species Act
mg/kg – milligram per kilogram
mg/L – milligram per liter
ng/L – nanogram per liter
pH – potential hydrogen
TMDL – total maximum daily load
TSS/L – total suspended solids per liter
μg/L – microgram per liter

[a] Idaho Power proposes site-specific criteria. However, EPA (letter from Christine Psyk, Associate Director, Office of Water and Watersheds, EPA, Seattle, Washington, to Barry Burnell, Administrator, Water Quality Division, Idaho Department of Environmental Quality, Boise, Idaho, dated September 27, 2006) states that Idaho Power's proposed site-specific temperature criteria would likely not protect salmon spawning and egg incubation. In its comments on the draft EIS, the Nez Perce Tribe objects to Idaho Power's proposal.

[b] Oregon's revised standards allow a cumulative increase from anthropogenic sources of no more than 0.3°C above the applicable criterion.

[c] Waters discharged from dams, reservoirs, and hydroelectric facilities are not subject to these criteria, but instead a 30-day mean of 6.0 mg/L, 7-day mean minimum of 4.7 mg/L, and an instantaneous minimum of 3.5 mg/L from June 15 through October 15.

[d] Algae concentrations exceeding one or both TMDL selected targets are indicative of nuisance levels.

3.5.1.2 Temperature

Inflows to the project area and the Snake River both upstream and downstream of the project are generally very warm during the summer. Although some tributaries with dams a short distance upstream of their confluence with the Snake River (e.g., the Owyhee and Malheur rivers) are relatively cool (table 18), a short distance downstream of the dam, spot measurements of temperature, provided by Idaho Power in its comments on the draft EIS, indicate that these streams warm considerably prior to entering the Snake River. For the most part, maximum summertime water temperatures in the Snake River and its tributaries exceed 20 degrees Celsius (°C).

Brownlee reservoir, which has an average hydraulic retention time of about one month, substantially alters Snake River temperatures. Storage of water in the reservoir and the depth of the powerhouse intake have delayed seasonal warming and cooling of water downstream of the Brownlee dam compared to conditions that occurred prior to project construction (figure 26). The reservoir has three zones with different general thermal characteristics (figure 27). Temperatures are nearly uniform throughout the water column in the uppermost zone referred to as the riverine zone, which extends down to about RM 325. Farther downstream the water is deeper, slower, and less turbulent, and thermal stratification begins to become evident in a zone referred to as the transition zone, which extends down to approximately RM 308, depending on the season. In the deepest portion of the reservoir, the lacustrine zone, strong summer stratification is evident. This zone consists of three classic strata: (1) the warm upper layer referred to as the epilimnion, (2) the metalimnion, which has a strong thermal gradient, and (3) the cold, deep hypolimnion. Figure 28 displays water temperatures and DO concentrations reported for mid-July and late September of 1995, a year with average hydrologic conditions. Summertime temperatures generally range from 18 to 25°C in the epilimnion, 8 to 17°C in the metalimnion, and cooler than 10°C in the hypolimnion. However, the extent of thermal stratification in Brownlee reservoir can be substantially different in wet years.

Table 18. Summary of Snake River tributary flows, water temperatures, and total phosphorus loadings, 1980–2003. (Sources: USGS, 2005e; StreamNet, 2005; IDEQ and ODEQ, 2004; IDEQ, 2005b; EPA, 2005; Hoelscher and Myers, 2003; WDOE, 2005b; NPCC, 2005, as modified by staff)

Stream or Discharge Source	Drainage Area[a] (square mile)	Snake River Mile	USGS Gage No.	Trib. RM	Mean Annual Flow[b] (cfs)	Mean May–Sept. Flow[b] (cfs)	Mean August Flow[b] (cfs)	Max Water Temp[c] (ºC)	Total Phosphorus Load (kg/day)
Salmon Falls Creek	2,106	587	13108150 near Hagerman, ID	1.9	158	140	106	23.0	--
Bruneau River	3,372	494	13168500 near Hot Spring, ID	22.0	356	497	86	29.5	56[d]
Owyhee River	11,108	396.7	13183000 below Owyhee dam, OR	27.3	512	418	200	10.0[e]	265[f]
Boise River	4,031	396.4	13213000 near Parma, ID	3.8	1,564	1,605	800	24.0	1,114[f]
City of Nyssa	NA	385	NA	NA	[g]	--	--	--	11[h]
Amalgamated Sugar	NA	385	NA	NA	[g]	--	--	--	50[h]
City of Fruitland	NA	373	NA	NA	[g]	--	--	--	5.5[h]
Heinz Frozen Foods	NA	370	NA	NA	[g]	--	--	--	412[h]
Malheur River	4,719	368.5	13233300 below Nevada dam, OR	--[i]	243	146	92	16.0[e]	461[f]
Payette River	3,309	365.6	13251000 near Payette, ID	4.1	2,861	3,202	1,172	24.5	710[f]
City of Weiser, ID, WWTP	NA	352		NA	[g]	--	--	--	32[h]
City of Weiser, ID, WTP	NA	352		NA	[g]	--	--	--	5.5[h]

Stream or Discharge Source	Drainage Area[a] (square mile)	Snake River Mile	USGS Gage No.	Trib. RM	Mean Annual Flow[b] (cfs)	Mean May–Sept. Flow[b] (cfs)	Mean August Flow[b] (cfs)	Max Water Temp[c] (ºC)	Total Phosphorus Load (kg/day)
Weiser River	1,686	351.6	13266000 near Weiser, ID	14.9	1,069	878	268	33.0	392[f]
Burnt River	1,100	327.5	13275000 at Huntington, OR	--	148[j]	149[j]	74[j]	26.8	52[f]
Powder River	1,705	296	13286700 near Richland, OR	--	255	223	51	27.5	126[i]
Brownlee Creek	61	288	13289650 near Heath, ID	--	--	--	--	--	--
Wildhorse River	177	283.3	13289960 at Brownlee dam, ID	0.25	135	141	31	24.0	32[k]
Indian Creek	40	271.3	13290060 near Oxbow, OR	--	--	--	--	--	--
Pine Creek	301	271	13290190 near Oxbow, OR	1.9	334	340	46	26.5	114[k]
Granite Creek	33	239	--	--	--	--	--	--	--
Sheep Creek	41	229	--	--	--	--	--	--	--
Imnaha River	871	191.6	13292000 at Imnaha, OR	19.3	513	732	211	25.5	--
Salmon River	13,923	188.2	13317000 at White Bird, ID	53.7	10,744	17,390	5,278	25.2	--
Grande Ronde River	4,000	168.7	13333000 at Troy, OR	45.3	2,968	3,065	777	31.3	--
Asotin Creek	320	145.3	13335050 AT Asotin, WA	0.1	103	93	36	23.8	--
Clearwater River	9,645	140	13342500 at Spalding, ID	11.6	14,530	18,870	8,795	26.5	--

Stream or Discharge Source	Drainage Area[a] (square mile)	Snake River Mile	USGS Gage No.	Trib. RM	Mean Annual Flow[b] (cfs)	Mean May–Sept. Flow[b] (cfs)	Mean August Flow[b] (cfs)	Max Water Temp[c] (ºC)	Total Phosphorus Load (kg/day)
Tucannon River	503	62	13344500 near Starbuck, WA	7.9	164	133	59	25.4	--
Palouse River	3,303	59.5	13351000 at Hooper, WA	19.6	590	212	41	31.1	--
Snake River	41,900	453.5	13172500 near Murphy, ID	NA	10,784	9,738	7,120	29.0	1,912[f]
Snake River	58,700	385.2	13213100 at Nyssa, OR	NA	13,702	12,738	8,651	28.0	--
Snake River	69,200	351.3	13269000 at Weiser, ID	NA	17,978	16,801	10,338	27.5	--
Snake River	73,300	247.0	13290450 at Hells Canyon dam, ID-OR state line	NA	19,768	18,682	11,817	24.0	--
Snake River	92,960	167.2	13334300 at Anatone, WA	NA	34,639	40,527	17,984	22.5	--

Notes: -- – no data
NA – not applicable
WTP – water treatment plant
WWTP – wastewater treatment plant

[a] Basin areas for streams upstream of Hells Canyon dam are from Chandler and Chapman (2003-E.3.1-2, Ch. 4), basin areas for Granite and Sheep creeks are from Chandler et al. (2003a), and basin areas for downstream tributaries are from the NPCC (2005) subbasin plans.

[b] Mean flow values were supplied by a variety of sources that used different assessment periods and are thus not directly comparable between sites.

[c] Availability and the type of water temperature data varied by stream and were not always available for USGS gage locations. We compiled data for the lower portions of tributaries from various sources, and used the maximum of daily mean temperatures for continuous (hourly) data sets. This compilation was done to show general trends, and the results are not directly comparable since temperature data were recorded for different periods at the sites.

[d] Annual loading, based on 1997 through 2002.

[e] In its comments on the draft EIS, Idaho Power reported that spot measurement of water temperature made in 1995 reached as high as 19.4°C in the Owyhee River at its mouth and 23.2°C in the Malheur River at its mouth.

[f] May through September loading, based on data from 1995, 1996, and 2000.

[g] Current design flow of less than 3.5 million gallon per day (5.4 cfs).

[h] May through September loading, based on 1995 and 2000.

[i] 0.1 mile downstream of Nevada dam.

[j] Based on a single year of data, October 1979 through September 1980.

[k] May through September loading, based on 1999.

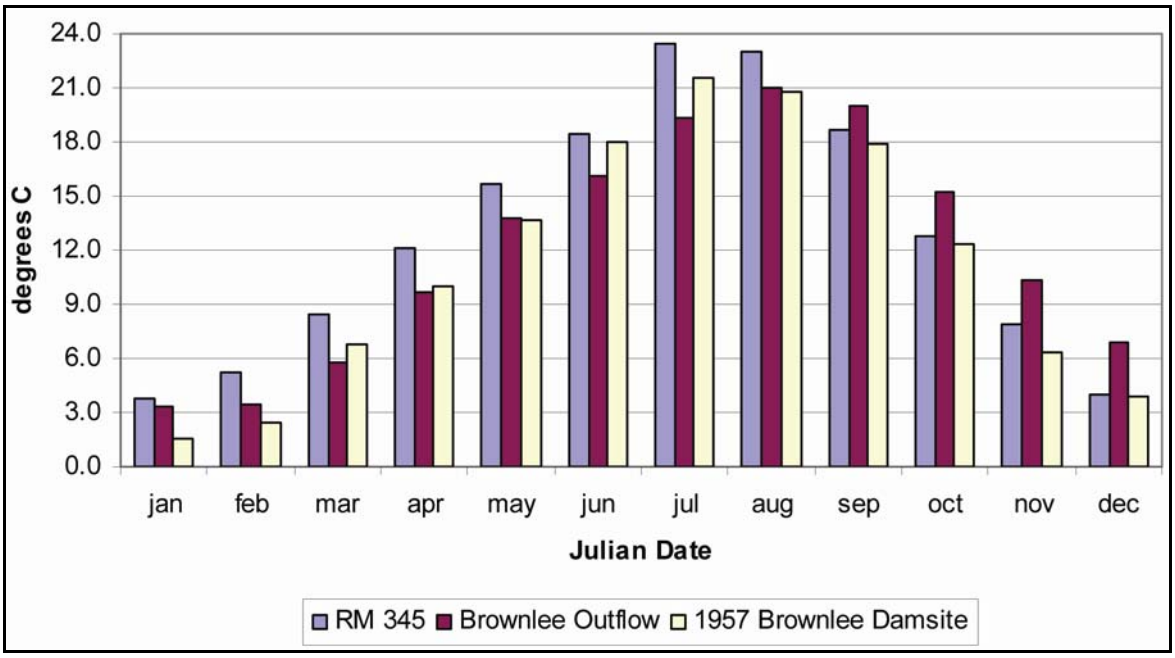

Figure 26. Recent (1990s) RM 345[a] and Brownlee reservoir outflow and pre-project (1957) Brownlee dam site mean monthly water temperatures for the Brownlee reservoir. (Source: IDEQ and ODEQ, 2004 [page 163, figure 2.3.23])

[a] RM 345 is plotted to show the temperature of Snake River inflow to Brownlee reservoir.

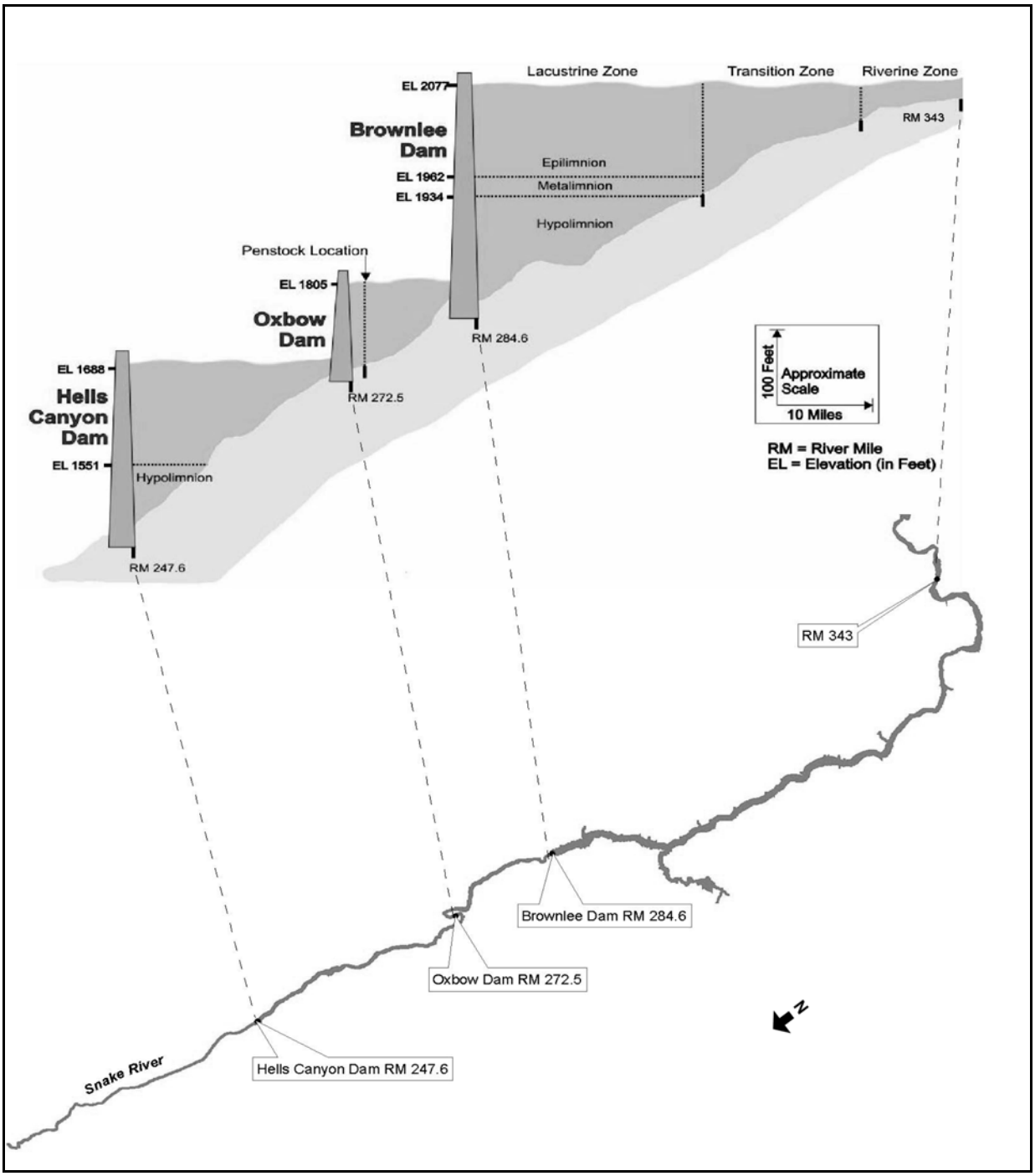

Figure 27. Reaches, zones, and strata of Brownlee, Oxbow, and Hells Canyon reservoirs. (Source: Myers et al., 2003a [page 117, figure 7])

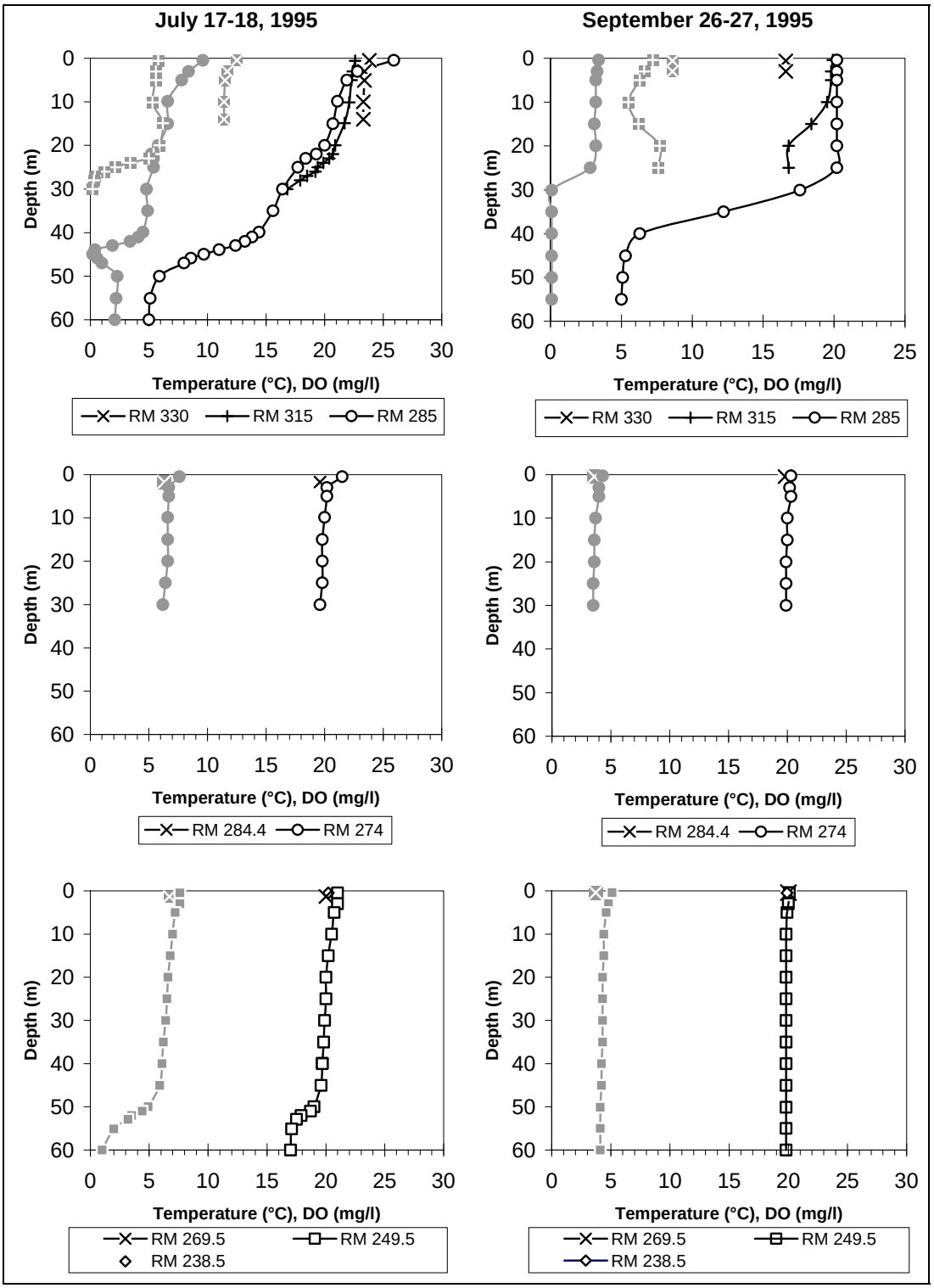

Figure 28. Vertical profiles of water temperature (open symbols) and DO concentrations (solid shaded symbols) in Brownlee reservoir (top), Oxbow reservoir (middle), and Hells Canyon reservoir (bottom), July and September 1995. (Sources: Myers et al., 2003b,c, as modified by staff)

For example, in early spring of the wet year of 1997, Brownlee reservoir was drawn down nearly 100 feet to an elevation of about 1,976 feet for flood-control purposes, which flushed the cold water from the reservoir. The water that was used to refill the reservoir had a temperature of about 12°C. Myers et al. (2003a) reported that the July water temperature at the centerline of the intake (1,948 feet) was 17°C in 1997 compared to 11°C in the dry year of 1992, but that the thermocline[43] was centered on the elevation of the powerhouse intake, as it was in other years.

Few data exist to describe the winter water temperatures in Brownlee reservoir. However, temperature data reported by Myers et al. (2003a) show that colder, less dense water sometimes occurs near the reservoir's surface rather than at depth in winter.

Water is routed rather quickly through the main body of Oxbow reservoir and Hells Canyon reservoir (refer to retention times in table 6), thus temperatures in these reservoir reaches are primarily determined by the temperature of releases from Brownlee dam. As can be seen in figure 28, the temperature generally remains relatively constant throughout the water column.

The portion of Oxbow reservoir that extends from the powerhouse intake (RM 272.8) to the dam (RM 272.5) typically receives little water compared to the rest of the reservoir. When the reservoir releases are less than 28,000 cfs, Idaho Power maintains a 100-cfs minimum flow release into the reach immediately downstream of the dam. This release water flows through the 0.3-mile-long portion of the reservoir and results in a longer hydraulic retention time for this part of the reservoir that averages 21.5 days. The combination of the slower routing of water through the reach and using three orifices in the spillway gate (with a centerline of approximately 1,776 feet) to provide the minimum flow releases into the reach downstream of the dam results in moderate thermal stratification in this portion of the reservoir during summer and into fall. During each of the profile measurements made in August 1998, temperature measurements ranged from about 23°C at the surface to about 14°C at the bottom. Even greater stratification was reported to occur during the summer of 1994, which was a dry year.

The Oxbow bypassed reach, which extends approximately 2.5 miles from the Oxbow dam (RM 272.5) to the Oxbow powerhouse (RM 270.0), receives a minimum flow of 100 cfs as described above. Water temperature in this bypassed reach is primarily determined by releases from the dam. Idaho Power's hourly monitoring results for the salmonid spawning period in 1997 and 1998 ranged from 17.2 to 24.3°C near the upper end of the reach (RM 272.2) and 20.2 to 24.8°C at the lower end of the bypassed reach (RM 270.2) (Myers and Chandler, 2003). Temperature measurements throughout the water column in the deep pool immediately upstream of the Indian Creek confluence showed that at flows of approximately 100 cfs, temperatures vary by about 1 to 3°C in August. Overall, temperatures in the Oxbow bypassed reach frequently exceed the 17.8°C coldwater target.

Based on an evaluation of temperature data collected during the 5-year period of 1996 through 2000, Myers and others (2003a) reported that both the 17.8°C-coldwater target and 13°C-spawning target were frequently exceeded in the project area. The Snake River inflows to Brownlee reservoir had annual exceedances of the 17.8°C target ranging from 37 to 47 percent of the days. Corresponding exceedance frequencies for the tailwaters of the Brownlee, Oxbow, and Hells Canyon developments were less than the inflow with one exception. In 1997, the 17.8°C target was exceeded 38 percent of the time in the inflow to Brownlee reservoir, but 57 percent of the time in the Oxbow tailwater. As discussed above, flood-control operations of Brownlee reservoir resulted in warmer temperatures during this high flow year. Annual exceedances of the 13°C target ranged from 40 to 47 percent of the days at the Snake River inflow to Brownlee reservoir and 31 to 38 percent of the days in the Hells Canyon tailwater.

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[43] The thermocline is the elevation within the metalimnion where the maximum rate of change in temperature occurs.

In its most recent application for water quality certification, Idaho Power (2007a) evaluated exceedance of the 7-day average maximum criterion of 20ºC and the 7-day average maximum salmonid spawning criterion of 13ºC for inflows to Brownlee reservoir and for outflows from Hells Canyon dam (figure 29). Table 19 presents the frequency that measured water temperatures exceeded these applicable water temperature criteria in each year between 1991 and 2004. In most years, the 7-day average maximum of 20°C was exceeded in the Snake River inflow to Brownlee reservoir and in outflows from each of the developments. Most of these exceedances occurred during the months of June through September. Exceedance of the 7-day average maximum criterion of 13°C was documented downstream of Hells Canyon dam in all years except 2001; however, measurements were made less than half the time during that year (table 19). Therefore, the evaluation suggests that Hells Canyon outflows exceed this criterion in all years. Idaho Power (2007a) reported that the elevated temperatures that exceed this criterion occurred during the first few weeks of the fall Chinook salmon spawning season, as can be seen in figure 29. The inflow to Brownlee reservoir also exceeded the 7-day average maximum criterion of 13ºC in some years, although in only 3 of the 9 years monitored. Exceedances of this criterion occurred during both fall and spring for the inflow to Brownlee reservoir.

Table 19. Percent of days that Hells Canyon Project water temperatures exceeded applicable numeric criteria, with the percent of applicable days monitored shown in parentheses. (Source: Idaho Power, 2007a)

	Resident Trout and Salmon/Steelhead Migration Corridor [a] (7-day average maximum of 20°C)				**Salmonid Spawning[b] (7-day average maximum salmonid spawning criterion of 13ºC)**	
Year	**Brownlee Reservoir Inflow**	**Downstream of Brownlee Reservoir**	**Downstream of Oxbow Reservoir**	**Downstream Hells Canyon Reservoir**	**Brownlee Reservoir Inflow**	**Downstream Hells Canyon Reservoir**
1991	---	---	---	26 (83)	---	8 (38)
1992	---	13 (60)	12 (47)	19 (90)	---	11 (100)
1993	---	0 (30)	0 (43)	17 (82)	---	2 (30)
1994	---	21 (85)	17 (78)	32 (71)	---	8 (70)
1995	---	19((78)	16 (77)	38 (91)	---	5 (80)
1996	19 (50)	7 (55)	0 (39)	27 (90)	0 (38)	5 (90)
1997	22 (80)	15 (76)	22 (55)	33 (86)	0 (100)	2 (79)
1998	23 (90)	24 (98)	16 (67)	45 (82)	0 (79)	4 (89)
1999	21 (63)	21 (90)	7 (72)	34 (95)	0 (49)	6 (92)
2000	25 (95)	12 (65)	1 (44)	24 (82	1 (100)	7 (86)
2001	0 (36)	18 (76)	8 (35)	31 (87)	0 (62)	0 (46)
2002	25 (76)	18 (94)	12 (74)	27 (84)	0 (69)	5 (93)
2003	24 (96)	19 (100)	0 (31)	37 (100)	2 (100)	9 (72)
2004	16 (71)	20 (98)	0 (1)	36 (100)	5 (75)	10 (82)

Notes: --- – data not available

[a] The 7-day average maximum temperature criterion of 20°C was applied year-round, except for downstream of Hells Canyon reservoir where it applies only from April 16 through October 22.

[b] The 13°C salmonid spawning criterion applies to the reach downstream of Hells Canyon reservoir from October 23 through April 15. This analysis evaluated exceedance of this criterion using 7-day averages for the designated period starting with October 23 through 29. Salmonid spawning criteria do not apply to the Brownlee reservoir inflow; evaluation for this site is for comparison purposes only.

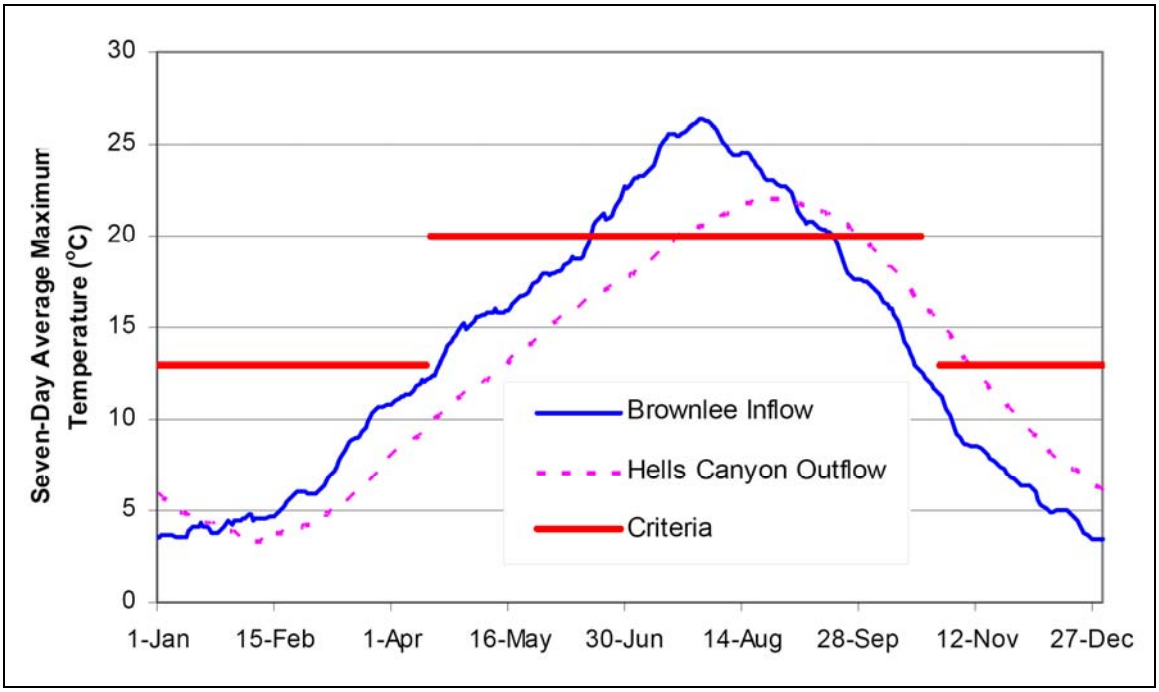

Figure 29. Average daily 7-day average maximum temperatures of Snake River inflow to Brownlee reservoir (1996–2004) and outflow from Hells Canyon dam (1991–2004). (Source: Idaho Power, 2007a)

The applicable water quality standards include a clause that allows temperature increases of 0.3°C over the site potential.[44] In the TMDL, IDEQ and ODEQ (2004) used Snake River inflow temperatures to Brownlee reservoir as an estimate of site potential for the Snake River downstream of Hells Canyon dam, although they acknowledged that this estimate should not be interpreted as natural conditions. In order to improve this estimate, Idaho Power (2007a) developed a flow-weighting model using the Corp's estimate of unregulated flow upstream of the project, a 1915 estimate of cumulative discharge from Thousand Springs (4,800 cfs), Salmon River temperatures measured near the confluence with the Snake River, and the median temperature of ground water inflows (14.5°C). They then determined the difference between simulated 7-day average maximum water temperatures for recent inflows and corresponding estimated historical temperatures, and subtracted these from corresponding measured 7-day average maximum temperatures. Figure 30 displays the resulting adjusted measured 7-day average maximum temperatures of outflow from Hells Canyon dam, which represent outflow temperatures based on Idaho Power's estimate of site potential, for the 7-day periods of October 23–29 through November 4–10. Temperatures above the 13.3°C line (i.e., the 13°C criterion plus the 0.3°C allowable increase) represent project exceedances of Oregon's water temperature standard for the fall spawning period. None of the values for representative high flow and medium-high flow years (1997 and 1999, respectively) exceeded the 13.3°C limit, and only one 7-day period exceeded this limit for the

[44] The site potential is generally considered natural conditions.

medium flow year (1995). In contrast, each of the representative low flow years (1992, 1994, and 2002) had exceedances of the 13.3°C limit. These exceedances occurred on 6 to 11 days per low flow year, and were as much as 1.6°C.

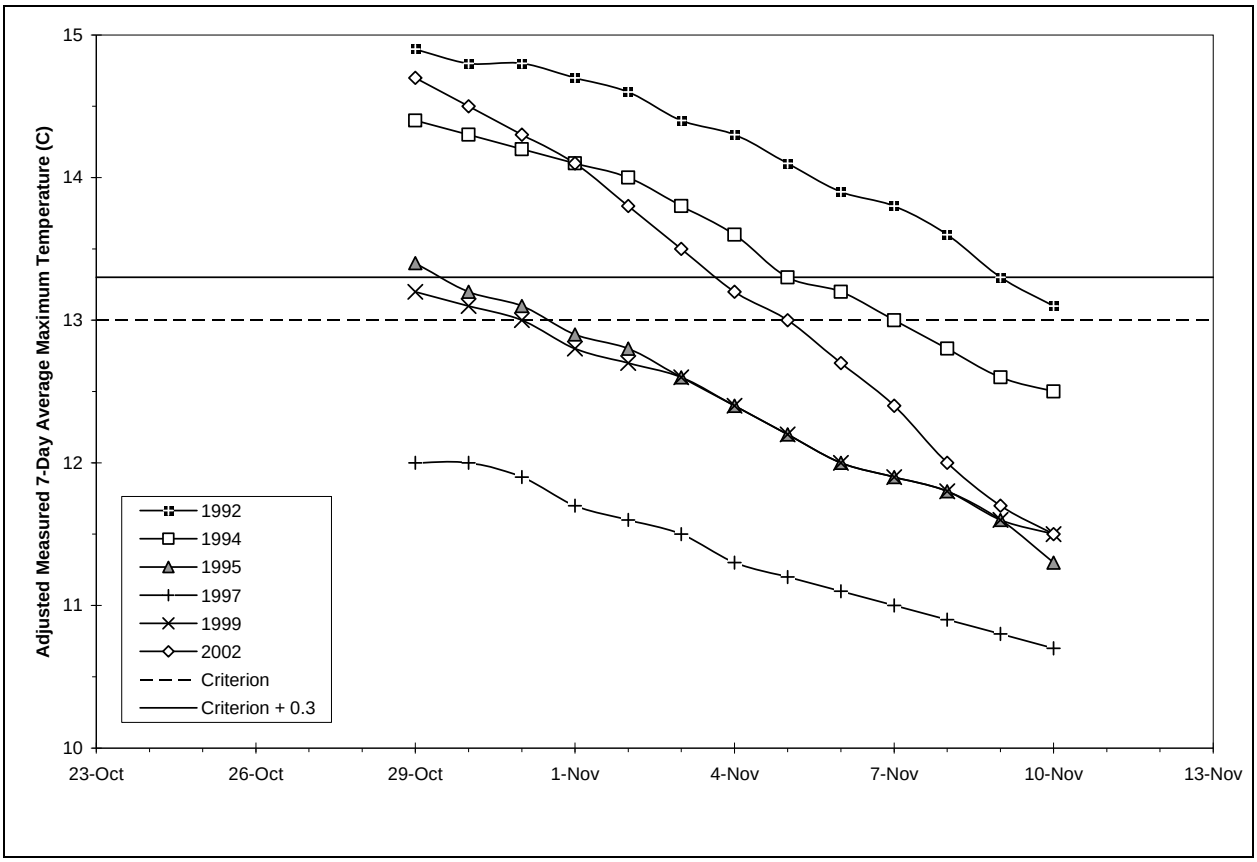

Figure 30. Adjusted measured 7-day average maximum temperatures of outflow from Hells Canyon dam for a portion of the fall Chinook spawning period. (Source: Idaho Power, 2007a, as modified by staff)

3.5.1.3 Biological Productivity

The project waters receive nutrients from numerous sources within the watershed. As part of an inventory of the nation's waters, EPA (1974, as cited by IDEQ and ODEQ, 2004) reported that the mountains along the southeastern border of the Snake River contain some of the world's richest phosphate deposits. In their comments on the draft EIS, AR/IRU emphasized that most of the phosphorus present in the Snake River derives from anthropogenic sources. Table 18 presents total phosphorus loadings of the Snake River and its tributaries, wastewater treatment plants, and industrial sources in the area. Median total phosphorus concentrations measured during 1992 through 1999 show that the TMDL total phosphorus target of 0.07 milligram per liter (mg/L) was exceeded more than half the time in all three of the project's reservoirs. The hypolimnion of Brownlee reservoir had the highest median total phosphorus and soluble reactive phosphorus concentrations of any of the project waters. Overall, the median concentrations of total phosphorus, total nitrogen, total Kjeldahl nitrogen (organic nitrogen and ammonia), and nitrate decreased through Brownlee reservoir, except in the hypolimnion. Median ammonia concentrations were also highest in Brownlee reservoir's hypolimnion. However, unlike the other nutrient parameters, ammonia increased through Brownlee reservoir. Median concentrations of each of the nutrient parameters measured were generally similar to one another in Oxbow reservoir, Hells Canyon reservoir, and Hells Canyon discharges. Summer of 1995 nitrogen to phosphorus ratios, which

were based on biologically available forms of these nutrients (ammonia, nitrate, and soluble reactive phosphorus), were generally greater than 10 throughout Brownlee reservoir, with the exception of the hypolimnion.

Primary productivity in the project area was evaluated primarily using trophic state assessment tools developed by Carlson (1977). Carlson developed trophic state index formulas to predict algal biomass from chlorophyll-*a* concentrations, total phosphorus concentrations, and Secchi depths (Carlson, 1977). Using chlorophyll-*a* trophic state indices as a surrogate for primary productivity indicated that hypereutrophic (nutrient rich) conditions occurred in the riverine zone of Brownlee reservoir, while meso-eutrophic tending to eutrophic (middle of the continuum from nutrient rich to nutrient poor) conditions occurred in Oxbow and Hells Canyon reservoirs (Myers et al., 2003a).

The phytoplankton community of the three project reservoirs varies by season and location (Myers et al., 2003a). In the spring, the phylum of Chrysophyta (golden algae) was the dominant phytoplankton in all three reservoirs. In the summer, the phylum of Cyanophyta (blue-green algae) was dominant throughout most of the reservoir sections, although the phylum of Chlorophyta (green algae) was dominant in the riverine zone of Brownlee reservoir. A single species, *Aphanizomenon flos-aquae*, comprised most of the algal cells in the lacustrine zone of Brownlee reservoir and in the Oxbow and Hells Canyon reservoirs during the summer. In the fall, the phylum Chrysophyta was once again the dominant phytoplankton. Dense blooms of blue-green algae have frequently been observed in the transition zone of Brownlee reservoir in late spring and late summer. Algal blooms also have been observed in surface waters of Brownlee reservoir and Oxbow reservoir, although blooms were not as pronounced as they were in the transition zone of Brownlee reservoir (IDEQ and ODEQ, 2004).

Substantial temporal and spatial trends in DO concentrations have been monitored in the project area (figure 28). Monitoring results showed that lower DO concentrations generally occurred in summer and early fall than the rest of the year. Lower DO concentrations occurred downstream of Hells Canyon dam than in the uppermost section (riverine zone) of Brownlee reservoir during low- to high-flow years (figure 31).

Figure 28 indicates that DO concentrations vary substantially within Brownlee reservoir. In the reservoir's riverine zone, DO concentrations generally ranged from about 6 to 14 mg/L with high levels of algal photosynthesis resulting in supersaturation of water during the spring and summer. DO concentrations varied substantially throughout the water column in areas of the transition zone even though the thermal gradient was minimal. Hypoxic (DO <2 mg/L) and anoxic (DO <0.5 mg/L) conditions were regularly recorded in the transition zone during late spring and summer. In this zone, DO concentrations were generally lowest near the bottom, although hypoxic conditions have, on occasion, encompassed nearly the entire transition zone. Low DO concentrations occurred throughout much of the water column in July 1990, resulting in a fish kill that included at least 28 adult white sturgeon. Dead fish that were observed throughout the upper reach of the reservoir included white sturgeon, catfish, crappie, and suckers (Idaho Power, 2003a). Monitoring results indicate that the lacustrine zone of Brownlee reservoir had a clinograde (decreasing DO concentrations with depth) characteristic of eutrophic systems. During low- and average-flow years, hypoxic conditions first reached Brownlee dam in the metalimnion and then proceeded into the hypolimnion. In contrast, the lowest DO concentrations initially occurred in the hypolimnion during the wet year of 1997. Water in the epilimnion generally remained well oxygenated, although low DO concentrations have occasionally extended to the surface of the lacustrine zone.

DO concentrations reported for inflows to Oxbow reservoir were generally less than corresponding values for the riverine zone of Brownlee reservoir. Oxbow reservoir DO concentrations were similar throughout most of the water column with the exception of the reservoir reach between the Oxbow powerhouse intake and Oxbow dam. However, a clinograde developed in the main body of the reservoir during the dry summer of 1992, resulting in anoxic conditions at depths of more than 82 feet

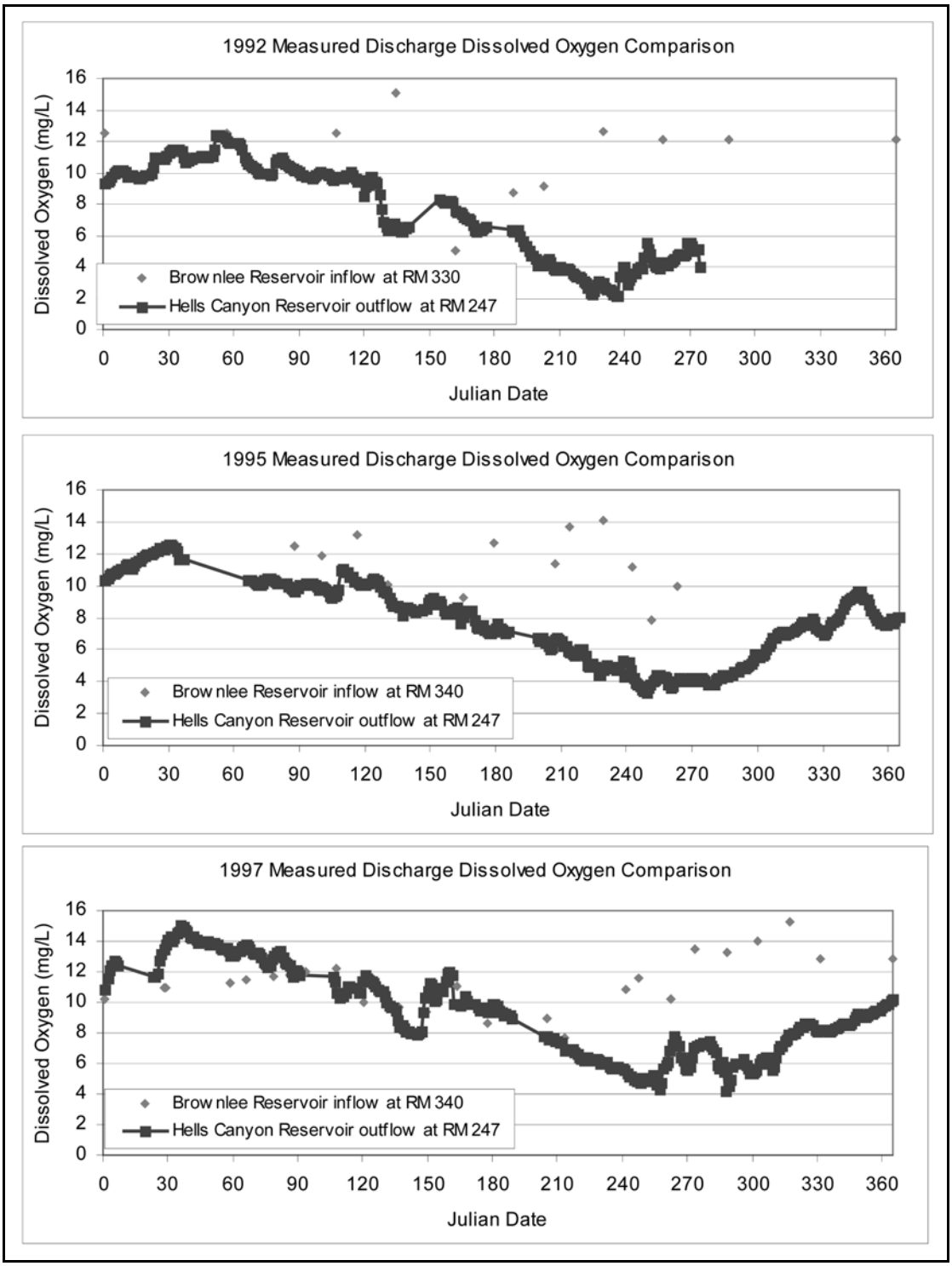

Figure 31. DO concentrations at the Brownlee reservoir inflow and downstream of Hells Canyon dam for 1992, 1995, and 1997 (low-, average-, and high-flow years). (Source: Myers et al., 2003a [page 135, figure 24])

near the Oxbow powerhouse intake. In the 0.3-mile-long reach between the powerhouse intake and Oxbow dam, development of a clinograde was more prevalent. This reach experienced relatively high DO concentrations near the surface and anoxic summer conditions near the bottom, even in the high-flow year of 1997.

Under current operations, the 2.5-mile-long bypassed reach that extends from immediately downstream of Oxbow dam down to Oxbow powerhouse receives inflow from the Oxbow dam via the spillway gates. Hourly DO measurements made during the summer of 1998 ranged from approximately 1.5 mg/L up to approximately 8.5 mg/L near the upper end of the bypassed reach and up to 11.5 mg/L near the lower end of the reach (Myers and Chandler, 2003). Vertical profiles of DO concentrations taken at a deep hole just upstream of Indian Creek (RM 272.4) showed considerable differences within the water column. Hypoxic/anoxic conditions occurred in the bottom 20 feet of the 49-foot-deep hole in August of 1997 and 1998, while near-surface values were about 6 mg/L.

In Hells Canyon reservoir, a clinograde developed with hypoxic conditions in deep water near the dam during dry, average, and wet years. During the dry year of 1992, a clinograde developed earlier in the season and anoxic conditions were more widespread for a longer period than in other years, as evidenced by anoxic conditions extending from the bottom to within 45 feet of the surface in September.

Discharges from Hells Canyon dam frequently had low DO concentrations. Results of monitoring DO concentrations at 10-minute intervals in the Hells Canyon dam tailwater showed that DO concentrations were less than the TMDL water quality targets (table 17) on more than half of the days in each of the years between 1991 and 2000. The DO targets were not met on 58 percent of the days in the high flow year of 1997 or on 98 percent of the days in the lower flow years of 1991 and 1993 (Myers et al., 2003). A breakdown of the timing of when the applicable targets were not met during each of the 10 years shows that the 11.0-mg/L spawning target was not met 100 percent of the time in the fall (October 24 through December 31) and 17 to 100 percent of the time in the spring (January 1 through May 10); at least one of the coldwater targets was not met 59 to 98 percent of the time during the remainder of the year (Myers et al., 2003c).

Idaho Power (2007a) reports that the outflows from each reservoir typically have the lowest DO concentrations in August and September. The Brownlee outflows have DO concentrations that are typically lower than the applicable criteria from June through November, and the Oxbow outflows have slightly higher DO concentrations during this critical period, with values less than the applicable criteria occurring during July through October. In the Hells Canyon outflows, DO concentrations are frequently lower than the applicable criteria during June through December.

Figure 32 displays daily mean DO concentrations measured in the Snake River at four locations within approximately the first 20 miles downstream of Hells Canyon dam. These results show that daily mean DO concentrations reported for critical periods in September and October increased to greater than 6.0 mg/L as water passed through the first few rapids in the first 9.1 miles downstream of the dam.

Myers et al. (2003a) reported that more than 90 percent of the potential hydrogen (pH) values recorded in each of the reservoirs between 1991 and 2000 were within the pH criteria/target levels of 7.0 to 9.0 units. Values greater than 9.0 were more common than values less than 7.0, and the highest pH values were recorded for the riverine zone of Brownlee reservoir. As part of development of the TMDL, IDEQ and ODEQ compiled a database of values reported by Idaho Power and/or obtained from EPA's STORET database for a wide range of flow and water quality conditions. The pH of 529 measurements made in Brownlee reservoir ranged from 7.4 to 9.6 units with less than 5 percent of the values falling outside the allowable range of 7.0 to 9.0 (IDEQ and ODEQ, 2004). The riverine zone had the highest mean seasonal pH values for all seasons.

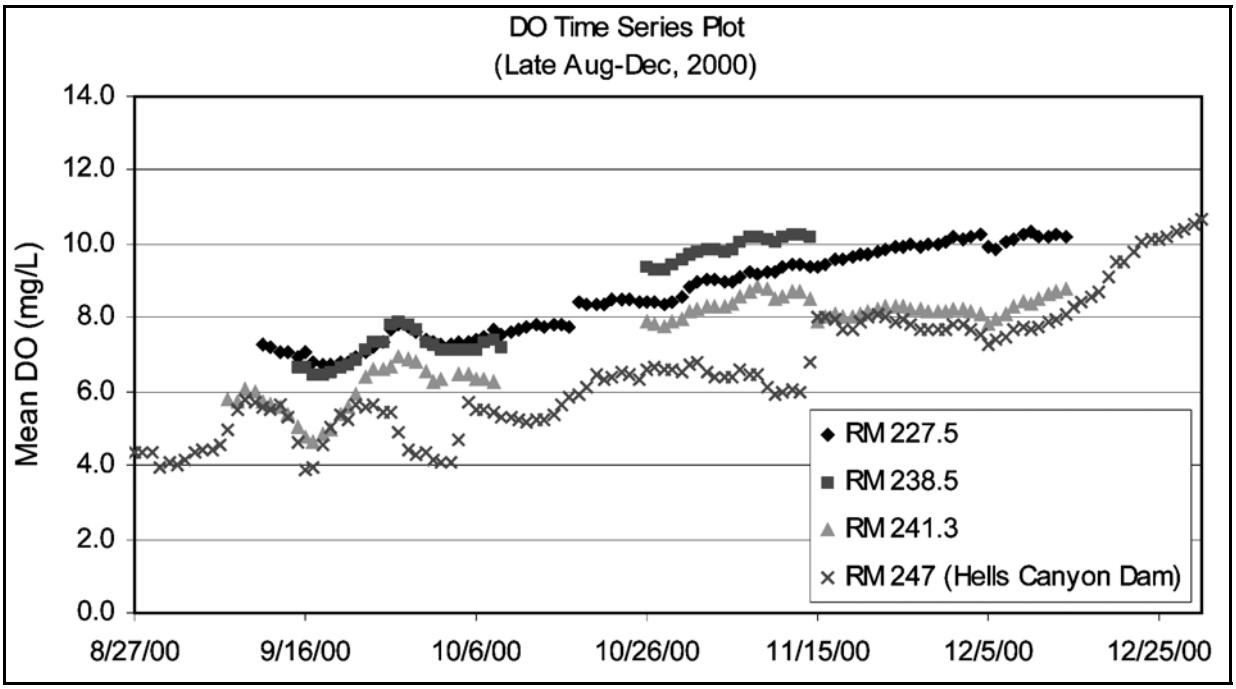

Figure 32. DO concentration time series for the Snake River downstream of Hells Canyon dam, late August through December 2000. (Source: Myers et al., 2003a [page 185, figure 75])

3.5.1.4 Total Dissolved Gas

Water flowing over and through dam spillways and plunging to depth in the pools below the spillways increases the hydrostatic pressure, causing air to be driven into solution and resulting in supersaturation of gasses in the water. Fish and other aquatic organisms that are exposed to excessive gas supersaturation can develop symptoms of Gas Bubble Trauma (GBT), a condition that can lead to a variety of abnormal physiological conditions, causing high levels of stress and mortality (Weitkamp and Katz, 1980; Ryan et al., 2000; Mesa et al., 2000).

Idaho Power evaluated the effects of routing water past the Brownlee, Oxbow, and Hells Canyon dams, along with dissipation rates downstream of Hells Canyon dam in 1997, 1998, and 1999 (Myers and Parkinson, 2003). In the spring of 1997 and 1998, Idaho Power routinely monitored TDG at eight sites (upstream of the spill gates at all three developments, in spilled water downstream of Brownlee and Oxbow dams, in turbine discharges of Brownlee Unit 5 and the Oxbow powerhouse, and at the Hells Canyon boat ramp located 0.8 mile downstream of Hells Canyon dam). Idaho Power did not consistently monitor TDG at any other locations downstream of Hells Canyon dam, but instead monitored TDG at target intervals of 5 to 10 miles down to near Lewiston. From March 3 to July 20, 1999, Idaho Power used a data logger to record hourly TDG levels at a depth of about 3.3 feet at RM 246, approximately 1.5 miles downstream of Hells Canyon dam. During the 2006 spill season, Idaho Power continuously monitored TDG along the left (spillway) and right (powerhouse) side of the channel at the bridge downstream of Brownlee dam, in the Oxbow forebay, and at the upper end of the Oxbow bypassed reach.

Results of these studies indicate that supersaturated TDG levels occurred in Brownlee reservoir immediately upstream of the dam, although levels remained lower than the 110-percent of saturation criterion. Maximum TDG levels recorded at this location were 108.1 percent of saturation in 1998 and 107.9 percent in 1997. Brownlee powerhouse discharges were found to have significantly ($p<0.005$) lower TDG levels than the reservoir. In contrast, TDG levels were significantly ($p<0.005$) higher

immediately downstream of the Brownlee dam spillway than in the reservoir. All spill events of greater than 3,000 cfs that were measured had TDG levels, exceeding 110 percent of saturation. During 1997–1998, the maximum TDG level recorded immediately downstream of the Brownlee dam spillway was 128.0 percent, which occurred during a spill of 49,000 cfs. During 2006, hourly TDG reached as high as 143 percent of saturation along the left side of the channel when spill was greater than 55,000 cfs (Richter et al., 2006).

Elevated TDG levels continued through Oxbow reservoir all the way to Oxbow dam. Richter et al. (2006) reported that TDG measurements made during a Brownlee spill of between 35,000 and 42,000 cfs showed unmixed conditions (113 to 138 percent of saturation) at the bridge downstream of Brownlee dam, mixed conditions about four miles downstream of the dam (135 percent), and a dissipation of 5 percent of saturation throughout Oxbow reservoir with TDG levels of 130 percent of saturation measured near Oxbow dam (table 3). Myers and Parkinson (2003) reported that TDG levels in Oxbow reservoir varied substantially depending on the rate of spill at Brownlee dam. The maximum TDG recorded immediately upstream of the Oxbow dam spillway was 125.3 percent of saturation. Routing water through the Oxbow turbines and spillway had mixed effects on TDG. TDG levels in powerhouse discharges were as much as 7.2 percent of saturation greater than in the reservoir and 11.3 percent of saturation less than in the reservoir. Although powerhouse tailrace TDG levels varied compared to levels recorded for the reservoir, these differences could not be attributed to varied powerhouse flow rates. Myers and Parkinson (2003) suggest that these differences may be due to the timing of sampling and/or comparison to near-surface reservoir samples rather than TDG levels in water at the intake depth, which is about 45 feet below the full pool elevation. This conclusion is supported by Parametrix (1974, as cited in Myers and Parkinson, 2003) findings that dissolved nitrogen levels varied considerably throughout the water column of Oxbow reservoir. Comparison of TDG levels measured immediately downstream of the Oxbow dam spillway with levels for the Oxbow reservoir also indicate that both increases and decreases in TDG occurred. Spill rates of less than 2,000 cfs and greater than 24,000 cfs reduced TDG, whereas spills of 5,000 to 24,000 cfs increased TDG. The largest increase (20.5 percent of saturation) occurred during a spill of 12,000 cfs. Due to the configuration of the Oxbow development, elevated TDG levels from the Oxbow dam spillway continue downstream for 2.5 miles before mixing with the powerhouse discharges.

Idaho Power evaluated the effect of spills that occurred at Oxbow dam in 2006, independent of spills at Brownlee dam, by analyzing conditions that coincided with Oxbow forebay TDG levels of less than 110 percent of saturation. Under these conditions, the maximum TDG measured in the Oxbow bypassed reach was 128 percent of saturation, which occurred when the Oxbow spill rate was 22,000 to 26,000 cfs (Idaho Power, 2007a). The 2006 study showed that Oxbow dam spills ranging from about 14,000 to 33,000 cfs increased TDG from less than 110 percent of saturation in the Oxbow forebay to more than 120 percent of saturation in the Oxbow bypassed reach.

TDG levels in Hells Canyon reservoir are closely associated with spills at Brownlee dam, although the effect of spills at Brownlee and Oxbow dams is minor to moderate beyond Hells Canyon dam. However, spills at Hells Canyon dam caused TDG to be supersaturated in mixed water downstream of the spillway and powerhouse. In 1999, hourly TDG levels recorded 1.5 miles downstream of Hells Canyon dam reached as high as 136.3 percent of saturation and were clearly related to spill rates despite considerable variability in TDG at similar spill rates (figure 33). Nearly all spill rates resulted in TDG levels greater than 110 percent of saturation.

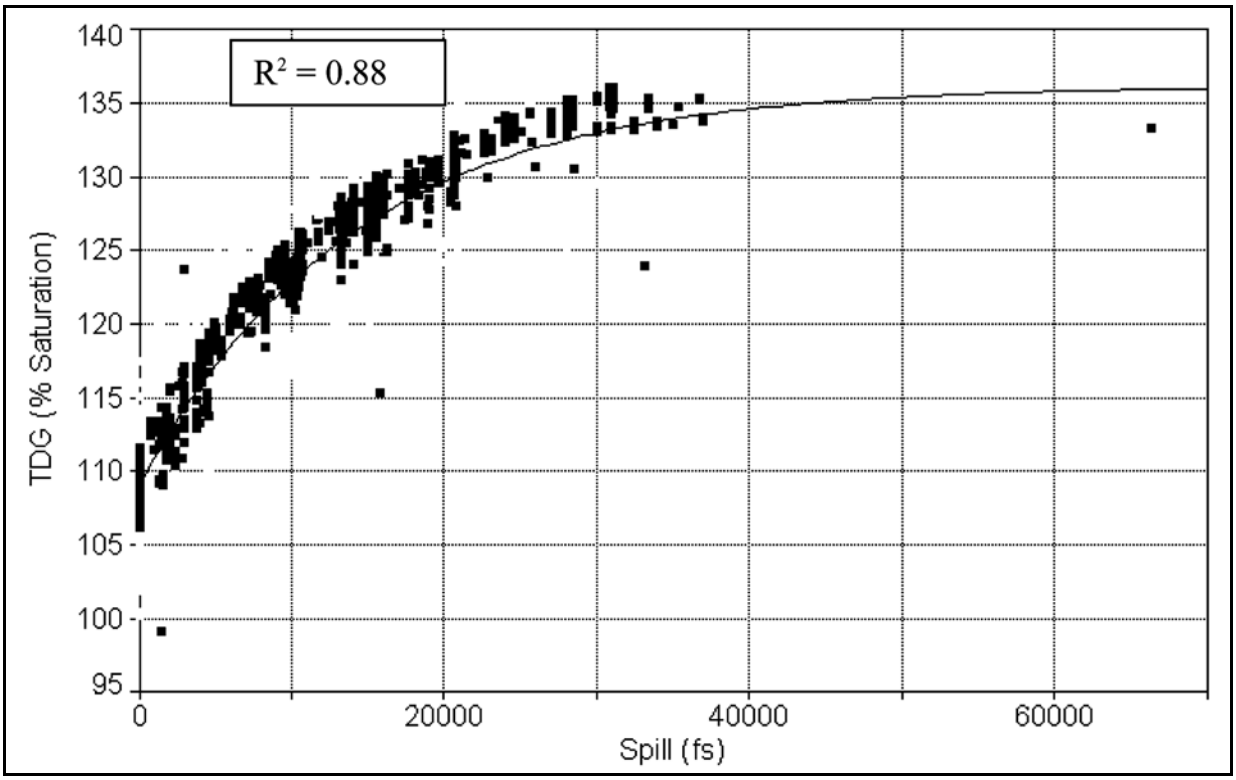

Figure 33. Relationship between spill rate at Hells Canyon dam and TDG approximately 1.5 miles downstream of the dam, 1997–1999. (Source: Idaho Power, 2007a)

The dissipation of elevated TDG downstream of Hells Canyon dam is displayed in figure 34. When TDG levels downstream of Hells Canyon dam exceeded 120 percent of saturation, it generally decreased approximately 0.3 percent of saturation per river mile. As TDG levels approached equilibrium with ambient air conditions (100 percent of saturation), dissipation rates decreased. Myers and Parkinson (2003) reported a direct relationship between the rate of spill and distance from the dam at which TDG levels exceeded 110 percent of saturation. For all measured spills of greater than 19,000 cfs, TDG levels exceeded the 110 percent of saturation criterion at all sites upstream of RM 180 (67 miles downstream of the Hells Canyon dam and about 8 miles downstream of the Salmon River confluence). Spills of 9,000 to 13,400 cfs resulted in exceedance of the 110 percent of saturation criterion down to RM 200 (47 miles downstream of the dam), and a spill rate of 2,400 cfs resulted in exceedance of the 110 percent criterion downstream to RM 230 (17 miles downstream of the dam). The results of the 1997–1999 TDG studies are consistent with Seattle Marine Laboratories' (1972, as cited in Myers and Parkinson, 2003) findings of maximum dissolved nitrogen levels of 125 percent of saturation immediately downstream of Hells Canyon dam, and reduction of these levels down to 107 percent of saturation nearly 60 miles downstream of the dam.

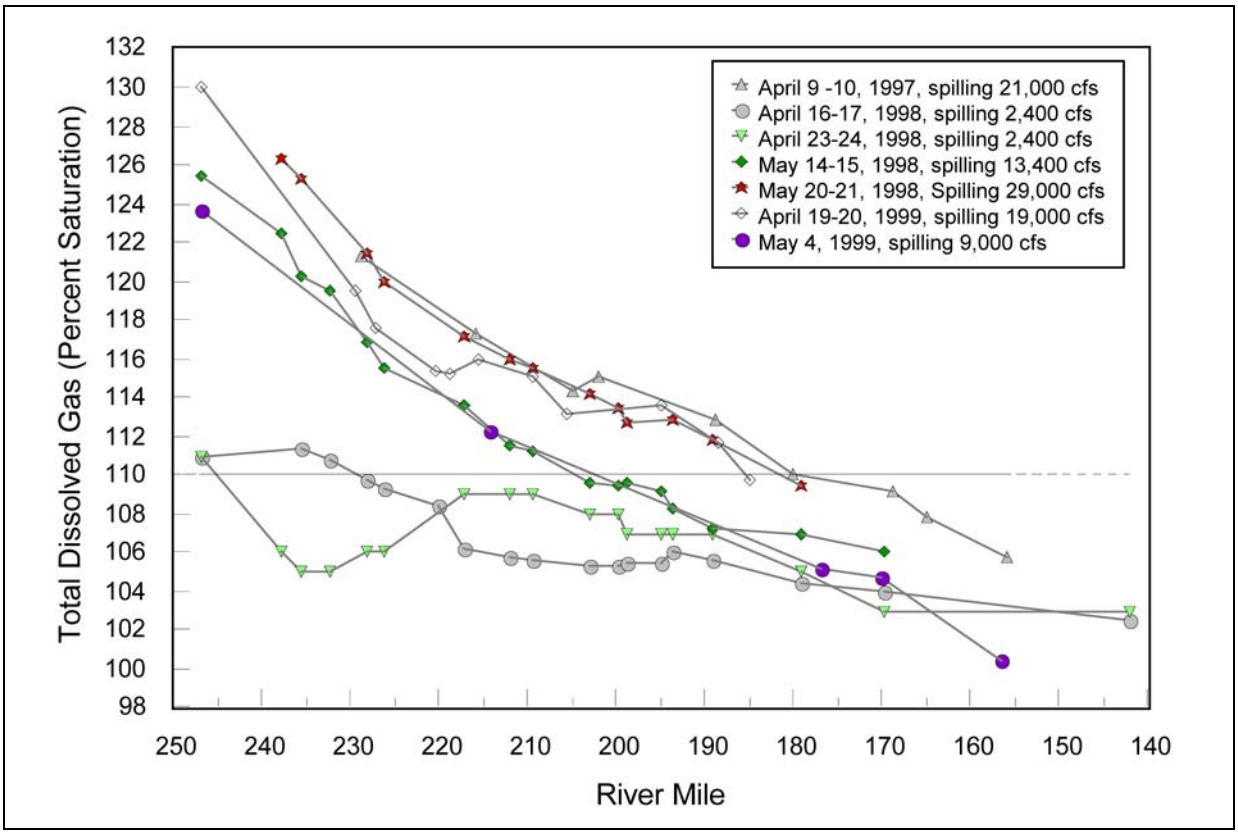

Figure 34. Dissipation of elevated TDG downstream of Hells Canyon dam relative to the 110 percent of saturation criterion, 1997–1999. (Source: Myers and Parkinson, 2003)

3.5.1.5 Turbidity

According to eyewitness accounts and personal photographs, the Snake River was described as being typically "murky" and "full of silt" between the 1920s and the early 1950s (personal communication, A. Barton, Barton Heights Homestead-Hells Canyon, and S. Zanelli, Idaho Power, on February 13, 2003, as cited by Miller et al., 2003c, App A; personal communication, V. Shirley, Wilson Homestead-Saddle Creek-Hells Canyon, and S. Zanelli, Idaho Power, on February 19, 2003, as cited by Miller et al., 2003c). Anecdotal information indicates that turbidity of the Snake River in Hells Canyon generally decreased in the early 1950s (Miller et al., 2003c). A summary of Snake River turbidity data reported for 1992 through 1997 is presented in table 20. These data indicate that turbidity generally decreases as water flows through Brownlee and Oxbow reservoir and remains low throughout Hells Canyon reservoir and its discharge.

Based on data collected from 1995 to 2000, total suspended solids (TSS) load supplied to the reach was estimated as being 76 percent from tributaries, 10 percent from drains, 12 percent from unmeasured sources, and the remainder from point sources (IDEQ and ODEQ, 2004). IDEQ and ODEQ estimates indicate that the majority (69 to 73 percent) of this loading generally occurred during the summer growing season of late April through October, followed by the spring period of February through early April (14 to 29 percent). Sediment loadings in November through January were relatively small (8 to 16 percent). During the growing season, approximately 15 to 25 percent of the total sediment load is organic matter in the Snake River upstream of Brownlee reservoir. This percentage increases in Brownlee reservoir.

Table 20. Summary of turbidity data for various reaches of the project, 1992–1997. (Source: Idaho Power, 2005d, as modified by staff)

Location	Snake River Miles	No. of Samples	Turbidity		
			Minimum (NTU)	Average (NTU)	Maximum (NTU)
Snake River upstream of Brownlee reservoir	409–343.1	213	0.9	39.0	291
Brownlee reservoir	343–284.6	978	0.4	13.5	213
Oxbow reservoir	284.5–272.5	265	0.4	4.1	50.2
Hells Canyon reservoir	272.4–247.6	434	0.4	5.4	48.9
Snake River downstream of Hells Canyon dam	247.5–247	174	0.5	5.0	41.7

Note: NTU – nephelometric turbidity unit

Table 21 summarizes suspended sediment data reported for the Snake River and its tributaries for 1970 through 1997. Based on monthly averages of TSS data for 1990 through 2000, exceedances of the 50-mg/L target occurred in the Snake River at RM 409 in May, and in Brownlee reservoir in March and April (IDEQ and ODEQ, 2004).

Table 21. Summary of total suspended solids data available for the Snake River and its tributaries near their terminus, 1970–1997.[a] (Source: IDEQ and ODEQ, 2004, as modified by staff)

Location	Snake River Mile	Number of Samples	Total Suspended Solids		
			Minimum (mg/L)	Average (mg/L)	Maximum (mg/L)
Snake River at Marsing	425	44	2	21.2	42
Owyhee River	396.7	169	7	65.2	562
Boise River	396.4	144	1	41.1	295
Malheur River	368.5	93	2	109.2	787
Payette River	365.6	98	3	36.5	406
Weiser River	351.6	59	2	27.5	117
Drains	NR	194	2	151.4	1,320
Snake River	409–335	304	1	38.3	685
Brownlee reservoir	335–285	147	1	21.1	411
Oxbow reservoir	285–272.5	113	1	7.8	215
Hells Canyon reservoir	272.5–247	58	1	9.4	116
Snake River downstream of Hells Canyon dam	247–188	69	1	6.9	24

Note: NR – not reported

[a] Total suspended solids data included in this summary include measurements of suspended sediment concentrations and total residue measurements.

3.5.1.6 Hazardous Materials

Idaho Power conducted an evaluation of possible oil leakage from the project's three power plants for 1999 and 2000. Using project records, Wolfe (2003) estimated that the amount of oil discharged to the Snake River during the 2-year period was 600 gallons at Brownlee, 120 gallons at Oxbow, and 50 gallons at Hells Canyon. The estimate for the Brownlee power plant is equal to an average volume of 0.8 gallons per day. In comparison, sump discharges of water from the project were between 105,000 and 229,000 gallons per day. The turbine guide bearings for Brownlee units 1 and 2 were the largest contributors to oil leakage during the study. Wolfe (2003) concluded that new gasket material and ring design appeared to have stopped slinger ring leaks in the turbine guide bearings as of March 2001.

Results of analyzing sediment samples collected from 1998 to 2000 from the thalweg in Brownlee reservoir at intervals of 5 miles or less show that trace metal concentrations generally increased in a downstream direction in both the main body of Brownlee reservoir and the Powder River arm, coinciding with increased percentages of fine material (Myers et al, 2003a). Idaho Power and the USGS compared the sample results to the corresponding threshold effect level (TEL) established to represent the upper limit at which adverse effects rarely occur to benthic life (Canadian Council of Ministers of the Environment, 1995, as cited in Clark and Maret, 1998). In the upper reservoir (RM 312 to RM 336), the TEL was exceeded for arsenic, chromium, mercury, and nickel. In the lower reservoir (RM 285 to RM 310), the TEL was exceeded for each of these elements as well as cadmium, copper, and zinc. A sediment sample taken from an elevation to represent pre-impoundment conditions exceeded the TEL for arsenic, chromium, and nickel. None of the measured lead concentrations exceeded the corresponding TEL. IDEQ and ODEQ (2004) reported that little water column data for mercury in the project area is available, and that most of the data collected since 1990 had non-detectable mercury concentrations using various detection limits ranging from 0.01 to 0.5 microgram per liter (μg/L).

A reconnaissance-level assessment of organochlorine compounds in bed sediments was conducted in August 1997 by collecting bed samples from Brownlee reservoir at Burnt River (RM 327) and Mountain Man Lodge (about RM 300) and then analyzing them for 33 organochlorine compounds, including pesticides, pesticide breakdown products (metabolites), and total polychlorinated biphenyls (PCBs) (Clark and Maret, 1998). Concentrations of these compounds were generally higher at the Burnt River site than at the Mountain Man Lodge site. The TEL and probable effect level (PEL) were both exceeded for p,p′-DDE, a metabolite of dichlorodiphenyltrichloroethane (DDT), at the Burnt River site. In 1999, additional sampling was conducted with similar sample handling and detection limits. However, none of the 42 samples collected had detectable concentrations of any organochlorine compounds, even though much of the samples consisted of fine-grained materials (CH2M HILL, 2000, as cited by Myers et al, 2003). No water column data are available for total DDT or dieldrin concentrations in Brownlee reservoir, although all of the values reported for total DDT and dieldrin (four each) in the upstream Snake River segment exceeded their respective target levels presented in table 17 (IDEQ and ODEQ, 2004).

In August and September 1997, fish were collected from Brownlee reservoir at Burnt River (RM 327) and Pittsburg Landing (RM 215) for analysis of contaminants. Composite samples that were analyzed consisted of whole-body and liver samples for largescale sucker and common carp, and fillet samples from sport fish. This analysis resulted in detectable concentrations of 17 trace metals (Clark and Maret, 1998). Concentrations of most trace metals were generally higher in liver samples than in sport fish fillets, although mercury concentrations were generally higher in fillets. Total mercury concentrations ranged from 0.02 μg/g (wet weight) in largescale sucker liver samples from the Snake River at Pittsburg Landing to 0.32 μg/g in both common carp liver samples and channel catfish fillets from the Brownlee reservoir at Burnt River. None of the fillet samples exceeded the FDA (2000) 1.0-μg/g action level, although the total mercury concentration in both channel catfish fillets and common

carp liver samples from the Brownlee reservoir at Burnt River were greater than 0.3 μg/g, which is the EPA (2001a) recommended concentration of methylmercury set to protect human health.[45] IDEQ and ODEQ (2004) reported that 3 percent of the fish tissue samples from Brownlee reservoir exceeded the FDA's 1.0-milligram per kilogram action level, and that 80 percent of all the data for the reach from RM 409 to RM 188 exceeded the 0.35-μg/g target. Due to elevated concentrations of mercury in fish, a fish consumption advisory has been in place for the Snake River, including the project area, since 1997 (ODHS, 2005, 1997; Idaho Department of Health and Welfare, 2004).

Detectable concentrations of 12 organochlorine compounds or metabolites were reported. All fish-tissue samples were found to contain DDT or a DDT metabolite; concentrations of total DDT ranged from approximately 96 μg/kg in white crappie fillets to 3,633 μg/kg in whole-body samples of common carp (Myers et al, 2003a). The 200-μg/kg protection level set for fish-eating wildlife (Newell et al., 1987, as cited by Clark and Maret, 1998) was exceeded in whole-body composite samples of largescale sucker and common carp and fillets of channel catfish. Whole-body samples of common carp had total PCB concentrations that exceeded the 110-μg/kg level set to protect fish-eating wildlife. None of the reported organochlorine compound concentrations exceeded FDA action levels, although DDT exceeded a cancer risk screening value of 10^{-6} established by the EPA (Nowell and Resek, 1994, as cited by Clark and Maret, 1998).

3.5.1.7 Coliform Bacteria

IDEQ and ODEQ (2004) indicate that the upper Snake River segment (RM 409 to RM 347) was included on the 303(d) list for bacteria; in the same document, they recommend that this reach be delisted for bacteria, based on analysis of fecal coliform and *E. coli* data collected in the summer of 1999. Weekly measurements of fecal coliform concentrations at three locations in the Oxbow bypassed reach in July to September of 1997 and 1998 ranged from less than 1 to 110 most probable number (MPN) (Myers and Chandler, 2003). Hardy et al. (2005) reported that measurement of fecal coliform indicated that the E. coli criterion for primary contact recreation was exceeded in three of 26 samples from the Snake River at Weiser, which is about 11 miles upstream of Brownlee reservoir. In the Final 2002 Integrated Report, ODEQ (2005) reported that the Snake River was attaining the fecal coliform criteria from RM 244.2 to RM 268.8 in the summer, and from RM 280.5 to RM 404 throughout the year.

3.5.2 Environmental Effects

3.5.2.1 Effects of Project Operations on Water Quality

We describe Idaho Power's proposed operations in section 2.2.2, *Proposed Project Operations*, and we assess the effects of the proposed operation on reservoir levels and project outflows in section 3.3.2, *Effects of Project Operations on Water Quantity*. We identify operation-related recommendations filed by agencies, tribes, and other parties (table 9), and we describe three alternative operational scenarios that we use to assess the effects of the various operation-related recommendations. At our request (AIR OP-1), Idaho Power simulated project operations for these representative scenarios under various hydrologic conditions. Refer to section 3.3.2.2 for additional discussion of the scenarios and the modeling process used for the simulations. We use the results of these simulations to assess the effects of the operation-related recommendations.

As provided below, we evaluate the effects of Idaho Power's Proposed Operations and of operation-related recommendations received from agencies, tribes, and other parties on the following

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[45] This 0.3-μg/g criterion is based on a total fish and shellfish consumption of 17.5 g per day for a 70-kg (154-pound) human, which is the estimated average consumption rate for recreational fishers (EPA, 2000).

resources: (1) temperature; (2) biological productivity (nutrients, DO, and pH); (3) TDG; and (4) hazardous materials.

Temperature

Changes in the seasonal flow regime caused by project operations and recommended changes to project operations made by agencies, tribes, and NGOs can affect water temperature. As we discuss later in section 3.5.1.2 *Temperature*, construction and operation of the project has altered the thermal regime of the Snake River within and downstream of the project. These alterations include a seasonal temperature shift downstream of Brownlee dam that is primarily due to the combination of thermal stratification in Brownlee reservoir and water being released from the reservoir's deep layers. Compared to without project conditions, the end result of these operations has been cooler conditions in spring and summer, and warmer conditions in fall.

Our Analysis

Idaho Power used the CE-QUAL-W2 model to simulate the effects of various project operations and potential measures on water temperatures (Idaho Power, 2005b,e,f; Bowling, 2004). CE-QUAL-W2 is a two-dimensional (longitudinal/vertical) hydrodynamic and water quality model that is capable of modeling conditions in river/reservoir systems (Portland State University, 2006). Idaho Power's setup, calibration, and use of the CE-QUAL-W2 model is described by Zimmerman et al. (2002). Differences in CE-QUAL-W2 simulation results can be used to evaluate likely differences in water temperatures that would result from operating the project under a variety of operational regimes.

Idaho Power's Proposed Operations would be similar to current operations and result in similar thermal regimes within and downstream of the project.

Operational recommendations to limit ramping downstream of Hells Canyon dam (refer to table 9) would have little effect on water temperatures in project waters or the project's outflows, since they would result in minimal changes in the residence time within each of the project reservoirs.

Operational recommendations involving the Flow Augmentation Scenario, on the other hand, would result in modified water temperature conditions compared to existing and proposed operations. These changes would result from releasing more water from Brownlee reservoir during early summer and maintaining the reservoir at a lower level during summer and fall. We discuss the simulated temperatures for both Brownlee reservoir and Hells Canyon outflow below.

Our analysis of the effects of flow augmentation on water temperatures in Brownlee reservoir focused on the overall thermal regime of the reservoir, with emphasis on the simulated locations for temperatures of 17.8°C. Table 22 summarizes the simulated thermal regimes for each of the 5 representative flow years. Flow augmentation in early summer (June 21 through July 31) would result in lower Brownlee reservoir water levels and a thinner epilimnion during the summer of medium to extremely low flow years. During the summer of higher flow years, the simulated flow augmentation produced little difference from Proposed Operations.

Table 23 summarizes our comparison of the CE-QUAL-W2 simulation results for Hells Canyon outflow to the TMDL water temperature targets. This summary indicates that flow augmentation recommendations would increase the frequency of exceedances of the 17.8°C target in July of medium-low to extremely low flow years, but that they would not affect the frequency of exceedances of the 13.0°C target.

Table 22. Summary comparison of Brownlee reservoir simulated temperatures for Proposed Operations and Scenario 2 (Flow Augmentation). (Source: Idaho Power, 2005e, as modified by staff)

Year	Proposed Operations	Scenario 2 (Flow Augmentation)
1992 (extremely low flow)	Stratification is evident in spring and by the beginning of summer the uppermost 55 feet of the reservoir, extending down to an elevation of about 2,020 feet msl, generally exceed 17.8°C while below 1,950 feet msl the hypolimnion remains at 6°C or cooler. By mid-August, 17.8°C is exceeded down to an elevation of about 1,970 feet msl, and the hypolimnion extends from about 1,940 feet msl to the bottom. Water warmer than 17.8°C is fully evacuated from the reservoir by mid-October, but most of the cool hypolimnion still remains in the reservoir.	During spring, virtually the same thermal regime occurs as under Proposed Operations. During summertime, the water level surface elevation is lower and a thinner epilimnion occurs. By mid-August, the water surface elevation is about 25 feet lower and 17.8°C water is about 5 feet lower than under Proposed Operations. In fall, the epilimnion thickness becomes closer to Proposed Operations, but continues to be slightly thinner than under Proposed Operations.
1994 (medium-low flow)[a]	Stratification is evident in spring and by the beginning of summer the uppermost 55 feet of the reservoir, extending down to an elevation of about 2,020 feet msl, generally exceed 17.8°C while below 1,945 feet msl the hypolimnion remains at 6°C or cooler. By mid-August, 17.8°C is exceeded down to an elevation of about 1,980 feet msl, and the hypolimnion extends from about 1,930 feet msl to the bottom. Water warmer than 17.8°C is fully evacuated from the reservoir by mid-October, but most of the cool hypolimnion still remains in the reservoir.	During spring, virtually the same thermal regime occurs as under Proposed Operations. During summertime, the water surface elevation is lower and a slightly thinner epilimnion occurs. By mid-August, the water surface elevation is about 25 feet lower and the 17.8°C water is about 10 feet lower than under Proposed Operations. Although the water surface elevation is slightly lower than under Proposed Operations in mid-October, water temperatures are very similar to Proposed Operations.
1995 (medium flow)	Stratification is evident in spring and around the beginning of summer a longitudinal gradient is evident for 17.8°C water. Virtually all of the reservoir upstream of RM 320 exceeds 17.8°C, while exceedances of 17.8°C near the dam only occur down to an elevation of about 2,060 feet msl. A hypolimnion that is 7°C and cooler develops below an elevation of about 1,920 feet msl. By mid-August, 17.8°C is exceeded down to an elevation of about 1,965 feet msl, and the hypolimnion extends from about 1,920 feet msl to the bottom. Water warmer than 17.8°C is fully evacuated from the reservoir by mid-October, but much of the cool hypolimnion still remains in the reservoir.	During spring, virtually the same thermal regime occurs as under Proposed Operations. During summertime, the water surface elevation is lower and a slightly thinner epilimnion occurs. By mid-August, the water surface elevation is about 20 feet lower and the 17.8°C water is about 10 feet lower than under Proposed Operations, which moves the up-reservoir end of the metalimnion from RM 316 to RM 312. In the fall, the thermal regime is virtually the same as under Proposed Operations.

Year	Proposed Operations	Scenario 2 (Flow Augmentation)
1999 (medium-high flow)	Stratification is evident in spring and around the beginning of summer a longitudinal gradient is evident for 17.8°C water. All of the reservoir upstream of RM 322 exceeds 17.8°C, while exceedances of 17.8°C near the dam only occur down to an elevation of about 2,055 feet msl. A hypolimnion that is 11°C and cooler develops below an elevation of about 1,930 feet msl with 6°C or cooler water only occurring below an elevation of about 1,850 feet msl. By mid-August, 17.8°C is exceeded down to an elevation of about 1,950 feet msl, and the hypolimnion extends from about 1,920 feet msl to the bottom. Water warmer than 17.8°C is fully evacuated from the reservoir by mid-October, and the hypolimnion continues to have nearly the same characteristics as in mid-August.	During spring, virtually the same thermal regime occurs as under Proposed Operations. During summertime, the water surface elevation is lower and a slightly more distinct break occurs between the epi- and metalimnion. By mid-August, the water surface elevation is about 15 feet lower and the 17.8°C water is about 5 feet lower than under Proposed Operations. In the fall, the thermal regime is virtually the same as under Proposed Operations.
1997 (extremely high flow)	Stratification is evident in spring and by the beginning of summer the uppermost 100 feet of the reservoir, extending down to an elevation of about 1,975 feet msl, generally exceed 17.8°C and a hypolimnion that is 12°C and cooler develops below about 1,915 feet msl. By mid-August, 17.8°C is exceeded down to an elevation of about 1,940 feet msl, and the hypolimnion extends from about 1,910 feet msl to the bottom. Water warmer than 17.8°C is fully evacuated from the reservoir by mid-October, and the hypolimnion is a little smaller than in mid-August.	During spring, virtually the same thermal regime occurs as under Proposed Operations. During summertime, the water surface elevation is lower and there is a less distinct break between the epi- and metalimnion. By mid-August, the water surface elevation is about 15 feet lower and the 17.8°C water is at about the same elevation as under Proposed Operations. In fall, the thermal regime is virtually the same as under Proposed Operations.

[a] Prior to issuance of the draft EIS, 1994 was identified as a representative medium-low flow year, based on analysis of the 1928 to 1999 flow record. However, Idaho Power's (2007a) subsequent analysis of the 1911 to 2005 flow record resulted in reclassifying 1994 to a low flow year.

Table 23. Summary comparison of simulated Hells Canyon outflow hourly water temperatures for Proposed Operations and Scenario 2 to TMDL water temperature targets.[a] (Source: Idaho Power, 2005e, as modified by staff)

Year	Proposed	Scenario 2 (Flow Augmentation)
1992 (extremely low flow)	Exceeds 13°C target in late October through early November, and exceeds 17.8°C target from mid-July through early October.	Generally about 1.0–1.7°C warmer in July, 0.5–1.0°C warmer in August, and up to about 0.5°C warmer in early September. Exceeds 17.8°C target for about 1 additional week in early July.
1994 (medium-low flow)[b]	Exceeds 13.0°C target for about 2 weeks in late October to early November, and exceeds 17.8°C target from early July through early October.	Generally about 0.5–1.0°C warmer in July through mid-August. Exceeds 17.8°C target for a couple of additional days in early July.
1995 (medium flow)	Exceeds 13°C target for about 1.5 weeks in late October to early November, and exceeds 17.8°C target from early July through early October.	Virtually the same as under Proposed Operations. Exceeds 13.0°C and 17.8°C targets during same periods as Proposed Operations.
1999 (medium-high flow)	Exceeds 13°C target for about 1.5 weeks in late October to early November, and exceeds 17.8°C target from mid-June through early October.	Virtually the same as under Proposed Operations. Exceeds 13°C and 17.8°C targets during same periods as Proposed Operations.
1997 (extremely high flow)	Exceeds 13°C target for a couple of days in late October, and exceeds 17.8°C target from late May through early October.	Virtually the same as under Proposed Operations. Exceeds 13°C and 17.8°C targets during same periods as Proposed Operations.

[a] We estimated compliance with the target water temperatures of 13°C for spawning for October 23 through April 15, and the 7-day mean maximum target of 17.8°C for the remainder of the year.

[b] Prior to issuance of the draft EIS, 1994 was identified as a representative medium-low flow year, based on analysis of the 1928 to 1999 flow record. However, Idaho Power's (2007a) subsequent analysis of the 1911 to 2005 flow record resulted in reclassifying 1994 to a low flow year.

Operational recommendations related to navigation target flow levels (refer to table 9) would increase outflows during some low flow periods, generally in the months of June to October. The extent of increases in outflows and the resulting potential for changing the thermal regime would be determined by the specific recommendations implemented.

Idaho Power's simulation of project operations under the navigation target flow operation (Scenario 3) is representative of operations that would result from recommendations made by the Corps and NPPVA for a minimum flow of 8,500 cfs upstream of the mouth of the Salmon River and 11,500 cfs downstream of the Salmon River. Scenario 3 simulations indicate that Hells Canyon outflow rates would be most affected in medium-low flow years when Brownlee reservoir inflows exceed 8,500 cfs, but would be affected little in medium to extremely high flow years (Bowling, 2005b). Although Hells Canyon minimum outflows would increase, maximum outflows during these periods would be reduced, which would result in Brownlee reservoir levels similar to those under Proposed Operations. We anticipate that the temperature of the outflows would be only a little higher than under Proposed Operations. In contrast, operating the project under the Forest Service's navigation flow recommendation, which would not allow for lower minimum flows when inflows are low, would substantially draw down Brownlee reservoir in extremely low flow years. Drafting water from closer to the reservoir's surface would result in warmer water being discharged from the Brownlee, Oxbow, and Hells Canyon developments than would occur under Proposed Operations.

Biological Productivity (Nutrients, DO, pH)

Changes in the seasonal flow regime caused by project operations can affect DO levels and other water quality parameters associated with biological productivity. In addition, some of the operating scenarios recommended by agencies, tribes, and NGOs in this proceeding have the potential to affect water quality parameters associated with biological productivity.

Our Analysis

As discussed in section 3.5.1.3, *Biological Productivity*, current operations result in lower DO concentrations downstream of Hells Canyon dam than the Snake River inflow to Brownlee reservoir. Hypoxic and anoxic conditions regularly occur in the transition zone of Brownlee reservoir during late spring and summer, and in the hypolimnion layer of Brownlee reservoir's lacustrine zone in summer and fall. Low DO waters are drafted from Brownlee reservoir and routed downstream resulting in Hells Canyon outflows that have DO levels that are frequently lower than the TMDL targets for salmonid spawning and coldwater aquatic life/salmonid rearing. Evaluation of Hells Canyon outflow DO levels for the 10-year period of 1991 through 2000 showed that DO concentrations were lower than the 11.0-mg/L spawning criterion/target throughout the entire fall period of each year and between 17 and 100 percent of the time in spring, and lower than coldwater criteria/targets more than half of the time in each year. Idaho Power proposes to continue current operations, which would result in similar DO conditions.

Operational recommendations to limit ramping downstream of Hells Canyon dam (refer to table 24) would have negligible effects on DO levels in outflows from Brownlee reservoir. Although these ramping limitations would have short-term effects on water levels and outflows of Oxbow and Hells Canyon reservoirs, these shifts would be so short so as to have negligible effects on DO levels of Hells Canyon outflows.

We evaluated the effects of recommended flow augmentation measures (refer to table 9) on DO levels by comparing Idaho Power's CE-QUAL-W2 simulated values for Proposed Operations to those for the flow augmentation operation (Scenario 2). For Brownlee reservoir, we focused on the simulated locations of hypoxic and anoxic conditions. For Hells Canyon outflows, we focused on general characteristics of differences between the simulated Scenario 2 and Proposed Operations and comparison to the criteria/target levels of 11.0 and 8.0 mg/L.

Table 24 summarizes our comparison of CE-QUAL-W2 simulation results for Brownlee reservoir under Proposed Operations and Scenario 2. Flow augmentation recommendations would lower the Brownlee reservoir water levels. The primary effects of these operations would occur during the summer when hypoxic/anoxic conditions would occur closer to the reservoir's surface. Scenario 2 (Flow Augmentation) simulation results indicate that in mid-August hypoxic/anoxic conditions would occur about 15 feet closer to the surface in extremely low flow years, 10 feet closer to the surface in medium-low flow years, and about 5 feet closer to the surface in medium and higher flow years.

Table 25 summarizes our comparison of CE-QUAL-W2 simulation results for Hells Canyon outflow to one another and DO criteria and TMDL targets. Flow augmentation recommendations would increase Hells Canyon outflow DO concentrations between July and October to varying extents in different types of flow years. Generally, the largest and earliest increases in DO concentrations would occur in extremely low flow years, and increases in DO concentrations would generally be negligible in medium-high to extremely high flow years. The simulation results also indicate that changes in minimum DO concentrations would be negligible in most years and the largest increases in minimum DO concentrations would occur in extremely low flow years.

Table 24. Summary comparison of Brownlee reservoir simulated DO concentrations for Proposed Operations and Scenario 2 (Flow Augmentation). (Source: Idaho Power, 2005e,g, as modified by staff)

Year	Proposed	Scenario 2 (Flow Augmentation)
1992 (extremely low flow)	Hypoxic/anoxic conditions start in the spring at RM 326 to 318. By the beginning of summer, hypoxic/anoxic conditions have progressed throughout most of the 1,950 to 2,020 feet msl band down to the dam, and most of the lacustrine zone within 50 feet of the bottom. As summer progresses, DO concentrations continue to decrease at elevations below 2,030 feet msl, resulting in anoxic conditions near the bottom of the transition and lacustrine zones. As fall progresses, hypoxic/anoxic water is flushed out of the transition zone and much of the lacustrine zone.	During summertime, lower water surface elevation with hypoxic/anoxic conditions at a lower elevation. In mid-August, the water surface elevation is about 25 feet lower and the top of the hypoxic/anoxic layer is about 10 feet lower than under Proposed Operations. There are no noticeable effects in spring, and minimal effects in the fall.
1994 (medium-low flow)[a]	Hypoxic/anoxic conditions start in the spring at RM 328 to 318. By the beginning of summer, hypoxic/anoxic conditions have progressed throughout most of the 1,940 to 2,010 feet msl band in the transition zone and the upper end of the lacustrine zone, and most of the lacustrine zone within 30 feet of the bottom. As summer progresses, DO concentrations continue to decrease throughout the entire water column resulting in anoxic conditions near the bottom of the transition and lacustrine zones. As fall progresses, hypoxic/anoxic water is flushed out of the transition zone and most of the lacustrine zone.	During summertime, lower water surface elevation with hypoxic/anoxic conditions at a lower elevation. In mid-August, the water surface elevation is about 25 feet lower and the top of the hypoxic/anoxic layer is about 15 feet lower than under Proposed Operations. There are no noticeable effects in spring, and minimal effects in the fall.
1995 (medium flow)	Hypoxic/anoxic conditions start in the spring at RM 305 to 298. By the beginning of summer, hypoxic/anoxic conditions have progressed throughout near bottom waters of the transition zone and just below the elevation of the powerhouse intake in the lacustrine zone. As summer progresses, the near bottom anoxic water is flushed out of the transition zone, but accumulates in the lacustrine zone even above the elevation of the powerhouse intake. As fall progresses, much of the hypoxic/anoxic water is flushed out of the lacustrine zone.	During summertime, lower water surface elevation with hypoxic/anoxic conditions at a lower elevation. In mid-August, the water surface elevation is about 20 feet lower and the top of the hypoxic/anoxic layer is about 15 feet lower than under Proposed Operations. There are no noticeable effects in spring, and minimal effects in the fall.

Year	Proposed	Scenario 2 (Flow Augmentation)
1999 (medium-high flow)	Hypoxic/anoxic conditions start in the spring at between RM 300 and the dam. By the beginning of summer, hypoxic/anoxic conditions have progressed throughout near bottom waters of the transition zone and most of the water below 1,920 feet msl in the lacustrine zone. As summer progresses, anoxic water accumulates near the bottom of the transition zone and is then flushed out of the transition zone, and anoxic water accumulates in the lacustrine zone even above the elevation of the powerhouse intake. As fall progresses, most of the hypoxic/anoxic water is flushed out of the lacustrine zone.	During summertime, lower water surface elevation with hypoxic/anoxic conditions at a lower elevation. In mid-August, the water surface elevation is about 15 feet lower and the top of the hypoxic/anoxic layer is about 10 feet lower than under Proposed Operations. There are no noticeable effects in spring, and minimal effects in the fall.
1997 (extremely high flow)	Hypoxic/anoxic conditions start in the spring at between RM 302 and the dam. By the beginning of summer, hypoxic/anoxic conditions have progressed throughout near bottom waters between the dam and RM 316, and in most of the lacustrine zone below 1,930 feet msl. As summer progresses, anoxic water accumulates near the bottom of much of the transition zone and in the lacustrine zone even slightly above the elevation of the powerhouse intake. As fall progresses, all of the hypoxic/anoxic water is flushed out of the lacustrine zone.	During summertime, lower water surface elevation with hypoxic/anoxic conditions at a lower elevation. In mid-August, the water surface elevation is about 15 feet lower and the top of the hypoxic/anoxic layer is about 10 feet lower than under Proposed Operations. There are no effects in spring and negligible effects in fall.

[a] Prior to issuance of the draft EIS, 1994 was identified as a representative medium-low flow year, based on analysis of the 1928 to 1999 flow record. However, Idaho Power's (2007a) subsequent analysis of the 1911 to 2005 flow record resulted in reclassifying 1994 to a low flow year.

Table 25. Summary comparison of simulated Hells Canyon outflow hourly DO concentrations for Proposed Operations and Scenario 2 (Flow Augmentation) to applicable criteria and TMDL targets.[a] (Source: Idaho Power, 2005e, as modified by staff)

Year	Proposed Operations	Scenario 2 (Flow Augmentation)
1992 (extremely low flow)	Lowest in July and August with a minimum of about 2 mg/L. Lower than 8.0- and 11.0-mg/L criteria/targets from early March through mid-April and from early May through December.	Generally about 1.0–1.5 mg/L higher in July and August, 0.5 mg/L higher in late October, and very similar to Proposed Operations for the remainder of the year. Overall minimum of about 3 mg/L. Lower than the 8.0- and 11.0-mg/L criteria/targets during the same periods as Proposed Operations.
1994 (medium-low flow)[b]	Lowest in August and September, with a minimum of about 3 mg/L. Lower than 8.0- and 11.0-mg/L criteria/targets from mid-March through mid-April and from late May through December.	Generally about 0.5 mg/L higher in July, 0.5 mg/L lower in August, and virtually the same as under Proposed for the remainder of the year. Overall minimum of about 3 mg/L. Lower than the 8.0- and 11.0-mg/L criteria/targets during the same periods as Proposed Operations.
1995 (medium flow)	Lowest in August and September, with a minimum of about 2.5 mg/L. Lower than 8.0- and 11.0-mg/L criteria/targets from early February through mid-April and from late June through December.	Generally about 0.5 mg/L higher in September and early October, virtually the same as under Proposed for the remainder of the year. Overall minimum of about 2.5 mg/L. Lower than the 8.0- and 11.0-mg/L criteria/targets during the same periods as Proposed Operations.
1999 (medium-high flow)	Lowest in August and September, with a minimum of about 2 mg/L. Lower than 8.0- and 11.0-mg/L criteria/targets from late June through December.	Virtually the same as under Proposed except in June, which is about ±1.2 mg/L of Proposed Operations. Overall minimum of about 2 mg/L. Lower than the 8.0- and 11.0-mg/L criteria/ targets during the same periods as Proposed Operations.
1997 (extremely high flow)	Lowest in August and September, with a minimum of about 4 mg/L. Lower than 8.0- and 11.0-mg/L criteria/targets from early July through December.	Generally about the same as under Proposed except in late May to early June, which is about ±1.2 mg/L of Proposed Operations. Overall minimum of about 4.5 mg/L. Lower than the 8.0- and 11.0-mg/L criteria/targets during the same periods as Proposed Operations along with a couple of days in late May.

[a] We estimated compliance with the criterion/target DO concentrations of 11.0 mg/L for spawning for October 23 through April 15, and the coldwater criterion/target of 8.0 mg/L for the remainder of the year.

[b] Prior to issuance of the draft EIS, 1994 was identified as a representative medium-low flow year, based on analysis of the 1928 to 1999 flow record. However, Idaho Power's (2007a) subsequent analysis of the 1911 to 2005 flow record resulted in reclassifying 1994 to a low flow year.

Idaho Power's simulation of project operations under navigation target flow levels (Scenario 3) is representative of operations that would result from recommendations made by the Corps and NPPVA for a minimum flow of 8,500 cfs upstream of the mouth of the Salmon River and 11,500 cfs downstream of the Salmon River. Based on Idaho Power's simulations of Scenario 3 (Bowling, 2005b), Hells Canyon outflow rates would be little affected in medium to extremely high flow years, and most affected in medium-low flow years when Brownlee reservoir inflows exceed 8,500 cfs. Although Hells Canyon minimum outflows would increase, maximum outflows during these periods would be reduced and thus

Brownlee reservoir levels would remain similar to Proposed Operations. We anticipate that DO concentrations in the Hells Canyon outflows under these circumstances would be a little higher than under Proposed Operations. Operating the project under the Forest Service's navigation flow recommendation, which would not allow for lower minimum flows when inflows are low, would substantially draw down Brownlee reservoir in extremely low flow years. We anticipate that this would result in somewhat higher DO concentrations being drafted from Brownlee reservoir and discharged from the Hells Canyon development than under Proposed Operations or the Corps/NPPVA navigation flow recommendations.

Total Dissolved Gas

Changes in the seasonal flow regime caused by project operations can affect the frequency of spill events at the project's dams and consequently affect gas super-saturation. In this section, we evaluate the effects that proposed and recommended operations would have on the frequency of spills that currently result in exceedance of the 110-percent of saturation TDG criterion. The effects of non-flow related issues that could influence the frequency and magnitude of exceedances of the TDG criterion are discussed in section 3.5.2.3, *Total Dissolved Gas*.

Our Analysis

As we discussed in section 3.5.1.4, *Total Dissolved Gas*, Brownlee dam spills of greater than 3,000 cfs increase TDG immediately downstream of the Brownlee dam spillway to levels above the 110-percent of saturation criterion. The effect of these spills is observed through both Oxbow and Hells Canyon reservoirs, but they have only a minor to moderate effect on TDG beyond Hells Canyon dam. Oxbow dam spills of 5,000 to 24,000 cfs increase TDG with the largest increases (about 20 percent of saturation) occurring at spills of 12,000 cfs. These elevated TDG levels continue through the 2.5-mile-long bypassed reach between the Oxbow dam and powerhouse. Nearly all spill rates at Hells Canyon dam result in exceedance of the 110-percent criterion at the monitoring station located approximately 1.5 miles downstream of the dam.

Idaho Power's Proposed Operations would be virtually the same as the current operations, with the exception of winter flood-control requirements that would apply only in December and January under a Corps request made on a case-by-case basis. Due to the occasional nature of this operational constraint, it was not separately modeled with the CHEOPS operations simulation model. As described in section 3.3.2.2, effects of Idaho Power's Proposed Operations were indistinguishable from the ongoing effects of Current Operations. This indicates that spills at each of the dams would result in negligible changes in the frequency of spills that would likely result in TDG exceedances of the 110-percent of saturation criterion.

We evaluated the effects of recommended project operations by comparing the frequency of spill events that would occur under Proposed Operations to the frequency occurring under the Flow Augmentation Scenario (Scenario 2) and the Navigation Scenario (Scenario 3) (see section 3.3.2.2).

Tables 26 and 27 summarize the CHEOPS modeling results for Brownlee outflows and the Hells Canyon dam gage that would likely result in TDG exceedances of the 110-percent of saturation criterion with the current spillway structures and operations.

Table 26. Summary of the occurrence of hourly modeled Brownlee outflows of greater than 38,000 cfs,[a] which likely would result in TDG exceeding the 110-percent of saturation criterion with current spillway structures and operations. (Source: Idaho Power, 2005b; Brink and Chandler, 2005, as modified by staff)

Year	Proposed	Scenario 1 (Stabilized Hells Canyon Release)	Scenario 2 (Flow Augmentation)	Scenario 3 (Navigation)
1992 (extremely low flow)	None	Virtually the same as proposed[b]	None	Virtually the same as proposed[b]
1994 (medium-low flow)[c]	None	NA	None	NA
1995 (medium flow)	A few days in mid-June	Virtually the same as proposed[b]	Virtually the same as proposed	Virtually the same as proposed[b]
1999 (medium-high flow)	Two-month period of late February through late April, and about 1 week in mid-June	NA	Slightly more frequent in mid-June	NA
1997 (extremely high flow)	Nearly 4-month period of January through April, and about 3 weeks in mid- to late June	Virtually the same as proposed[b]	Slightly more frequent in early June	Virtually the same as proposed[b]

Note: NA – indicates no CHEOPS model results, although there is no reason to believe Brownlee outflows would differ from Proposed Operations since this scenario uses Hells Canyon reservoir to reregulate Brownlee and Oxbow load-following operations.

[a] Flows of 38,000 cfs are equal to the Brownlee turbine hydraulic capacity of 35,000 cfs plus 3,000 cfs for spills that result in exceedance of the 110-percent criterion.

[b] Based on comparison of modeled Brownlee reservoir elevations plotted in Idaho Power's response to AIR OP-1(f).

[c] Prior to issuance of the draft EIS, 1994 was identified as a representative medium-low flow year, based on analysis of the 1928 to 1999 flow record. However, Idaho Power's (2007a) subsequent analysis of the 1911 to 2005 flow record resulted in reclassifying 1994 to a low flow year.

Table 27. Summary of the occurrence of hourly modeled Hells Canyon dam gage (No. 13290450) flows of greater than 30,500 cfs, which likely would result in TDG exceeding the 110 percent of saturation criterion with current spillway structures and operations. (Source: Bowling, 2005b, as modified by staff)

Year	Proposed	Scenario 1 (Stabilized Hells Canyon Release)	Scenario 2 (Flow Augmentation)	Scenario 3 (Navigation)
1992 (extremely low flow)	None	None	None	None
1994 (medium-low flow)[b]	None	None	None	None

Year	Proposed	Scenario 1 (Stabilized Hells Canyon Release)	Scenario 2 (Flow Augmentation)	Scenario 3 (Navigation)
1995 (medium flow)	One-month period of late May through late June nearly continuously	Virtually the same as proposed	Slightly more frequent and higher spills in late June-early July	Virtually the same as proposed
1999 (medium-high flow)	Total of about 4 months ranging from mid-January to late June	Virtually the same as proposed	Slightly less frequent in June, but higher	Virtually the same as proposed
1997 (extremely high flow)	About 6-month period of January through June nearly continuously	Virtually the same as proposed	Slightly less frequent spills in late May, but higher in early June	Virtually the same as proposed

[a] Flows of 30,500 cfs are equal to the Hells Canyon turbine hydraulic capacity.

[b] Prior to issuance of the draft EIS, 1994 was identified as a representative medium-low flow year, based on analysis of the 1928 to 1999 flow record. However, Idaho Power's (2007a) subsequent analysis of the 1911 to 2005 flow record resulted in reclassifying 1994 to a low flow year.

Under the Flow Augmentation Scenario, the frequency of modeled spills increased slightly, potentially resulting in TDG exceedances in early to mid-June of medium-high to extremely high flow years. A similar comparison for modeled Hells Canyon dam gage flows suggests that the frequency of spills could be affected in medium to extremely high flow years, but that the overall likelihood of Hells Canyon spills causing TDG exceedances would be about the same for the Flow Augmentation Scenario as Proposed Operations. In its comments on the draft EIS, NMFS states that the slight increases in the frequency of modeled discharges above the turbine hydraulic capacity at Brownlee and Hells Canyon dams are modeling artifacts likely caused by the model attempting to meet refill targets set by the program in every year, regardless of inflow. During high flow years, when aiming for a June 20 refill might incur unacceptable risk of involuntary spill, we anticipate that Idaho Power, NMFS, and FERC would confer and likely delay refill as appropriate; therefore, the increase in spill frequency predicted by the model would not occur.

Operational recommendations related to navigation target flow levels (Scenario 3) would not affect the outflows from any of the three developments during high-flow periods when spills are occurring. Thus, such recommendations would not result in a change in the frequency or magnitude of TDG exceedances of the 110-percent of saturation criterion.

Hazardous Materials

Changes in the seasonal flow regime caused by project operations can affect DO levels, which in turn can affect the formation and accumulation of hazardous water quality constituents (e.g., ammonia and methylmercury). In addition, some of the operating scenarios recommended by agencies, tribes, and NGOs in this proceeding have the potential to affect concentrations of hazardous materials. These scenarios include augmenting flows to improve outmigration survival of juvenile salmon and steelhead (Scenario 2, Flow Augmentation). Because the project needs to store and use petroleum products and other hazardous materials, there is a risk that these products could be discharged into the Snake River.

In addition to Idaho Power's proposed operations and operation-related recommendations received from agencies, tribes, and other parties (table 9), the ODFW, Umatilla Tribes, Nez Perce Tribe, and AR/IRU provide specific recommendations about hazardous materials. We discuss these recommendations below.

The Umatilla Tribes (CTUIR-23) and Nez Perce Tribe (NPT-17) recommend that Idaho Power prevent the discharge of point-source pollutants into the Snake River from the project as necessary to meet the applicable water quality standards. They recommend that Idaho Power develop a plan, in consultation with appropriate federal, state and tribal water quality and fish and wildlife agencies, to prevent discharge of pollutants from the project into the Snake River within 6 months of obtaining a new license, and implement measures to assure that point-source pollutants are not discharged from the project into the river within 1 year of issuance of a new license. If these measures do not meet applicable water quality standards, Idaho Power should re-consult with those agencies to develop and implement other means to meet standards within 2 years of the issuance of a new license.

AR/IRU (AR/IRU-20) recommend that Idaho Power obtain a permit under section 402 of the federal CWA for any discharges related to turbine operation from the Brownlee development. They indicate that this would include oil, grease, pH, cooling water, and any other pollutants created by the Brownlee powerhouse.

ODFW-43 recommends that Idaho Power, in consultation with ODFW and the White Sturgeon Technical Advisory Committee,[46] evaluate potential adverse effects on white sturgeon from the bioaccumulation of contaminants. Idaho Power would develop, fund, and implement a contaminant study for white sturgeon populations isolated within Hells Canyon and Oxbow reservoirs and the reach between Brownlee and Swan Falls dams. Under this recommendation, Idaho Power would provide ODFW and the White Sturgeon Technical Advisory Committee with annual updates and an annual plan, and allow a 30-day comment period for the draft annual plans. Idaho Power would also provide ODFW and the White Sturgeon Technical Advisory Committee a final report at the completion of the study. In addition, ODFW-57 recommends that Idaho Power consult with ODEQ and ODFW to develop and conduct a study to determine mercury, dieldrin, and DDT/DDE levels in fish in Brownlee reservoir. Such data would be used in modeling biomagnification of analytes for target species that include white sturgeon, bald eagles, and golden eagles.

Our Analysis

Operating the project would continue to require the storage, use, and potential spill of oil and other potentially hazardous materials. As discussed in section 3.5.1.6, *Hazardous Materials*, project power plants leaked/released oil at the rate of about 300 gallons per year at Brownlee, 60 gallons per year at Oxbow, and 25 gallons per year at Hells Canyon. To substantially reduce oil leakage from the Brownlee power plant, Idaho Power developed a new ring design and installed new gasket ring material at Brownlee units 1 and 2, which were the largest contributors to oil leakage.

The prevention and countermeasures for spills of the aforementioned hazardous materials is managed by Idaho Power through implementation of Spill Prevention Control and Countermeasure plans, which are approved by EPA and WDOE, in accordance with 40 CFR 112, EPA Oil Pollution Prevention Regulations. These plans describe management practices, procedures, structures, and equipment at project facilities to prevent spills and to mitigate or preclude any adverse effects on the environment. The plans provide: (1) the locations, quantities, and contents of oil products stored at the project; (2) a description of potential spill situations and control systems; (3) a detailed list of spill prevention measures associated with specific runoff and other drainage systems; (4) storage locations; (5) oil-containing equipment; (6) maintenance activities; (7) personnel training; and (8) reporting procedures. The existing Spill Prevention Control and Countermeasure plans fulfill the requirements of 40 CFR 112. To comply with 40 CFR 112, Idaho Power periodically reviews and revises the plans for the project at least every

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[46] The White Sturgeon Technical Advisory Committee is an interagency group that was established by Idaho Power to identify and develop measures to protect or enhance white sturgeon in the Snake River from Shoshone Falls (RM 615) to the mouth of the Salmon River (RM 188.2).

3 years or within 60 days of a spill. Continued implementation of practices implemented as components of these plans (e.g., training personnel in appropriate notification and cleanup procedures), would continue to ensure that project spills would be identified before they could enter project waters or cause much biological harm, and appropriate cleanup procedures would be done.

The only other considerable project point sources of pollutants are discharges of warm cooling and sump water from the project's power plants. Idaho Power has National Pollutant Discharge Elimination System (NPDES) permits that limit the temperature of these discharges from each of the project power plants. Meeting the requirements of these NPDES permits and the Spill Prevention Control and Countermeasure plans would ensure that the project does not discharge point-source pollutants into the Snake River, as recommended by the Umatilla Tribes and Nez Perce Tribe, and is consistent with section 402 of the federal CWA as recommended by AR/IRU.

Although these actions would limit the project's supply of point-source pollutants, operation of the project would still result in the production, accumulation, and discharge of ammonia and trace metals (including mercury) that form in the anoxic reservoir waters; and bioaccumulation of methylmercury and organochlorine compounds (including dieldrin, DDT/DDE, and PCBs) in fish in the project area. Operating the project under Idaho Power's Proposed Operations would result in essentially the same flow regime as current conditions, and thus would result in virtually the same production, accumulation, and discharge of ammonia and trace metals; and bioaccumulation of contaminants in fish and wildlife.

Because operational recommendations to limit ramping downstream of Hells Canyon dam (refer to table 9) would result in minimal changes in the water residence time within each of the project reservoirs, they would have negligible effects on ammonia and trace metal concentrations in water, as well as bioaccumulation of contaminants in fish and wildlife.

Operational recommendations related to flow augmentation (refer to table 9) would result in earlier drawdown of Brownlee reservoir, and greater drawdown of the reservoir in low to medium-low flow years. Because the near-bottom anoxic conditions would change little, the amount of ammonia produced and the amount of trace metals transferred from the sediments to the water column are expected to be similar to under Proposed Operations. However, increasing summertime discharges from Brownlee reservoir would tend to expedite discharge of ammonia and trace metals from Brownlee reservoir, and routing of them through the other two reservoirs and the lower Snake River. Consequently, accumulation of ammonia and trace metals would tend to be reduced in the meta- and hypolimnion of Brownlee reservoir during summer and early fall; hence, fall discharges would have lower concentrations of ammonia and trace metals. We anticipate that fish in the project area would bioaccumulate methylmercury and organochlorine compounds at roughly the same rate as under Proposed Operations.

Operational recommendations related to navigation target flow levels (refer to table 9) would have little effect on the seasonal outflows from Brownlee reservoir and is therefore expected to have negligible effects on the production, accumulation, and discharge of ammonia and trace metals; and bioaccumulation of methylmercury and organochlorine compounds in fish in the project area.

Data obtained for fish collected from Brownlee reservoir and the Snake River at Pittsburg Landing indicate that bottom dwelling fish (channel catfish, common carp, and largescale sucker) have concentrations of total mercury, total DDT, and/or total PCBs that indicate excessive contamination (refer to section 3.5.1.6, *Hazardous Materials*). No sampling of white sturgeon was done during this study, so the extent of contamination of this species is unknown. However, white sturgeon are particularly susceptible to bioaccumulation of contaminants due to their long life span, benthic feeding habits, and position at the top of the food chain. In section 3.7.2.1, *Effects of Project Operations on Terrestrial Resources*, we indicate that evidence suggests that fish-eating (piscivorous) wildlife would likely be adversely affected by some contaminants. DDT/DDE concentrations are at levels that adversely affect great blue heron and river otter, and mercury concentration are at levels that likely adversely affect bald eagle.

Monitoring the bioaccumulation of methylmercury and organochlorine compounds (particularly DDT/DDE) in fish from the project area, as recommended by ODFW, would provide data to refine estimates of the level of risk to fish and piscivorous wildlife, including bald eagles, golden eagles, and river otters. Additional monitoring of contaminant levels in the ODFW-recommended reaches upstream of Brownlee reservoir would provide added data for a more widespread evaluation of risks to fish and piscivorous wildlife. However, such reaches are beyond the hydrologic influence of the project. In the draft EIS, we stated that water quality conditions would likely improve through TMDL implementation before new year classes of white sturgeon attain reproductive age in 10 to 20 years, and ODFW's recommended monitoring of contaminants in white sturgeon would provide limited value if a sturgeon conservation aquaculture program is implemented. After re-evaluating these issues, we conclude that implementing the TMDL would take decades to attain substantial water quality improvements and even longer to reduce the effects of legacy contaminants. Therefore, we conclude that there would be a negligible change in bioaccumulation rates for toxic contaminants within the first 20 years (period for white sturgeon to reach sexual maturity) of a license, and that monitoring bioaccumulation in white sturgeon in a non-lethal manner would aid in determining the effects of bioaccumulation of contaminants on reproductive success and recruitment.

3.5.2.2 Dissolved Oxygen

Low DO levels greatly reduce habitat suitability for both cold and warmwater species in the project reservoirs during the summer months, and DO levels in the first 6 to 7 river miles downstream of Hells Canyon dam are below optimal during the first month of the fall Chinook salmon spawning season. Increasing DO levels in project reservoirs and downstream of Hells Canyon dam could greatly increase the usable habitat in the project reservoirs, reduce the incidence of fish kills, and improve conditions for fall Chinook salmon spawning downstream of Hells Canyon dam.

In its license application, Idaho Power proposed two measures to improve DO conditions. To improve DO conditions within the Hells Canyon Project, Idaho Power proposed to supplement DO in Brownlee reservoir at a rate consistent with the draft TMDL (average annual rate of 1,450 tons oxygen per year). Idaho Power also proposed to install and operate turbine-venting systems in Brownlee powerhouse units 1 through 4 and to investigate, and install and operate if practical, a turbine-venting system in Brownlee powerhouse unit 5 to enhance oxygen concentrations in the waters downstream of Hells Canyon dam. Following revision of the project's DO TMDL load allocation in the final TMDL, Idaho Power revised its proposed supplementation rate to 1,125 tons of oxygen per year, which is consistent with the final TMDL. Idaho Power also withdrew its proposals to vent the Brownlee turbines.

In a filing with the Commission on April 26, 2007, Idaho Power superseded its original proposal with the measures proposed in its January 31, 2007, application for water quality certification (Idaho Power (2007a). In this new proposal, Idaho Power proposes to fulfill its responsibility for the TMDL load allocation of 1,125 tons of oxygen per year for Brownlee reservoir either through implementing a Brownlee reservoir aeration system or through upstream phosphorus trading. Idaho Power proposes to implement aeration options using an adaptive management approach. However, phosphorus trading offers the potential for enhanced resource benefits over mechanical aeration. Therefore, Idaho Power proposes to devote a limited period (i.e., up to 1 year after license issuance) to identifying appropriate trading partner(s) first and, if that fails, to then proceed with design and installation of the reservoir diffuser system.

In addition to the DO load assigned to Idaho Power in the TMDL, Idaho Power (2007a) has estimated the project's responsibility for lowering DO concentrations downstream of Hells Canyon dam at a maximum of 637 tons of oxygen per year and developed measures to satisfy this responsibility. Idaho Power proposes to offset the project's contribution to low DO downstream of Hells Canyon dam by using a forced-air (blower) system at the Hells Canyon power plant to add 1,500 tons of oxygen annually or alternatively using a turbine aeration system at Brownlee power plant. Idaho Power proposes to work

with IDEQ and ODEQ to develop a monitoring plan for DO that would document the injection of 1,125 tons of oxygen per year into Brownlee reservoir or the removal of an equivalent phosphorus load upstream, and the addition of 1,500 tons of oxygen per year at Hells Canyon dam or Brownlee dam to augment DO levels downstream of the project. Idaho Power would monitor TDG in Hells Canyon turbine discharges whenever turbine aeration is occurring to ensure that its aeration does not cause TDG to exceed the 110 percent of saturation criterion. In addition, Idaho Power proposes to install and operate a destratification system in the Oxbow bypassed reach, and conduct monitoring to evaluate the effectiveness of this system. We discuss Idaho Power's proposed Oxbow bypassed reach DO measures in section 3.5.2.5, *Oxbow Bypassed Reach Flows.*

ODFW-55 recommends that Idaho Power consult with ODEQ to develop and implement a plan, approved by ODEQ in a water quality certification, to ensure that the project does not contribute to violation of Oregon's DO standard within or downstream of the project. This plan would include appropriate implementation measures, a timeframe, and an effectiveness monitoring plan. In addition, ODFW-58 recommends that Idaho Power consult with ODEQ and ODFW to develop appropriate water quality monitoring, including DO, and that the monitoring measures be approved by ODEQ in a water quality certification.

NMFS-12 recommends that Idaho Power, in cooperation with NMFS, IDEQ, ODEQ, and other interested agencies and tribes, evaluate and design the most effective means (blowers, aerating runners, or other technologies) of increasing late summer and fall DO levels in outflows of the Hells Canyon Project developments, with the goal of increasing DO levels downstream of Hells Canyon dam to at least 6 mg/L (an increase of roughly 2 mg/L over typical conditions at present). The initial evaluation would be completed within 2 years of issuance of a new license, with final design and construction completed within 5 years of license issuance. NMFS-14 also recommends that Idaho Power fund and maintain 6 permanent water quality monitoring stations in the mainstem Snake River to document trends in water quality (temperature, DO, TDG, and pH) and collect additional water quality samples twice each month to assess progress in reducing nutrient and fine sediment loads in the Snake River. Water quality monitoring stations would be located downstream of Hells Canyon, Brownlee, Swan Falls, C.J. Strike, and Bliss dams as well as between Brownlee reservoir and the Weiser River confluence. The specific location of each monitoring station would be determined by the Aquatic Resources Committee. Idaho Power would make this water quality information available to members of the Aquatic Resources Committee and FERC. In the 10(j) meeting, NMFS emphasized that funding water quality monitoring stations is a critical step toward re-establishment of a second population of fall Chinook salmon.

The Umatilla and Nez Perce Tribes (CTUIR-21 and NPT-16) recommend that Idaho Power construct structures on Hells Canyon dam, within 2 years of the issuance of a new license, to add DO to the Snake River downstream of the project. If these structures do not result in meeting the applicable DO standards, Idaho Power would re-consult with those agencies to develop and implement other structural approaches to increase the discharge of DO within 5 years of the issuance of a new license. In addition, the Nez Perce Tribe recommends including injecting oxygen in Brownlee reservoir to meet the 6.5-mg/L DO target, as designated by the load allocation in the Snake River-Hells Canyon TMDL (IDEQ and ODEQ, 2004).

Interior-42 recommends that Idaho Power implement measures to improve water quality conditions in Oxbow and Hells Canyon reservoirs, to the point that they meet all water quality standards for designated beneficial uses for the states of Idaho and Oregon. In more specific recommendations, Interior-61 recommends that Idaho Power, in consultation with ODEQ and IDEQ, install and operate a turbine-venting system on units 1 through 4, and potentially on unit 5, at the Brownlee development and the units at Hells Canyon dam. If any of the evaluated turbine venting systems for the units were found to be feasible, Idaho Power would coordinate with ODEQ and IDEQ to develop a design and operations plan, and an effectiveness monitoring plan, for turbine-venting system(s) on any of the feasible units. Interior-67 recommends that Idaho Power monitor water quality, including DO, TDG, temperature,

dissolved constituents, organic pesticides, mercury, and other heavy metals at numerous locations downstream of Hells Canyon dam. At least three replicate samples/readings would be taken from mid-channel in runs or pools at or near the following locations:[47] Hells Canyon Boat Ramp (RM 247), Stud Creek (RM 246), Warm Springs Bar (RM 243), Rocky Bar (RM 240.5), Granite Rapids (RM 239), and additional downstream locations or similar locations. Sampling would be conducted twice per month for the term of any new license, with more frequent sampling during low DO periods and when DO enhancement mitigation is being implemented.

AR/IRU-16 recommend that the Commission require Idaho Power to locate, fund, construct, and oversee operations of projects to reduce nutrient and suspended particle delivery from on-land sources to the Snake River and its tributaries above, and within, the project. These entities state that the purpose of this program would be to address unmitigated project impacts to DO, as well as improve tributary habitats and upstream mainstem habitat sufficiently to support white sturgeon and fall Chinook salmon under a future reintroduction program. They recommend that this program be implemented instead of Idaho Power's DO supplementation proposal for Brownlee reservoir.

AR/IRU-17 recommend that the Commission require Idaho Power to take steps to increase DO levels in flowing reaches within, and below, the project to meet applicable water quality standards. They recommend that this be done with an adaptive management approach using real-time monitoring results to trigger aeration/oxygenation of reservoir outflows. They recommend that these efforts start at the Brownlee development with sequential evaluation at the other two dams, and that this effort be overseen by a Technical Advisory Committee. These efforts would include the following elements:

- monitor DO on a real-time basis in deep water at the Brownlee forebay near the outlet structure and Brownlee outflows at the dam, and at Hells Canyon and Oxbow dams, if needed to measure project-caused low DO levels at these dams; and
- aerate or oxygenate the outflows (not including spill) and/or the forebay waters to address low DO levels in the project reservoirs. Idaho Power would start with aeration or oxygenation of reservoir outflows, and subsequently aerate or oxygenate deep waters in the forebay, if needed to satisfy the applicable water quality standards. Any system to bubble air or molecular oxygen in the forebay would be designed to avoid re-suspension of sediments and associated contaminants.

AR/IRU-26 recommend that Idaho Power locate and develop new water quality monitoring stations immediately downstream of Hells Canyon dam, upstream of Brownlee reservoir, and downstream of Brownlee dam. The two stations downstream of project dams would be designed for real-time monitoring of stage, discharge, water temperature, TDG, DO, pH, turbidity, and ammonia. Parameters that would be measured above Brownlee reservoir include total discharge, water temperature, DO, pH, nutrients, turbidity, and community production to respiration ratios.

Our Analysis

Currently, low DO levels regularly occur in the transition zone and much of the lacustrine zone of Brownlee reservoir during late spring and summer, and downstream of Hells Canyon dam in spring through fall. These DO conditions are primarily a result of the high nutrient (phosphorus) loads to the project, and the reduction in assimilative capacity caused by converting the riverine system into a reservoir system. As described in section 3.5.2.1, *Effects of Project Operations on Water Quality*, operating the project under any of the proposed and recommended operational regimes would not

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[47] Interior indicates that sample locations are to emphasize numerous locations within the first 10 miles downstream of Hells Canyon dam and states that this is the area most affected by operations and low DO levels.

substantially alter the DO regime in the project's reservoirs or Hells Canyon outflows. Measures that increase DO levels would provide direct benefits to aquatic habitat and indirect benefits to aquatic resources by expediting the degradation of organochlorine contaminants and reducing the availability of methylmercury (the biologically available form of mercury) in reservoir sediments.

We present our analysis in four parts: upstream watershed phosphorus trading, reservoir supplementation, aeration of downstream waters, and planning and monitoring.

Upstream Watershed Phosphorus Trading

In developing the Snake River-Hells Canyon TMDL for nutrients and DO, IDEQ and ODEQ (2004) represented the water quality narrative standards that were applicable at the time by setting a chlorophyll-*a* mean growing season (May through September) target at 14 μg/L and a total phosphorus target at no greater than 0.07 mg/L. Subsequent computations showed that reducing the nutrient loadings to the target level would not in itself satisfy the 6.5 mg/L DO target in Brownlee reservoir's transition zone and metalimnion during parts of July and August. Furthermore, IDEQ and ODEQ (2004) indicate that they anticipate it will take up to 70 years to reduce nutrient levels to the target levels. Based on modeling the reduction in assimilative capacity caused by converting the riverine system into a reservoir system, IDEQ and ODEQ (2004) assigned Idaho Power a load allocation equivalent to the addition of 1,125 tons of oxygen during a 65-day-long period per season. Although the calculated time period when exceedances occurred in the metalimnion of Brownlee reservoir was between Julian days 182 and 247 (July 1 through September 4[48]), IDEQ and ODEQ (2004) state that the timing of oxygen addition or other equivalent implementation measures should coincide with the actual periods when DO sags occur and where it would be the most effective in improving aquatic life habitat and supporting designated beneficial uses. IDEQ and ODEQ (2004) specifically stated that improvements in DO concentrations can be accomplished through equivalent reductions in total phosphorus or organic matter upstream, or by using other appropriate mechanism that can be shown to result in the required improvement of DO in the metalimnion and transition zones to the extent required. They also indicate that they expect water column DO monitoring to be undertaken as part of this scheduling effort.

In its January 31, 2007, application for water quality certification, Idaho Power (2007a) proposes to implement one of two measures (upstream phosphorus trading or Brownlee reservoir supplementation) to address the TMDL load allocation equal to 1,125 tons of oxygen per year. Idaho Power would try to identify an appropriate upstream phosphorus trading partner(s), and if that is unsuccessful within a limited period, it would proceed with Brownlee reservoir aeration to fulfill its obligation for the TMDL load allocation. Identifying one or more appropriate trading partners would be the first step to developing a legal agreement (trade) with another party under which the trading partner would reduce its phosphorus load to the Snake River more than required under regulations or established in the TMDL. This surplus phosphorous reduction (credit) would be in lieu of Idaho Power's supplementing oxygen at its TMDL allocation of 1,125 tons of oxygen per year. The intent of the trade would be to achieve an equivalent improvement in Snake River water quality, but at a lower cost. For the trade(s) to be successful, several factors would need to be addressed to ensure that the reductions in phosphorous loading provided a water quality improvement that would be functionally equivalent to supplementing oxygen at the TMDL allocation. A key component of any phosphorus trading would be identifying trading ratios for converting the required oxygen load to equivalent phosphorus loads. In its application for water quality certification, Idaho Power (2007a) provides ratios as a starting point for evaluating upstream trades. The total phosphorus to organic matter ratios presented range from 0.005 to 0.02, and the total phosphorus to oxygen ratios range from 0.0036 to 0.0143. Prior to arranging a trade, it would be important to determine acceptable ratio(s) to be used for upstream trading by consulting with IDEQ and ODEQ. In addition to

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[48] In a non-leap year.

determining the magnitude of any trade(s), it would be important to address the timing of the actual action so that it increases DO levels during the critical period. Reducing phosphorus loading to the reservoir would decrease the potential for algae growth, and over time would lower internal cycling of phosphorus, which would add to the overall benefits of source reduction. Implementing phosphorus reduction measures in tributaries also would enhance the DO regime, thereby improving fish habitat. Currently, it is impossible to quantify benefits that are likely to occur from an upstream phosphorus trade (or trades) since the location and nature of the trade(s) has yet to be identified.

Reservoir Supplementation

In the event that it does not locate an upstream phosphorus-trading partner(s), Idaho Power proposes to provide reservoir supplementation at an average annual rate of 1,125 tons oxygen per year, which would be consistent with the allocation in the final TMDL. Idaho Power provided a conceptual design of its proposed reservoir aeration system and described its proposed operations, along with CE-QUAL-W2 simulation results for each of the five representative flow years, in its final report on DO augmentation (Idaho Power, 2005g). In order to maximize the benefits of the aeration system, Idaho Power designed it with the goal of extending adequate DO levels for fish into the upstream end of the transition zone and preventing extreme hypoxic conditions from developing in this area.

Idaho Power's conceptual design of the reservoir aeration system includes an on-shore oxygen supply facility, supply piping from the facility to the reservoir, and two porous hose line diffusers. The oxygen supply facility would be located on flat terrain near the distribution site, and would include a storage tank for liquid oxygen, vaporizers, a pressure-regulating assembly, control valves, distribution piping, and truck access. The system is designed so that it could be used to deliver between 17.3 tons of oxygen per day (equivalent to 1,125 tons per year when applied for 65 days) and 34.6 tons of oxygen per day (equivalent to 2,250 tons per year when applied for 65 days). The amount of liquid oxygen needed for aeration at these rates, with an oxygen transfer efficiency of 85 percent and a safety factor of 1.15, would be 23.4 to 46.8 tons/day. This quantity could be delivered to the facility with three trucks every two days or three trucks every day, respectively. In order to provide an adequate storage volume and a flexible schedule for delivery of liquid oxygen, Idaho Power proposes installing a 50,000-gallon tank for storing liquid oxygen at the facility. Supply lines from the oxygen supply facility to the diffuser system would be routed in a trench under the road and then underwater to the deepest part of the reservoir. Then oxygen would be supplied to two porous-hose line diffusers in about a 2-mile-long reach of the reservoir centered around RM 325. The porous-hose diffusers would be maintained slightly off the bottom of the reservoir with several anchors and a buoyancy pipe, which could be used to re-float the porous hose for maintenance. MEI (2004a) estimates that the porous hose would need to be replaced about every 10 years.

Constructing the proposed reservoir aeration system would require clearing and grading the upland site for the oxygen supply facility, trenching for the supply lines, placing anchors for the diffuser system, and assembling the diffuser system at a site along the reservoir. Each of these activities has the potential to increase the turbidity in the nearby area. However, implementing reasonable management practices that are commonly employed for such activities would limit the magnitude and duration of these events to minor short-term events primarily within the construction period.

DO concentrations exhibit substantial interannual variability in Brownlee reservoir. Evaluation of vertical profiles for RM 325 collected in July of 1991 through 2003 shows that hypoxic conditions are common in low flow years, sometimes occur in medium-low flow years, and seldom if ever occur in years with higher flows (Idaho Power, 2005g). Simulations of DO concentrations indicate that reservoir aeration at 1,125 tons of oxygen per year (17.3 tons per day over the 65-day period of Julian day 182 to 247) would increase DO in the vicinity of the diffusers, but have little effect down-reservoir (table 28) and negligible effects farther downstream.

Table 28. Summary comparison of Brownlee reservoir simulated DO concentrations for Proposed Operations with and without proposed reservoir DO supplementation. (Source: Idaho Power, 2005g, as modified by staff)

Year	Without Proposed Reservoir DO Supplementation	With Proposed Reservoir DO Supplementation
1992 (extremely low flow)	Hypoxic/anoxic conditions start in the spring at RM 326 to 318. By the beginning of summer, hypoxic/anoxic conditions have progressed throughout most of the 1,950 to 2,020 feet band down to the dam, and most of the lacustrine zone within 50 feet of the bottom. As summer progresses, DO concentrations continue to decrease at elevations below 2,030 feet, resulting in anoxic conditions near the bottom of the transition and lacustrine zones. As fall progresses, hypoxic/anoxic water is flushed out of the transition zone and much of the lacustrine zone.	During summertime, near-bottom DO concentrations substantially increase between RM 327 and 324, and minor increases in DO concentrations occur in the upper layers of the transition zone. Hypoxic/anoxic conditions occur near the bottom for several miles just upstream of the oxygenated water. In addition, anoxic conditions continue to occur near the bottom of most of the transition zone and the entire lacustrine zone, and near the powerhouse intake. There are no noticeable effects in the fall.
1994 (medium-low flow)[a]	Hypoxic/anoxic conditions start in the spring at RM 328 to 318. By the beginning of summer, hypoxic/anoxic conditions have progressed throughout most of the 1,940 to 2,010 feet band in the transition zone and the upper end of the lacustrine zone, and most of the lacustrine zone within 30 feet of the bottom. As summer progresses, DO concentrations continue to decrease throughout the entire water column resulting in anoxic conditions near the bottom of the transition and lacustrine zones. As fall progresses, hypoxic/anoxic water is flushed out of the transition zone and most of the lacustrine zone.	During summertime, near bottom DO concentrations substantially increase between RM 328 and 322, and minor increases in DO concentrations occur in the upper layers of the transition zone. Hypoxic conditions occur near the bottom for about 2 miles just upstream of the oxygenated water. In addition, anoxic conditions continue to occur near the bottom of most of the transition zone and the entire lacustrine zone, and near the powerhouse intake. There are no noticeable effects in fall.
1995 (medium flow)	Hypoxic/anoxic conditions start in the spring at RM 305 to 298. By the beginning of summer, hypoxic/anoxic conditions have progressed throughout near bottom waters of the transition zone and just below the elevation of the powerhouse intake in the lacustrine zone. As summer progresses, the near bottom anoxic water is flushed out of the transition zone, but accumulates in the lacustrine zone even above the elevation of the powerhouse intake. As fall progresses, much of the hypoxic/anoxic water is flushed out of the lacustrine zone.	During summertime, near bottom DO concentrations substantially increase between RM 328 and 324, and minor increases in DO concentrations occur in the upper layers of the transition and lacustrine zones. Anoxic conditions continue to occur near the bottom in much of the transition zone and the entire lacustrine zone, and near the powerhouse intake. There are virtually no effects in fall.

Year	Without Proposed Reservoir DO Supplementation	With Proposed Reservoir DO Supplementation
1999 (medium to high flow)	Hypoxic/anoxic conditions start in the spring at between RM 300 and the dam. By the beginning of summer, hypoxic/anoxic conditions have progressed throughout near bottom waters of the transition zone and most of the water below 1,920 feet in the lacustrine zone. As summer progresses, anoxic water accumulates near the bottom of the transition zone and is then flushed out of the transition zone, and anoxic water accumulates in the lacustrine zone even above the elevation of the powerhouse intake. As fall progresses, most of the hypoxic/anoxic water is flushed out of the lacustrine zone.	During summertime, near bottom DO concentrations substantially increase between RM 326 and 324, and minor increases in DO concentrations occur in the upper layers of the transition zone. Anoxic conditions continue to occur near the bottom in varied amounts of the transition zone and the entire lacustrine zone, and near the powerhouse intake. There are no noticeable effects in fall.
1997 (extremely high flow)	Hypoxic/anoxic conditions start in the spring at between RM 302 and the dam. By the beginning of summer, hypoxic/anoxic conditions have progressed throughout near bottom waters up to RM 316, and most of the water below 1,930 feet in the lacustrine zone. As summer progresses, anoxic water accumulates near the bottom of much of the transition zone and in the lacustrine zone even slightly above the elevation of the powerhouse intake. As fall progresses, all of the hypoxic/anoxic water is flushed out of the lacustrine zone.	During summertime, near bottom DO concentrations substantially increase between RM 326 and 323, and minor increases in DO concentrations occur in the upper layers of the transition and lacustrine zones. Anoxic conditions continue to occur near the bottom in varied amounts of the transition zone and the entire lacustrine zone, and near the powerhouse intake. There are no noticeable effects in fall.

[a] Prior to issuance of the draft EIS, 1994 was identified as a representative medium-low flow year, based on analysis of the 1928 to 1999 flow record. However, Idaho Power's (2007a) subsequent analysis of the 1911 to 2005 flow record resulted in reclassifying 1994 to a low flow year.

Using the aeration system to provide 1,125 tons of oxygen per year in years when DO levels are not low in the vicinity of the aeration system (e.g., high flow years) would provide minimal increases to DO concentrations. In addition, simulation results indicate that aerating at the rate of 1,125 tons of oxygen per year could create an isolated area of oxygenated water surrounded by hypoxic conditions in low flow years (table 28). Placing the reservoir aeration system farther upstream would be undesirable due to the shallower depths that would reduce the efficiency of aerating the water.

Idaho Power's conceptual operational plan for the aeration system includes adaptively adjusting the rate of aeration based on potential benefit, and satisfying its TMDL load allocation on a long-term average period instead of an annual basis. Using this strategy, Idaho Power would inject more oxygen in years when there is a higher likelihood of formation of a hypoxic barrier surrounding the highly oxygenated area, and would inject less oxygen when this situation is unlikely to occur. Idaho Power suggests meeting the TMDL allocation of 1,125 tons per year using a 10-year average and providing aeration rates of 2,250 tons per year in low and medium-low flow years, 1,125 tons per year in medium flow years, and no aeration in higher flow years. Idaho Power also indicates that adjusting the aeration period to begin earlier may be warranted based on historical data and model results.

Providing higher aeration rates in low and medium-low flow years would provide an incremental increase in DO concentrations, although there is a possibility that the aerated water would be surrounded by hypoxic conditions that would form a barrier to aquatic organisms. The resulting conditions would be dependent on many factors including the flow conditions, nutrient loading, and oxygen demand. Recently collected data in Brownlee reservoir's transition zone suggests that there may be a significant oxygen demand near the sediment resulting from chemical products of anoxic conditions (including sulfide, ferrous iron, and methane), which are not specifically included in the CE-QUAL-W2 model. Currently, it is not clear how extensive oxygen demand from these materials would be upon initiation of aeration and ongoing aeration. This uncertainty, along with the potential for hypoxic water to surround aerated water, show the importance of adaptively managing any reservoir aeration process implemented to maximize its benefit in a cost-effective manner. Monitoring water quality in Brownlee reservoir would be essential for providing information to assist in making decisions about when to initiate aeration and the aeration rate to be used.

Idaho Power's proposed reservoir aeration system was designed for the current level of nutrient loading. As long-term improvements in upstream sources result from implementing the TMDL, the location of low DO levels would move down-reservoir and it may be beneficial to relocate the diffusers to the new low DO area. Idaho Power has designed the diffusers to facilitate this relocation, although it would not be practical to relocate the diffusers annually.

IDEQ and ODEQ (2004) state that "[i]mprovements in DO concentrations can be accomplished through equivalent reductions in total phosphorus or organic matter upstream, or other appropriate mechanism that can be shown to result in the required improvement of DO in the metalimnion and transition zones to the extent required." Since Idaho Power's proposed reservoir supplementation efforts would typically provide negligible benefit in most of Brownlee reservoir and downstream of Brownlee dam, there is reason to explore the potential to reduce nutrient and organic matter loadings from tributaries. In addition to reducing loadings to Brownlee reservoir, tributary restoration is likely to improve water quality in the tributaries, themselves, and aid in tributary fish restoration efforts. We discuss potential effects of tributary restoration efforts in section 3.6.2.10, *Tributary Habitat Improvements*.

TDG

In the immediate vicinity of the diffusers, DO could be increased to supersaturated levels, and thereby elevate TDG. Under current organic matter loadings, the resulting oxygen demand would result in the injected oxygen being used quickly. Simulations of reservoir aeration show that, under current

conditions, the oxygen plume from aeration in the transition zone would not affect the DO levels of Brownlee discharges. Likewise, TDG levels in discharges from the Brownlee development would not likely be affected by reservoir aeration under current levels of nutrient and organic matter loadings.

Temperature

The oxygen bubbles from aerating the reservoir may promote some mixing of water layers in the vicinity of the diffusers, and thus affect water temperature in the area. However, Mobley and Brock (1996) report that minimal mixing has resulted from porous-hose line diffusers at other sites. We anticipate, therefore, that any effect on water temperatures would likely be minimal. While water temperatures would be affected in the immediate vicinity of the diffusers, we expect negligible temperature effects in discharges from the Brownlee and Hells Canyon dams.

pH and Ammonia

In eutrophic waters similar to Brownlee reservoir, photosynthesis raises pH in the photic zone, and CO_2 generation from heterotrophic decay of organic matter, nitrification of ammonia, and oxidation of sulfide lowers pH in deep waters (Wetzel, 1975). Elimination of anoxic conditions in portions of the reservoir likely would increase the pH and reduce the production and accumulation of ammonia in those areas. When water stored in the transition zone is discharged during drawdown, Brownlee and Hells Canyon discharges may have elevated pH levels and lower ammonia concentrations as a result of reservoir aeration.

Mercury and Organochlorine Compounds

Mercury and organochlorine compounds (including pesticides and their break down products, along with PCBs) are strongly associated with sediments. There is the potential for suspending sediments and their associated toxic contaminants while constructing the porous hose system and by operating the system if the porous hose is installed too close to the reservoir's bottom. Therefore, it would be important to (1) avoid disturbing sediments while constructing reservoir aeration system, and (2) install the porous hose line at a level that would minimize disturbance of the reservoir's sediments during operation. Based on the conceptual design of the aeration system and the proven means of floating the porous hose diffusers, we anticipate that any disturbance of sediments would be minimal.

Under anoxic conditions, contaminated sediments can act as a source for mercury, and organochlorine contaminants degrade at a slower rate. Therefore, elimination of anoxic conditions near the bottom of the reservoir would reduce the availability of methylmercury (the biologically available form of mercury) and organochlorine contaminants. The extent of these reductions would primarily be a function of the extent and location of sediment contamination, and the extent and duration of shifting from anoxic to higher DO concentrations. Any ongoing adverse effects of these contaminants on aquatic organisms and their predators (including bald eagles) would be reduced accordingly.

Aeration of Downstream Waters

Although Idaho Power's proposed reservoir supplementation would not increase DO concentrations of Brownlee or Hells Canyon discharges to above the 6.5-mg/L target, it would fulfill the intent of the TMDL load allocation (IDEQ and ODEQ, 2004) and would be responsive to the Nez Perce Tribe's recommendation for reservoir supplementation. High levels of nutrient and organic matter loading would be the primary cause of these low DO concentrations, and would continue until implementation of the TMDL resulted in substantial reductions in the loadings to project waters. Nutrient loads to the project would be reduced at a faster rate if Idaho Power identified a trading partner and successfully implemented an upstream phosphorus trade. However, we anticipate that substantial

reduction in the overall nutrient and organic matter loadings from non-point sources would not occur for decades.

At the time that Idaho Power filed its license application (Idaho Power, 2003a), there was little evidence as to the extent that the project contributes to the low DO concentrations downstream of Hells Canyon dam, other than the reduction in assimilative capacity caused by Brownlee and Oxbow reservoirs. Nonetheless, Idaho Power initially proposed additional aeration measures in its license application. Idaho Power proposed to install and operate turbine venting systems in Brownlee units 1 through 4 and to evaluate the feasibility of implementing turbine-venting technology at Brownlee unit 5 with the goal of increasing DO levels downstream of Hells Canyon dam. This proposal, which Idaho Power subsequently withdrew after further study, was consistent with Interior's recommendation for turbine-venting measures.

The Brownlee development's turbine units 1 through 4 have the centerline of their runners above the tailwater elevation, while unit 5 has a lower runner elevation that is below the normal tailwater elevation. In August 2000, Idaho Power installed 4-inch hub baffles on Brownlee unit 4 and conducted tests to investigate the potential for turbine venting to increase DO concentrations in units 1 through 4. Initial evaluation of the 2000 tests suggested that the baffles may increase DO uptake by 1.0 to 1.5 mg/L (MEI et al., 2000). However, further evaluation indicates that changes in air flow were largely driven by tailwater elevations, which were different during the pre- and post-modification tests. Re-evaluation of the August 2000 data, along with another study conducted by Idaho Power in September 2004, indicates that the baffles have negligible effects on airflow and DO uptake in units 1 through 4 (Idaho Power, 2005g). Idaho Power examined the turbine drawings and found that the vacuum breaker air enters the head cover and exits the runner cone and, therefore, the baffles cannot induce additional airflow into the turbine.

The investigation indicated that normal aspiration of air without modification of the units varies by wicket gate openings and tailwater elevations. DO uptake for units 1 through 4 is about 1.0 mg/L at low tailwater elevations (1,800 to 1,801.9 feet) and about 0.7 mg/L at high tailwater elevations (1,804 to 1,805.1 feet). Therefore an estimated DO uptake of 0.5 mg/L is a conservative estimate of the effects of aspiration under normal operations without any modifications. Based on a mass balance approach, normal aspiration increases DO concentrations of Brownlee discharges by 0.33 mg/L when all of the units are being operated near their full capacity. Since unit 5 is located below the tailwater elevation, the pressure differential would not enable use of turbine-venting technology to aerate its discharges. Based on the results of these investigations, Idaho Power withdrew its proposal to implement turbine-venting technology in any of the units at the Brownlee facility.

Idaho Power (2007a) estimates that the project's contribution to downstream depressed DO levels is a maximum of 637 tons of oxygen per year, based on CE-QUAL-W2 simulations for the low flow year of 2002. Idaho Power indicates that it would use a forced-air system at Hells Canyon power plant to add 1,500 tons of oxygen annually to offset the project's contribution to low DO downstream of Hells Canyon dam (Idaho Power, 2007a). However, Idaho Power continues to evaluate turbine aeration measures for the Brownlee power plant. Consequently, additional information may be developed as to benefits, feasibility, or cost effectiveness of the power plant aeration measures that indicates the installation of a turbine aeration system at Brownlee may be preferable to one at Hells Canyon. In that case, Idaho Power plans to evaluate whether turbine aeration at the Brownlee powerhouse would provide reasonable assurance that the targets downstream of Hells Canyon dam would be met. Pending ODEQ and IDEQ approval, measures at Brownlee dam would be implemented within a specified time frame following license issuance.

To further evaluate the potential to increase DO levels downstream of Brownlee dam, Idaho Power analyzed the effects of implementing forced air blowers at Brownlee units 1 through 4 and unit 5. Conceptual designs of forced air systems were developed to meet the goal of attaining DO increases of

between 1 and 2 mg/L (MEI, 2004b). A discrete bubble model was used to track oxygen and nitrogen transfer from bubbles and determine the air requirements to increase an incoming DO concentration of 4 mg/L by 1 mg/L and 2 mg/L. MEI estimated oxygen transfer efficiencies of about 40 percent for unit 5 and 20 percent for units 1 through 4.

Model results indicate that DO concentrations in the unit 5 tailrace would increase about 1 mg/L for every 107 cfs of air that is injected when the unit is operating near its maximum capacity of 11,800 cfs. Model results for units 1 through 4 indicate that each unit would have DO increases of about 1 mg/L for every 95 cfs of air that is injected when the respective unit is being operated near its maximum capacity of 5,675 cfs. Injecting atmospheric air would result in a substantial amount of nitrogen also being dissolved in the water and would, thus, increase TDG levels substantially. Model results indicate that injecting enough air into any of the five Brownlee units to increase the DO concentration from 4 mg/L to 6 mg/L would increase TDG levels to above the 110 percent of saturation criterion; whereas, the model predicted that injecting air at levels that would increase DO by 1 mg/L would maintain TDG levels below the 110 percent of saturation criterion. By injecting oxygen instead of atmospheric air, Idaho Power could avoid producing TDG in excess of 110 percent of saturation while substantially increasing DO.

Idaho Power has continued evaluating forced-air systems and aerating runners for the Brownlee and Hells Canyon power plants. Idaho Power (2007a) reported that preliminary evaluations indicate that various combinations of turbine aeration measures at Brownlee are feasible to meet the 1,500 tons of oxygen per year load downstream of Hells Canyon dam, but model simulations indicate that additional DO may need to be added at the Brownlee power plant to account for processes in the Oxbow and Hells Canyon reservoirs. Preliminary evaluations indicate that turbine aeration at Brownlee dam could provide the 1,500 tons per year and 440 tons for 37 days to compensate for adverse DO conditions caused by a Brownlee reservoir bubble upwelling system (see section 3.5.2.4, *Water Temperature*). However, further evaluation is necessary to verify both the adverse effects from implementing a Brownlee reservoir upwelling system, as well as the capability of the Brownlee turbine aeration measures to increase DO. Turbine aeration at Brownlee would have the added benefit of enhancing DO conditions within Oxbow and Hells Canyon reservoirs. Idaho Power (2007a) reported that numerical simulations of a Hells Canyon blower system delivering atmospheric air at a rate of 2,000 standard cubic feet per minute during July through November could provide 1,654 tons of oxygen, which is about 150 tons more than the required load allocation. Simulation results indicate that the DO concentration would increase an average of 0.4 mg/L, and that it was unlikely that the blower system would cause TDG to exceed the 110-percent of saturation criterion. Based on their evaluations, Idaho Power states that a forced-air system for Hells Canyon power plant would be the most cost-effective technology to implement.

Planning and Monitoring

The study results summarized in the preceding sections provide a basis for Idaho Power to develop a DO enhancement plan, in consultation with IDEQ, ODEQ, and other federal, state, and tribal agencies responsible for managing fish and wildlife, to compensate for the project's adverse effects on DO levels. Developing this plan and implementing appropriate measures to compensate for the project's adverse effects on DO would be consistent with ODFW's recommendation (ODFW-55). The plan would help outline a process to identify appropriate upstream phosphorus trading partner(s), refine the proposed reservoir DO supplementation measure and the need for additional aeration measures, and confirm whether reservoir supplementation is cost effective. This plan would provide a vehicle to evaluate the effectiveness and feasibility of alternative measures including reducing nutrient and organic matter loadings from tributaries, injecting oxygen or air into forebay waters or turbines, and using aerating runners to increase DO in turbine flows. We anticipate that consultation would include finalizing trading ratios to be applied in the event of implementing upstream phosphorus trading.

Regardless of what methods are implemented to increase DO levels, monitoring of nutrients, TSS, DO, and pH would provide data to confirm their effectiveness. In addition, these data also would aid in adaptively implementing measures so as to maximize the benefit. Monitoring the quality of Snake River inflows to Brownlee reservoir would provide data that could be used to determine long-term reduction of nutrients and suspended sediment loads as the TMDL and other restoration efforts are implemented. If reservoir supplementation is selected for implementation, this information could be used to determine when (both which years and the timing within selected years) supplementation would occur and the rate at which it would occur. Monitoring the quality of inflows and outflows of Brownlee reservoir would provide data that could be used to select the appropriate time in the season to begin reservoir supplementation and document the effectiveness of the supplementation. A long-term assessment of inflowing water quality also could aid in determining if upstream conditions have sufficiently improved to warrant relocating the diffuser system to a down-reservoir location. Monitoring water quality at the three sites recommended by NMFS that are about 120 to 220 miles upstream of Brownlee reservoir (i.e., downstream of Swan Falls, C.J. Strike, and Bliss dams) would not provide any incremental information to aid in selecting control measures for the project or determining their effectiveness. However, monitoring at these sites would facilitate assessment of whether upstream water quality would likely support restoring fall Chinook in these areas.

During development of the plan, Idaho Power would consult with IDEQ and ODEQ to confirm agreement with Idaho Power's estimate of project effects that contribute to low DO levels in the Snake River downstream of Hells Canyon dam. Once the appropriate DO load allocation is set for the project, the feasibility of implementing Idaho Power's proposed Hells Canyon forced-air system and other measures to meet this load allocation, including oxygen injection at the Hells Canyon turbines and Brownlee powerhouse forced-air and aerating runner systems, would be evaluated. A monitoring plan would be used to: (1) confirm that Idaho Power is meeting their obligations for improving the DO regime; and (2) evaluate the effectiveness of the measures implemented, as well as any adverse effects on TDG downstream of the turbine aeration measures implemented. To accurately document the effectiveness of increasing DO downstream of Hells Canyon dam, monitoring would need to be conducted near the dam. Sampling water quality at a single downstream site would provide insight into the level of discharges from the project, including the effects of aeration measures implemented at the project.

Sampling water quality at numerous locations within the first 10 miles downstream of Hells Canyon dam at least twice per month, as recommended by Interior, would provide information on the reaeration rate and changes in other water quality parameters in this reach. However, we anticipate that sampling at this intensity would provide little incremental value over monitoring at just one site, since reaeration rates are relatively predictable and there are no primary sources of contaminants in this reach. At the 10(j) meeting, FWS expressed some flexibility regarding the frequency and number of water quality measurements that would be needed downstream of Hells Canyon dam to track changes in water quality associated with implementation of water quality improvement measures. As part of developing the DO enhancement plan, Idaho Power would consult with the appropriate federal and state agencies and the tribes to determine an appropriate level of monitoring downstream of Hells Canyon dam. The FWS's recommended level of monitoring effort would be addressed during these consultations.

3.5.2.3 Total Dissolved Gas

Spills occur at the project's dams when river flows exceed the capacity of the respective powerhouse. Spills are routed over the project spillways, which results in water plunging to depth in the pool below the dams. This can increase TDG to levels exceeding the applicable Idaho and Oregon state standards. The frequency and extent of these increases are dependent on the spillway structures and the flow of water routed through them. We discuss the frequency of flows routed through the spillways

above in section 3.5.2.1, *Effects of Project Operations on Water Quality*. In this section, we discuss the effects of varied operational procedures, structural changes at the dams, and TDG monitoring.

In its license application, Idaho Power proposed to continue preferential use of crest (upper spillway) gates for passing spills at Brownlee dam and to install flow deflectors on the Hells Canyon dam spillway, consistent with the conceptual design presented in Technical Report E.2.2-4 (Myers and Parkinson, 2003). In an April 26, 2007, filing with the Commission and its January 31, 2007, application for water quality certification, Idaho Power (2007a) added several proposed measures to address spill-related TDG. Under Idaho Power's amended proposal, it would:

- Continue preferential use of crest gates for passing spills at Brownlee dam until spillway deflectors are constructed at Brownlee dam.
- Evaluate TDG reduction structures for Oxbow dam.
- Install Hells Canyon dam spillway flow deflectors.
- Install Brownlee dam spillway flow deflectors.
- Install the most effective, safe, and economically feasible measure designed to reduce TDG at Oxbow dam (Idaho Power did not specify the measures under consideration, and indicates that the final design cannot be completed until the Brownlee dam spillway flow deflectors are installed and TDG levels downstream are monitored. The monitoring data would provide a basis for more accurately estimating the dynamics of the effects of Brownlee dam on TDG levels at Oxbow dam).
- Work with ODEQ and IDEQ to develop a TDG monitoring plan that would include monitoring during spill to determine compliance with the TMDL load allocation assigned to Idaho Power and biological monitoring of fish communities during spill to determine the degree to which aquatic life is being protected; and
- If monitoring during spill indicates that these measures fail to meet the TDG criterion or protect aquatic life, Idaho Power would adaptively manage TDG at the project through evaluation and implementation of additional measures designed to further reduce TDG levels.

ODFW-54 recommends that Idaho Power develop and implement a plan, in consultation with and as approved by ODEQ, for satisfying Idaho Power's TDG allocation of less than 110 percent of saturation at the edge of the aerated zone below each dam. Under this plan, Idaho Power would develop measures to assure compliance with Oregon's 110-percent of saturation criterion below all three dams, and the plan would include a schedule and a monitoring component. ODFW-58 also recommends that Idaho Power consult with ODEQ and ODFW to develop appropriate monitoring of water quality parameters including TDG, and that the monitoring measures be approved by ODEQ in a water quality certification.

NMFS recommends that Idaho Power design, in consultation with NMFS, IDEQ, ODEQ, and other interested agencies and tribes, and construct a gas abatement structure at spillways of both Hells Canyon (NMFS-10) and Brownlee (NMFS-11) dams to reduce TDG levels in Oxbow and Hells Canyon reservoirs and the free-flowing Snake River downstream of Hells Canyon dam. It recommends that Idaho Power complete the designs and provide them for agency review no later than 1 year following issuance of a new license; the Hells Canyon structure would be built no later than 3 years after issuance of a new license, and the Brownlee structure no later than 4 years after license issuance. In addition, NMFS-14 recommends that Idaho Power fund and maintain six permanent water quality monitoring stations in the mainstem Snake River to document trends in water quality, including TDG (see section 3.5.2.2, *Dissolved Oxygen)*. Water quality monitoring stations would be located downstream of Hells Canyon, Brownlee, Swan Falls, C.J. Strike, and Bliss dams, as well as between Brownlee reservoir and the Weiser River confluence.

Interior-62 recommends that Idaho Power install flow deflectors on the spillways of Hells Canyon and Brownlee dams. The deflector at Hells Canyon would be as described in the license application (Idaho Power, 2003d; Myers and Parkinson, 2003), and Idaho Power would work with the IDEQ and ODEQ to design similar structures that are appropriate for the Brownlee dam spillway. Interior's recommendation includes an effectiveness monitoring plan. Interior-64 recommends that Idaho Power comply with the terms set forth by the IDEQ and ODEQ water quality certifications in a manner that is consistent with the implementation timelines described by IDEQ and ODEQ through the certification process.

The Umatilla and Nez Perce Tribes (CTUIR-20 and NPT-15) recommend that within 6 months of obtaining a new license Idaho Power, in consultation with appropriate federal, state and tribal water quality and fish and wildlife agencies, develop a plan to implement structural means and measures to abate TDG from the project, and implement such structures within 2 years of the issuance of a new license. If the resulting structures do not meet standards, Idaho Power would re-consult with those agencies to develop and implement other structural approaches to meet water quality standards within 5 years of the issuance of a new license.

AR/IRU-18 recommend that the Commission require Idaho Power to eliminate or minimize TDG levels in excess of 110 percent of saturation. This effort would include the following elements:

1. Implementation of a real-time monitoring program for TDG that would operate only during times of spill or consistent with Idaho Power's water quality certification, whichever is the most rigorous. This monitoring program should be designed to first detect TDG violations and then to quantify affected reach length downstream of project dams.
2. An adaptive-management approach beginning at Hells Canyon dam working upstream to the other two dams using measurements of TDG as an indicator of priority.
3. Installation of deflectors (flip-lip-like devices) to minimize the deep plunge of water immediately downstream of the dam face.[49]
4. Evaluation of whether non-plunging discharge should be horizontally separated from water plunging over the dam to prevent entrainment of those non-plunging flows that would take them to deep water.
5. An adaptive management approach, on a site-specific basis, to determine if horizontal separators are needed to prevent entrainment of otherwise non-plunging discharges.
6. A compensation program to address the losses of aquatic biota in those years when TDG attainment is not feasible. This would include a method to quantify losses and to determine the appropriate level and nature of compensation for those losses.

Our Analysis

Spills of greater than 3,000 cfs at Brownlee dam currently result in TDG levels exceeding the 110 percent of saturation criterion downstream of the Brownlee dam spillway and have substantial effects on TDG levels in the Oxbow and Hells Canyon reservoirs. Nearly all spills at Hells Canyon dam result in exceedance of the 110-percent of saturation criterion, and at spills of 19,000 cfs and greater, the entire Hells Canyon reach down to the Salmon River confluence exceeds the criterion. As described in section 3.5.2.1, *Effects of Project Operations on Water Quality*, operating the project under any of the proposed and recommended operational regimes would result in spill rates at Brownlee and Hells Canyon dams that exceed the 110 percent of saturation criterion at Brownlee and Hells Canyon dams. These spills would

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[49] AR/IRU do not specify the dams for which they recommend the installation of deflectors or how to make that decision.

occur for prolonged periods in medium-high to extremely high flow years, less frequently in medium flow years, and seldom, if ever, in low flow years.

Idaho Power's proposal and the recommendations of others to address TDG abatement cover a variety of approaches including operational changes at Brownlee dam, designing and constructing TDG abatement structures for Hells Canyon, Brownlee, and/or Oxbow dams, monitoring, adaptive management, and development of a compensation program for high TDG levels.

Idaho Power study results (Myers and Parkinson, 2003) indicate that spilling water through the Brownlee dam upper spillway gates and Hells Canyon dam lower spillway gates provide lower TDG levels than using the other gates at these dams. For example, TDG levels at Brownlee dam are reduced by 14 percent using the upper spill gates at spill releases of 39,000 cfs, and TDG levels at Hells Canyon dam are reduced by about 4 percent of saturation by using the lower spillway gates at spill releases of 28,000 cfs. Therefore, continued preferential use of the upper spillway gates at Brownlee dam, as proposed by Idaho Power, would aid in avoiding unnecessary elevation of TDG below the dam. Depending on the Brownlee spill rates, these beneficial effects could continue through Oxbow reservoir and down to Hells Canyon dam. After spillway deflectors are added to Brownlee dam, there would be less need to reduce TDG through operational measures. The deflectors would alter the hydraulics of the spillway and therefore the effectiveness of using the upper spillway gates to reduce TDG.

The benefit associated with preferential use of the lower gates at Hells Canyon dam appears to be much smaller than the benefit of using the Brownlee upper gates. However, it still would provide some benefit. Based on the study results, TDG reductions would occur with total flows of up to at least 74,000 cfs at Brownlee dam and 58,500 cfs at Hells Canyon dam if the turbines are operating at their full hydraulic capacity. Since the 110 percent of saturation criterion does not apply when flows exceed the 10-year 7-day average flood flow of approximately 67,900 cfs at Brownlee dam, these reductions would occur at Brownlee dam for the entire applicable range of the 110 percent of saturation criterion. However, this may not be the case at either Oxbow or Hells Canyon dams, where Idaho Power (2007a) estimates the 10-year 7-day average flood flows are approximately 69,060 cfs and 71,500 cfs, respectively.

In addition to evaluating operational procedures to reduce the project's elevation of TDG, Idaho Power funded development of physical models of both Brownlee and Hells Canyon dams to investigate the potential to reduce entrainment of air through structural changes at the dams (Lyons and Weber, 2005a,b; Myers and Parkinson, 2003). Initial use of the physical model for Hells Canyon dam indicated that deflectors for the upper spillways would not be effective at reducing TDG and could cause dam stability problems. Subsequently, the focus has been on developing an acceptable deflector design for the lower level sluiceways. The design for a total flow of up to 60,000 cfs includes 16-foot-long deflectors with a 5-degree upward lip angle located on the spillway face at an elevation of 1,468 feet msl. To quantitatively optimize the final Hells Canyon spillway flow deflector design to the 10-year 7-day average flood flow of approximately 71,500 cfs, Idaho Power (2007a) proposes to use a three-dimensional finite element computational fluid design model.

In its January 31, 2007, application for water quality certification, Idaho Power (2007a) proposes to construct deflectors on the Brownlee dam spillway. The qualitatively optimized design consists of 18-foot-long deflectors located on the spillway face at an elevation of 1,800 feet msl. Idaho Power proposes to further refine this design using a computational fluid dynamics model. The physical models indicate that flow characteristics of the proposed Hells Canyon lower level spillway deflectors and intended Brownlee dam spillway deflectors would provide the best hydraulic conditions for the greatest range of flows. Installation of Hells Canyon and Brownlee deflectors, with refined designs, would reduce the frequency and severity of supersaturation events related to flows up to the 10-year 7-day average flood flow.

At the time the draft EIS was issued, it was not evident whether spill at Oxbow dam independent of Brownlee dam spills elevate TDG to levels above the 110 percent of saturation criterion. In 2006, Idaho Power (2007a) conducted a study that showed that spill at Oxbow dam can elevate TDG to at least 128 percent of saturation in the Oxbow bypassed reach when TDG is less than 110 percent in the Oxbow forebay. This shows that effective TDG abatement at Brownlee dam would not resolve all TDG issues at the Oxbow dam. To address this, Idaho Power is currently evaluating TDG reduction structures for Oxbow dam. It intends to finalize its design of appropriate Oxbow dam TDG abatement measures after the Brownlee dam spillway deflectors are installed and their effectiveness is monitored, and implement the Oxbow TDG abatement measures once it has obtained required permits. Currently, the effectiveness of an Oxbow dam TDG abatement measure would be difficult to determine because of the effects of spills at Brownlee dam. Idaho Power's proposed approach for abating TDG at the Oxbow dam would help reduce TDG in the Oxbow bypassed reach and through Hells Canyon reservoir. Also, the proposed approach would be consistent with ODFW's recommendation (ODFW-54) to ensure compliance with TDG standards below each of the project dams.

In summary, Idaho Power's proposed operational changes and deflector installations at Hells Canyon and Brownlee dams would reduce the frequency of spill events that exceed the TDG criterion and reduce the magnitude of exceedances at flows up to the 10-year 7-day average flood flow at both Brownlee and Hells Canyon dams. Idaho Power's proposed implementation of an appropriate TDG abatement measure for Oxbow dam would reduce the magnitude of TDG exceedances of 110 percent of saturation in the Oxbow bypassed reach and Hells Canyon reservoir. However, we do not have sufficient information to accurately estimate the extent of these reductions in TDG.

Because it is not known whether the combination of Idaho Power's proposed operational changes, the installation of Brownlee and Hells Canyon spillway deflectors, and the selected Oxbow dam TDG abatement measure would satisfy the applicable TDG standards, additional abatement measures may be warranted. Development of a TDG abatement monitoring plan such as recommended by ODFW, the Nez Perce Tribe, and the Umatilla Tribes would provide an effective way of proceeding toward compliance with applicable TDG standards in an adaptive fashion that is consistent with Idaho Power's proposed approach to monitoring. Developing the plan through consultation with agencies and tribes responsible for managing water quality and fisheries would help to focus efforts on their concerns. Including an adaptive monitoring program as part of the overall plan would provide a means of documenting the effectiveness of TDG abatement measures and the need for any additional abatement measures to satisfy applicable TDG standards. If additional TDG abatement measures are deemed necessary, Idaho Power could evaluate the potential for additional operational and/or structural TDG abatement measures, as well as the feasibility of implementing these measures.[50] The plan also could provide an effective means to schedule the design and implementation of TDG abatement measures in a practical way that maximizes their benefits, monitor the effectiveness of these measures, document compliance with TMDL allocations and applicable TDG standards, and report these activities.

Water quality could be monitored downstream of Bliss, C.J. Strike, and Swan Falls dams to document conditions downstream of these dams. However, monitoring TDG at these sites, as recommended by NMFS, would not assist in determining the need for TDG-abatement measures at the Hells Canyon Project dams or in documenting their effectiveness.

Idaho Power (2007a) indicates that it proposes to work with IDEQ and ODEQ to develop a monitoring protocol that includes a specific methodology for monitoring TDG during spills, which may

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[50] Potential abatement measures that could be evaluated include modifying the flow deflectors after installation, modifying the training walls to better separate turbine and spill flows, increasing the turbine capacity by refurbishing or adding units, modifying the stilling basin, building off-gassing structures, and constructing a bypass conveyance to pass spill flows.

include monitoring effects of TDG on aquatic organisms. We anticipate that this protocol would include collecting data on the timing and quantity of spill at each of the project dams, TDG measurements at the point of compliance, and data to determine whether the point of compliance was completely mixed and representative of conditions in the river. Near-field TDG studies also may be necessary to more closely evaluate mixing downstream of the spillways and potential measures to reduce entrainment of powerhouse flows into the stilling basins. Reporting this information annually along with any recommendations for relocation of the compliance site would provide valuable information to help determine the effectiveness of measures implemented, the need for any additional TDG abatement measures, and whether continued monitoring of TDG is warranted.

We anticipate that achieving applicable TDG standards would take several years to accomplish, even with implementation of the foregoing measures. AR and IRU recommend that a compensation program be developed to address losses of aquatic biota in years when attaining the TDG standards is not feasible. We discuss this recommendation along with the effects of TDG abatement measures on aquatic resources in section 3.6.2.3, *Total Dissolved Gas*.

3.5.2.4 Water Temperature

As a result of the large volume of water stored in the project reservoirs and the project's relatively deep intakes, the project substantially alters Snake River temperatures by delaying the seasonal warming and cooling of water downstream of the project. Compared to inflows, this thermal lag reduces exceedances of criteria for supporting coldwater aquatic life during the summer, but increases the exceedances of temperature criteria for salmonid spawning at the start of the spawning season for fall Chinook salmon. We evaluate the biological effects of altered water temperatures on fall Chinook salmon in section 3.5.3, *Aquatic Resources*, in the subsection 3.5.3.4, *Water Temperature*.

In its license application, Idaho Power did not propose any measures to control downstream water temperatures. However, in its January 31, 2007, submittals to IDEQ and ODEQ (Idaho Power, 2007a), Idaho Power proposes to follow an adaptive management approach in implementing appropriate measures to demonstrate compliance with the existing water temperature standards. Idaho Power's adaptive management approach would consist of:

- monitoring water temperature of the mainstem Snake River and three major tributaries downstream of Hells Canyon dam (i.e., the Imnaha, Salmon, and Grande Ronde rivers) to determine the thermal conditions under which fall Chinook salmon spawn, and when fry emerge from the gravels;
- continuing to monitor Snake River fall Chinook salmon redds[51] to provide a basis for evaluating the urgency and need for implementing specific measures for altering the thermal regime, and to assess the risks and benefits of these measures; and
- implementing Idaho Power's proposed Temperature Adaptive Management Plan, under which Idaho Power, in consultation with IDEQ and ODEQ, would: (1) define the extent and nature of the project's temperature responsibility; (2) evaluate potential measures and select the appropriate measure; and (3) implement the appropriate measure.

ODFW-56 recommends that Idaho Power consult with ODEQ to develop and implement a temperature management plan. This plan would include implementing measures, a timeframe, and an effectiveness monitoring plan. In addition, ODFW-58 recommends that Idaho Power consult with ODEQ

[51] Redd monitoring is also used to establish protective flows for fall Chinook salmon redds during the incubation period.

and ODFW to develop appropriate monitoring protocols for water temperature and other water quality parameters.

The Nez Perce and Umatilla Tribes (NPT-13 and CTUIR-22) recommend that Idaho Power, in consultation with appropriate state and federal agencies and interested tribes, continue to investigate the installation of a temperature control structure at Brownlee reservoir to meet CWA numeric and narrative criteria to support the beneficial use of fisheries. The tribes also recommend that Idaho Power install a temperature control structure in a timely and expeditious manner should it be determined that installation of such a structure is appropriate.

AR/IRU-19 recommend that Idaho Power, in cooperation with a Technical Advisory Committee, continue to investigate the installation of a temperature control structure at Brownlee dam to meet CWA standards. They recommend that Idaho Power install the temperature control structure upon determination by the Technical Advisory Committee that installation of such a structure is appropriate. Idaho Power also would work with the Technical Advisory Committee to identify and implement other possible remedies for achieving temperature control of outflows at Brownlee, Oxbow, and Hells Canyon dams.

Interior does not make any recommendations specifically associated with a temperature control structure. However, Interior-42 recommends that Idaho Power implement measures to improve water quality conditions in Oxbow and Hells Canyon reservoirs to the point that they meet all water quality standards for designated beneficial uses for the states of Idaho and Oregon.

In commenting on the draft EIS, NMFS states that it worked extensively with Idaho Power during the relicensing process to investigate several temperature control measures for the project, as well as various strategies for using these structures. Based on these evaluations, NMFS concludes that these structures would not provide the substantial benefits to incubating, rearing, migrating, or spawning fall Chinook salmon that the agency had hoped would be attained with these structures. However, NMFS states that it does not object to further consideration or analysis of methods to improve discharge water temperatures, particularly if new or innovative approaches can be found.

Our Analysis

Operation of the project has delayed the seasonal pattern of the thermal regime downstream of Brownlee dam compared to without project conditions. Under Idaho Power's Proposed Operations, water temperatures would continue to be cooler than without project conditions in spring and summer and warmer than without project conditions in the fall (refer to section 3.5.1.2, *Temperature*, and section 3.5.2.1, *Effects of Project Operations on Water Quality*). This thermal shift would continue to adversely affect fall Chinook salmon downstream of Hells Canyon dam by: (1) causing high water temperatures in the fall that can adversely affect the survival of adult fall Chinook salmon until spawning and the viability of eggs after spawning; and (2) delayed warming in the spring, which can slow the growth of newly emerged fall Chinook salmon fry, which may adversely affect their survival during rearing and outmigration. In the following section, we describe several approaches that were evaluated by Idaho Power to address these effects, including several new elements that were included in its January 31, 2007, application for water quality certification. We then discuss the effects of these measures on water temperatures downstream from Hells Canyon dam and within the project reservoirs.

The Commission, as part of the relicensing, requested that Idaho Power conduct an evaluation of potential alternative Brownlee temperature control structures having capabilities ranging from using the existing Brownlee powerhouse intake channel to accessing full-depth control to a depth of about 250 feet below full pool for all units. In response, Idaho Power developed conceptual designs, provided a preliminary screening of those designs, and evaluated potential temperature control structures for the Brownlee development (Idaho Power, 2005e, 2005h, 2005i, 2005j). The general objectives for temperature control structures would be: (1) accelerating warming of Hells Canyon discharges in the

spring to promote growth and early outmigration of fall Chinook salmon; and (2) providing cooler fall Hells Canyon discharges in the early part of the fall Chinook salmon spawning period.

Idaho Power evaluated the potential for using a temperature control structure at the Brownlee intake to meet the above objectives by drafting more warm water from closer to Brownlee reservoir's surface in the spring and early summer and then drafting cool water from deeper reservoir depths in the fall. The volume of cool water stored in Brownlee reservoir is controlled by several factors including the volume and timing of inflows, meteorological conditions, and project operations. During high flow years, flood control operations result in the reservoir being drafted to a lower level in the spring, resulting in less coolwater storage than in low and medium flow years. The volume of cool water available for release from Brownlee reservoir is also limited by the configuration of the intakes. The existing Brownlee intakes are located in a 500-foot-long channel that was excavated into the rock abutment on the Idaho side of the Snake River. The sill of the intake channel and the invert elevation of the intakes is approximately 1,930 feet msl, about 147 feet below full pool elevation, thereby limiting access to the reservoir's lowermost 180,000 acre-feet of cool-water storage.

Idaho Power initially developed conceptual designs of alternative temperature control structures that could be installed at the Brownlee intakes with the goals of providing control down to the depth of the intake channel, partial control of the reservoir's full depth, and full-depth control (Idaho Power, 2005h). Based on a preliminary evaluation of the most effective least-cost methods to achieve the downstream temperature and DO objectives, the following five alternatives were selected for further evaluation:

1. **Stop-log weir** consisting of an overflow stop-log weir in the existing intake channel, for which the crest elevation could be adjusted between 2,077 and 1,930 feet.
2. **Gated weir** consisting of a variable-height gate structure in the existing powerhouse intake channel.
3. **Gated weir and tunnel** consisting of a variable-height gate structure in the existing intake channel; re-opening the original, existing, plugged, diversion tunnel; and connecting it to the existing intake channel, with coldwater uplift provided by elevation control at the channel-gate structure and by pumping.
4. **12,000-cfs small tower** consisting of a new 10,000 to 12,000 cfs variable-height-gated intake tower with trashracks above the re-opened original diversion tunnel, a new vertical shaft with trashrack in the shaft, and tunnels from the old diversion tunnel directly to the unit 5 penstock.
5. **35,000-cfs tower** consisting of a new 35,000-cfs variable-height-gated intake tower above an enlarged old diversion tunnel to a vertical shaft to a new tunnel into the existing intake channel, and a concrete dam across existing intake channel.

Idaho Power provided detailed evaluations of three of the alternatives to show the likely range of potential effects of installing a temperature control structure (Idaho Power, 2005e). The alternatives include: (1) stop-log weir; (2) gated weir with tunnel; and (3) 35,000-cfs intake tower. The temperature modeling presented in this filing focused on meeting a fall spawning target of 13°C. At the request of Commission staff, Idaho Power performed a second set of simulations (Idaho Power, 2005f) that evaluated a withdrawal strategy focused on the objectives of promoting early emergence, enhanced growth, and early outmigration of juvenile fall Chinook salmon.

As discussed in section 3.5.1.2, *Temperature*, Idaho Power (2007a) conducted an evaluation of the project's effect on elevated fall temperatures. Based on the average of the three low flow years

evaluated, Idaho Power believes the project's salmonid spawning temperature responsibility averages 0.8°C for 8 days in low flow years. [52] Although no model simulations were conducted for medium-low flow years, we concur that the project likely has some level of temperature responsibility during those years. In its application for water quality certification, Idaho Power (2007a) also accepts limited responsibility, in accordance with its estimated historical temperature analysis, for medium-low flow years. Idaho Power believes this is a conservative assumption because responsibility was estimated based only on low flow years and there was negligible modeled effect in higher flow years. However, Idaho Power (2007a) acknowledges the need for additional refinement of the appropriate project temperature responsibility through further study and assessment.

Under its proposed Temperature Adaptive Management Plan, Idaho Power would evaluate two potential approaches for meeting its temperature responsibility for the project: (1) a Brownlee reservoir bubble upwelling system; and (2) implementing watershed measures. The primary objective of a bubble upwelling system would be to cool the Brownlee reservoir outflows by lifting the cool water from the hypolimnion up to a higher elevation in the water column where it could be withdrawn from the reservoir through the existing turbine intakes. A successful upwelling system would create a bubble plume starting deep in the cold portion of the water column that would entrain the surrounding water as it rises through the water column toward the surface.

Idaho Power developed a preliminary design for an upwelling system for Brownlee reservoir. This design would consist of four 400-hp air compressors and piping connecting the compressors to the diffusers, which would extend approximately 3,800 feet from the compressor location to the forebay (MEI et al., 2006). The effects of upwelling plumes of atmospheric air within Brownlee reservoir, as well as the resulting turbine outflow temperatures, were simulated using a custom model that integrates a bubble plume model (BUBBLEP) into the standard CE-QUAL-W2 water quality model. MEI et al. (2006) used this model to simulate several different upwelling configurations to develop the optimal combination for providing the temperature decrease needed to address the project's estimated temperature responsibility. We discuss the modeling results in the subsections that follow.

Watershed measures, such as temperature trading, offer an alternative approach for meeting the project's temperature responsibility by implementing measures in the watershed upstream of the project that would act to cool inflows to and outflows from the project. Potential methods for reducing fall temperatures in upstream reaches include increasing shade by restoring/enhancing riparian vegetation, altering channel morphology to reduce warming, and altering the hydrologic regime by reducing the volume of warm agricultural return flows or by augmenting existing flows. These measures would tend to reduce water temperatures in and downstream of the tributaries where they are implemented for a prolonged period in the summer and fall. In addition to reducing water temperatures, some watershed measures have the potential to enhance water quality and aquatic habitat by reducing sediment/nutrient loads and improving the quantity and quality of instream and riparian habitat. Implementing watershed measures within a watershed trading framework is an approach that has proven acceptable to IDEQ and ODEQ for meeting a project's temperature responsibility in other TMDLs (Idaho Power, 2007a).

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[52] We conclude that Idaho Power's estimate under-represents its responsibility based on the increases in the adjusted measured 7-day average maximum temperatures compared to 13°C and the allowable human use allowance of 0.3°C (refer to table 6.1-12 in Idaho Power, 2007a) by not taking into account that each of the 7-day values represents more than a single day. Eight 7-day periods extending from October 23 through November 5 had average values starting at 1.4°C and decreasing to 0.2°C, and the average for just the first eight days of the spawning period (October 23 through October 30) is 1.3°C. Based on this method, we estimate an average project responsibility of approximately 0.8°C for 14 days in low flow years.

Temperature Downstream of Hells Canyon Dam

Idaho Power's evaluations (Idaho Power, 2005e,f) show that each of the temperature control structures could be used to increase Hells Canyon outflow temperatures after approximately March 14, and that the warming effects would get larger as spring progresses. CE-QUAL-W2 simulations indicate that the most warming would occur in low flow years, with only minor warming (less than 0.5°C) in medium to extremely high flow years. For extremely low and medium-low flow years, simulated late May temperatures were about 2.0 to 2.5°C warmer than Idaho Power's Proposed Operations and Scenario 2 (Flow Augmentation), respectively, with the stop-log weir and gated weir with tunnel, and about 1.5 to 2.0°C warmer than the respective operations with the 35,000-cfs tower (Idaho Power, 2005e).

The summer/fall cooling effects of a temperature control structure would largely depend on its ability to access Brownlee reservoir's coolwater storage, as well as the amount of this storage that is used to provide cooling in summer versus the fall. The stop-log weir would be able to access water down to the existing sill elevation of 1,930 feet. In contrast, the gated weir and tunnel structure would provide limited access to the 180,000 acre-feet of low-level hypolimnion water that is below the existing sill, and the 35,000-cfs tower would provide full access to the 180,000 acre-feet of low-level hypolimnion water that is below the existing sill (Idaho Power, 2005i). Placing a high priority on cooling the river in the fall would reduce the extent and duration of any summertime cooling that could occur because the volume of coolwater storage would be limited in Brownlee reservoir. Similarly, fall cooling would be less likely if a higher priority were placed on cooling the river in summer. In addition to the tradeoff between summer and fall cooling, placing a high priority on cooling the river in the fall would add the complexity of needing to forecast the amount of cool water to reserve for fall cooling. Because the need for cool water could not be accurately forecast during the summer, Idaho Power would need to reserve more cool water than it might need for fall cooling and, thus, forego some of the summer cooling that could be accomplished otherwise.

Idaho Power reported temperatures that were simulated with the goal of maintaining Hells Canyon discharge temperatures at or below the higher of 13°C or the daily Snake River inflow temperature to Brownlee reservoir on and after October 23 (Idaho Power, 2005e). Simulated temperatures satisfied this target in all 5 representative years for both the gated weir and tunnel structure and 35,000-cfs tower, with either Proposed Operations or Scenario 2 (Flow Augmentation). The stop-log weir satisfied the fall temperature target in 4 of the 5 representative years, but did not satisfy the target in the representative medium-high flow year (1999). Simulated summer temperatures for Hells Canyon outflows without a temperature control structure exceeds Oregon's 20°C criterion nearly 100 percent of the time in the extreme high flow year (1997) and progressively less in relation to the overall flow condition, with exceedances of roughly 20 percent of the time in the extreme low flow year (1992). These simulations indicate that the installation of a temperature control structure has the potential to reduce exceedance of Oregon's 20°C criterion for medium to low flow years (1995, 1994, and 1992), but has little potential to reduce exceedance of the 20°C criterion in the high flow years (1999 and 1997). The greatest improvement from the temperature control structures was simulated for the 35,000-cfs tower, followed by the gated weir with tunnel and finally the stop-log weir. The stop-log weir actually increased exceedance of the 20°C criterion in the extreme low flow year (1992).

To evaluate the effects that Brownlee temperature control structures would have on lower Snake River temperatures, Idaho Power, in coordination with the Corps, assessed the thermal effects of the stop-log weir and gated weir with tunnel in the representative extremely low flow year (1992) and medium flow year (1995) (Idaho Power, 2005j). Simulated temperatures for the Anatone gage[53] and the Lower Granite tailwater,[54] without a temperature control structure, were warmer than the Hells Canyon outflow

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[53] The Anatone gage is located approximately 80 miles downstream of Hells Canyon dam.

[54] The Lower Granite tailwater is located just downstream of the Lower Granite dam, which is about

for most of the summer, especially in the low flow year (1992). Compared to the Hells Canyon outflow, these simulated temperatures exceeded the Oregon and Washington[55] 20°C criteria more frequently at the Anatone gage, but less frequently at the Lower Granite reservoir tailwater. Simulated temperatures for the Anatone gage and the Lower Granite tailwater show that the warmer summer Hells Canyon outflows caused by the stop-log weir and gated weir with tunnel would result in slightly warmer summer conditions at the Anatone gage and the tailwater of Lower Granite reservoir compared to Proposed Operations, but would have little effect on exceedance of the Oregon and Washington 20°C criteria at either of these locations. Similarly, the cooler fall Hells Canyon outflows would result in cooler fall conditions at the Anatone gage and the tailwater of Lower Granite reservoir. Considerable cool summertime inflow from the Clearwater River, which includes flows from Dworshak reservoir, would continue to moderate the effects of Hells Canyon outflows on temperatures in and downstream of Lower Granite reservoir.

In its comments on the draft EIS, EPA reported simulation results based on the RBM10 model (Yearsley et al., 2001), which EPA used to simulate lower river temperatures for the medium-low flow year of 1994 using historical flows. EPA's simulation results for the temperature control structure operations modeled by Idaho Power indicate that the two most effective temperature control structures (gated weir and tunnel and 35,000-cfs tower) would reduce Snake River temperatures upstream of the Clearwater River confluence by about 1.5 to 2°C during the summer and early October. Considerable cool summertime inflow from the Clearwater River, which includes flows from Dworshak reservoir, would continue to moderate the effects of Hells Canyon outflows on temperatures in and downstream of Lower Granite reservoir. EPA simulation results for the temperature control structure operations modeled by Idaho Power indicate that a temperature control structure would reduce Snake River temperatures downstream of Lower Granite reservoir by about 0.5 to 1°C during the summer and about 1.5°C in early October. EPA's simulation of the effects of short-term summer Hells Canyon dam releases of 15 to 16°C indicates that Snake River temperatures would be reduced by about 1.5 to 2.5°C upstream of the Clearwater River confluence and about 0.5 to 1.0°C downstream of Lower Granite reservoir. CRITFC and EPA also suggested that a temperature control structure could be used to access warmer water from deep in Brownlee reservoir during portions of the winter (McCullough, 2007). Based on our review of the limited winter temperature data for Brownlee reservoir, we conclude that there would be some potential to increase the temperature of Hells Canyon releases during a portion of at least some winters.

Idaho Power provides an evaluation of maintaining Hells Canyon discharges at 15°C in the summer, and maintaining the same temperature that would occur without a temperature control structure in the fall (Idaho Power, 2005f).[56] Simulated Hells Canyon outflow temperatures for the stop-log weir under Proposed Operations in an extremely low flow year were 15 to 16°C from late May through early July and then steadily increased to a maximum of nearly 20°C in early September. Compared to Proposed Operations without a temperature control structure, outflow temperatures were warmer between mid-March and late June, cooler from late June through early October, and virtually the same after early October. Idaho Power's qualitative analysis of the other structures and representative years indicates that there would be less ability to maintain cooler summer temperatures in years with higher flows, and that both the gated weir and tunnel, as well as the 35,000-cfs tower would be better able to maintain cooler summer temperatures than the stop-log weir (Idaho Power, 2005f).

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140 miles downstream of Hells Canyon dam and about 32.5 miles downstream of the Clearwater River confluence.

[55] Washington's temperature criterion for the Snake River upstream of the Clearwater River is an absolute maximum of 20°C with an allowable increase of up to 0.3°C for a single source.

[56] These targets emphasize the benefits of providing near optimal temperatures for fall Chinook salmon growth and rearing in the summertime over the Oregon and Idaho State numeric water temperature criteria for the fall.

As discussed above, Idaho Power also investigated the possibility of addressing the project's temperature responsibility through the use of a Brownlee reservoir bubble upwelling system or watershed measures. The bubble upwelling system would lift cool water from deep in Brownlee reservoir so that it could be withdrawn and provide cooler fall temperatures downstream of Hells Canyon dam. Idaho Power's preliminary CE-QUAL-W2 simulations indicate that it would take about 8 days for the cool, upwelled water discharged from Brownlee powerhouse to pass downstream through Hells Canyon dam. The simulation results also indicate that a Brownlee reservoir upwelling system could reduce fall Hells Canyon outflow temperatures by as much as 1.0°C compared to existing conditions, but would frequently reduce temperature by only 0.5°C or less (Idaho Power, 2007a). Based on these results, we conclude that the installation of a bubble upwelling system alone may not be sufficient to meet all of the project's temperature responsibility, which Idaho Power estimates to be 0.8°C for 8 days in low flow years.

Idaho Power did not undertake any modeling of watershed measures, or the extent to which watershed measures would need to be implemented to meet the project's temperature responsibility downstream of Hells Canyon dam. Rather, Idaho Power proposes to identify and evaluate measures for implementation through a stakeholder process that would include: (1) formation of a watershed stakeholder group; (2) defining goals and objectives; (3) screening trading opportunities by identifying potential trades and obstacles to trades; (4) selecting potential trading alternatives for further analysis; and (5) selecting the preferred trading alternative(s) for implementation. We conclude that this represents a logical approach for identifying and prioritizing watershed measures. Given the size of the watershed upstream of Hells Canyon dam and the extent of habitat degradation in many of the upstream tributaries, we consider it likely that there are sufficient opportunities to identify a suite of measures that would meet the temperature responsibility of the project.

Temperature of Brownlee Reservoir and Downstream to Hells Canyon Dam

Many factors, including the level at which water is withdrawn, control the thermal regime of Brownlee reservoir. Using any temperature control structure or a bubble upwelling system to regulate water quality conditions downstream of Hells Canyon dam also would affect the thermal regime of the reservoir. For a temperature control structure, the extent and timing of changes would primarily depend on the depths of seasonal withdrawals in spring, summer, and fall. Withdrawing water from closer to the reservoir's surface in spring and early summer would raise the thermocline resulting in a thinner epilimnion and additional cool-water storage in the reservoir. The extent of deep-water summer and fall withdrawals would control how much cool-water storage is used and any associated lowering of the thermocline.

Load-following operations at Brownlee development would have localized effects on temperatures near the intake(s) used but would have negligible effects in the rest of the reservoir. However, these operations would result in large reductions in Brownlee tailrace temperatures as cool water is released from Brownlee reservoir. Idaho Power (2005i) concludes that these temperature fluctuations could be as large as 10°C during the summer and fall cooling periods, and that these large temperature fluctuations would proceed through the Oxbow reservoir and into the Hells Canyon reservoir and could adversely affect aquatic resources in these waterbodies.

MEI et al. (2006) reported that a Brownlee reservoir upwelling system with eight 21.3-foot-diameter circular plume diffusers placed at an elevation of 1,788 feet, about 290 feet deep in the Brownlee reservoir forebay, would create eight independent bubble plumes to entrain and lift cool water. Simulation results indicate that the system could entrain and lift about 30,000 cfs of cool water. Because the cool water would not be lifted directly in front of the turbine intakes, not all of the cool, upwelled water would be immediately drafted through the turbine intakes. The simulations indicate that only a small fraction of the cool, upwelled water would be expected to travel directly into the Brownlee intakes. The hydrodynamic model results indicate that water in the hypolimnion of the upper portion of the reservoir would generally flow down-reservoir to replace the upwelled water, but the metalimnion would

tend to flow up-reservoir to maintain an overall balance in the reservoir. Therefore, these reservoir currents would route much of the cool upwelled water a considerable distance up-reservoir, and would not be available for withdrawal. For a bubble upwelling system, simulated temperatures for Brownlee reservoir outflows were reduced by as much as 1.5°C. As water proceeds through the Oxbow development and Hells Canyon reservoir, the cooling effect would generally be reduced by about 0.4°C in late October.

As described above, implementing upstream watershed measures would reduce summer and fall water temperatures within and downstream of the tributaries where they are implemented. This would improve the thermal regime for native resident salmonids within and downstream of the project area, and for anadromous salmonids downstream from Hells Canyon dam.

Dissolved Oxygen

Based on simulated DO concentrations for Brownlee reservoir with temperature control, anoxic conditions could extend farther up-reservoir during some low flow years. For an extremely low flow year (1992), simulated mid-June anoxic conditions extended about 3 to 4 miles farther up-reservoir with the temperature control structures (i.e., RM 332 to 331 with the stop-log weir, gated weir with tunnel and 35,000-cfs tower compared to RM 328 without a temperature control structure). Another simulated effect for the extreme low flow year (1992) and low flow year (1994) was higher DO concentrations in much of the metalimnion, which became surrounded with hypoxic/anoxic water during the summer and fall, for each of the three temperature control evaluated. Simulation results for wetter years indicate varied results for the temperature control structures. The 35,000-cfs tower would result in anoxic conditions in less of the water column than existing conditions, but the stop-log weir, as well as gated weir and tunnel, would extend anoxic conditions further up in the water column. The effects of the three simulated temperature control structures on near-bottom fall anoxic conditions were not consistent among control structures or years. The overall trend was that simulated near-bottom anoxic conditions for the 35,000-cfs tower were typically slightly smaller than without a temperature control structure, but the gated weir and tunnel had a slightly larger area and the stop-log weir showed a much bigger area. In mid-October of the extreme low flow year (1992), simulated near-bottom anoxic conditions extended upstream to RM 325 for the stop-log weir in comparison to RM 308 for the 35,000-cfs tower. Differences in the extent of near-bottom anoxic conditions were more subtle in other water year types.

The temperature control structures would provide varied effects on DO concentrations in Hells Canyon outflows. These effects would vary considerably depending on the type of flow year, the temperature control structure used, and the overall goals for its operation. Simulation results indicate that using the 35,000-cfs tower to draft cool, deep water would tend to lower DO concentrations in discharges. In contrast, simulation results indicate that using the stop-log weir or gated-weir and tunnel would generally increase DO concentrations in discharges during summer. Simulation results for fall are much more variable, with both increases and decreases in discharge DO concentrations with the stop-log weir or gated weir and tunnel.

As discussed above, a Brownlee reservoir bubble upwelling system would change flow patterns in Brownlee reservoir, and thereby alter the complex physical, biological, and chemical processes in the reservoir, causing in-reservoir water quality effects. Simulation results indicate that, during operation of the upwelling system, the DO regime in Brownlee reservoir may be altered substantially, with regions of higher or lower DO concentrations extending nearly 25 miles upstream of the dam. Simulated DO concentrations indicate that changes in DO concentrations would happen rapidly and persist for some time following operation of the bubble upwelling system. Although simulation results show that operation of an upwelling system may change Brownlee outflow DO concentrations, additional study is needed to determine the extent of this effect.

As described above, implementing a nutrient (e.g., phosphorus) trading program has the potential to reduce nutrient loads within and downstream of the tributaries where the measures are implemented. This could incrementally enhance DO levels within and downstream of these tributaries, including the project reservoirs. Some measures, such as reducing the volume of agricultural return flows, could provide reductions in stream temperatures as well as phosphorus loads.

pH and Ammonia

In eutrophic waters similar to Brownlee reservoir, photosynthesis raises pH in the photic zone as well as carbon dioxide generation from heterotrophic decay of organic matter, nitrification of ammonia, and oxidation of sulfide lowers pH in deep waters (Wetzel, 1975). Alterations in the reservoir's thermal structure could alter pH within the reservoir. Simulated Brownlee reservoir DO concentrations suggest that production of ammonia would increase for the stop-log weir and gated weir and tunnel, but ammonia production would be somewhat reduced for the 35,000 cfs tower. The pH is expected to be somewhat lower in portions of the riverine reach of the reservoir for the stop-log weir and gated weir and tunnel, and is less influenced by the 35,000-cfs tower. Operation of the temperature control structures also is expected to influence pH levels in the metalimnion and some of the hypolimnion. The simulated DO concentrations suggest that the 35,000-cfs tower would have a larger influence on pH levels than either the stop-log weir or gated weir with tunnel. The 35,000-cfs tower would tend to increase pH in larger portions of the metalimnion and hypolimnion than the stop-log weir or gated weir with tunnel. The stop-log weir or gated weir with tunnel is expected to lower pH in areas of the metalimnion and hypolimnion closer to the water surface in some years.

The project currently accumulates ammonia in the hypolimnion and deeper areas of the transition zone. Idaho Power (2005e) reports that ammonia concentrations in discharges from Hells Canyon dam closely mirror concentrations in Brownlee discharges and show some seasonal patterns with peaks in spring and late fall. A raised and stronger thermocline would be expected to result in greater accumulation of ammonia in Brownlee reservoir that would occur earlier in the season. If the gated weir and tunnel or 35,000-cfs tower were used to directly draft hypolimnetic water, the discharges would have higher ammonia concentrations and lower pH. Using the gated weir and tunnel to draft water from the bottom of the hypolimnion would have the highest ammonia concentrations and could disturb and mobilize bed sediments. Although the stop-log weir would not directly access hypolimnetic water, it could be used to access cool water from the metalimnion and would have the potential to export water with elevated ammonia concentrations and lower pH. Installing and operating a bubble upwelling system in Brownlee reservoir would mix deep water in the reservoir with water in upper layers and likely increase ammonia concentrations in portions of the epilimnion and metalimnion, as well as the outflows from the reservoir.

Mercury and Organochlorine Compounds

Mercury and organochlorine compounds (including pesticides and their break down products, and PCBs) are strongly associated with sediments. Therefore, it would be important to avoid disturbing sediments while constructing and operating any temperature control structure or bubble upwelling system. With the construction of any temperature control facilities, we anticipate that sediment disturbance would generally be minimal. However, special attention would need to be applied to limit the disturbance of bed sediments by operation of the bubble upwelling system and the gated weir and tunnel that would make near-bottom withdrawals.

Under anoxic conditions, contaminated sediments can act as a source for mercury. Therefore, any changes to the anoxic conditions in the reservoir could affect its storage/release in reservoir sediments. Directly drafting water from deeper in the water column would be expected to increase concentrations of mercury and organochlorine compounds in discharges. We anticipate that operating the deeper intake structures (i.e., gated weir and tunnel and 35,000-cfs tower) to draft cool, near-bottom water

would cause the largest increases in the discharge of these contaminants. A bubble upwelling system may result in substantial mixing of near-bottom anoxic water with the rest of the water column and, thereby, substantially increase the discharge of these contaminants. Any ongoing adverse effects of these contaminants on aquatic organisms and their predators (including bald eagles) would increase accordingly.

Planning and Monitoring

Idaho Power's completed evaluation of various potential alternative Brownlee temperature control structures shows that a temperature control structure could be used to increase Hells Canyon outflow spring and early summer temperatures and reduce Hells Canyon outflow late summer and/or fall temperatures. However, we conclude that the magnitude of spring increases would be limited in medium and high flow years and in the early spring in all years. Also, the volume of cool water stored in Brownlee reservoir would not be sufficient to reduce both late summer and fall temperatures to provide optimal thermal conditions for fall Chinook salmon growth and satisfy the 13°C spawning criteria (section 3.6.2.4, *Water Temperature*). Of the temperature control structures evaluated, the 35,000-cfs tower would provide the greatest potential to manage water temperatures and the stop-log weir would provide the least potential to manage water temperatures. Using a temperature control structure to provide a better thermal regime for fall Chinook salmon downstream of Hells Canyon dam, however, could potentially degrade water quality by reducing DO levels and increasing concentrations of ammonia, mercury, and organochlorine compounds.

Idaho Power's proposed Temperature Adaptive Management Plan includes a three-step planning and implementation process. In the first step, Idaho Power would determine the project's thermal load allocation in consultation with IDEQ and ODEQ. The second step includes evaluation of potential measures to address the project's thermal load allocation and selection of the appropriate measure for implementation. The evaluation would include conducting pilot testing of the upwelling system and forming a stakeholder group to develop watershed measures. In the third step, Idaho Power would develop a final design of the selected measure for approval by the Commission and all necessary regulatory agencies, and would implement the selected measure. Idaho Power estimates that step 1 would require 2 to 4 years, step 2 would require 4 to 5 years if watershed measures are selected and 4 to 10 years if a bubble upwelling system is selected. Completion of step 3 would require 3 to 10 years.

Idaho Power's proposed adaptive approach to temperature management is consistent with ODFW's recommendation (ODFW-56) to develop and implement a temperature management plan. This adaptive approach would facilitate Idaho Power's development of a program to monitor and address adverse effects of the project on water temperatures, and to report on the progress made towards addressing such effects. Following the implementation of any temperature control measures, it would be important to monitor water temperature and other water quality parameters to document the effectiveness and secondary effects of the measures. Because water quality conditions, including water temperatures, have strong influences on aquatic resources, we conclude that it would be beneficial for Idaho Power to consult annually with the state and federal fish management agencies and interested tribes to determine whether the measures implemented are sufficient or if additional measures are needed. Reporting the results of monitoring efforts and any changes in implemented measures each year would help to ensure that progress continues to be made towards addressing the project's temperature responsibility.

3.5.2.5 Oxbow Bypassed Reach Flows

Diversion of flow through the Oxbow powerhouse reduces flow in the lowermost portion of Oxbow reservoir and bypassed reach, affecting water quality in both of these reaches.

Idaho Power proposes to continue to release 100 cfs from the Oxbow dam spillway into the bypassed reach immediately downstream of the dam to help maintain water quality in the bypassed reach.

In its April 26, 2007, filing with the Commission and its January 31, 2007, application for water quality certification, Idaho Power (2007a) proposes to install and operate a destratification system for the deep pool in the Oxbow bypassed reach just upstream of the Indian Creek confluence.

Interior-43 recommends that Idaho Power develop and implement, within 1 year of license issuance, a plan to establish a conservation flow in the Oxbow bypassed reach sufficient to meet state water quality standards and life history requirements for bull trout. Following approval by FWS, Idaho Power would submit the plan to the Commission for its approval and implement the plan within 2 years of plan approval and continue for the remainder of the term of the new license. Interior-63 also recommends that Idaho Power provide adequate flows and oxygen supplementation to maintain water quality that supports native fishes in the Oxbow bypass reach.

Our Analysis

Operation of the Oxbow development results in bypassing water around the lowermost 0.3 mile of Oxbow reservoir and a 2.5-mile-long reach immediately downstream of Oxbow dam. Behind Oxbow dam, thermal stratification occurs during summer and into fall, and hypoxic/anoxic conditions occur in deep water. In the reach downstream of the Oxbow dam, frequent exceedances of the applicable water temperature criteria and minimum DO criteria occur during summer and fall, and occasionally a slimy growth is observed on the substrate. Idaho Power's proposal to continue to provide a 100-cfs minimum flow release from Oxbow dam would not affect water quality in either of these bypassed reaches compared to current conditions.

Water temperature and DO levels in the bypassed reach downstream of Oxbow dam are influenced primarily by the condition of water released from Oxbow reservoir and the backwaters from Hells Canyon reservoir. Oxbow reservoir is very warm throughout the summer and fall and tends to exhibit minimal thermal stratification (Myers, et. al., 2003a). Idaho Power conducted flow studies for this reach in August 1999 and 2000. During these studies, Idaho Power adjusted Oxbow dam flow releases to approximately 100, 500, 800, 1,350, and 1,850 cfs, while monitoring water quality in the bypassed reaches. Study results suggest that regardless of the rate of flow released into the reach downstream of the dam, the temperature and DO concentrations of water released from the dam would remain nearly the same as under the existing minimum flow release of 100 cfs. However, increased flows in the bypassed reach downstream of the dam would slightly reduce warming in the reach and may reduce diel fluctuations of DO concentrations at the lower end of the reach (Myers and Chandler, 2003). Increasing flow releases resulted in more uniform temperatures and DO concentrations in the upper layers of deep pools in the bypassed reach, but continued to result in the deepest layers of the deep pool at RM 271.3 having extremely low DO concentrations. At flows of 1,350 cfs and more, this entire pool's water column would have virtually the same temperature and DO concentrations.

The short duration of flow manipulation (i.e., less than 1 day for each target flow) did not allow monitoring of changes that would take longer to occur (e.g., the effect of reducing the average retention time in the reservoir's bypassed reach from 21.4 days at 100 cfs to 4.3 days at 500 cfs, and the long-term effects of mixing in the deep pool at RM 271.3). Maintaining increased flow releases from Oxbow dam would reduce warming of near surface water in the bypassed reach of the reservoir and, thereby, reduce stratification of both temperature and DO, although these changes would likely result in minimal changes in the temperature and DO concentration of water released from the dam. We anticipate that increasing flow releases from the dam would result in more mixing in the RM 271.3 pool than it appears based on the short period monitored, since the study was not long enough to capture the full effects of flushing through the pool.

Although Idaho Power's flow study (Myers and Chandler, 2003) does not provide conclusive results of the water quality effects associated with increasing flow releases from Oxbow dam, there is a strong indication that substantial increases in flow releases would be needed to satisfy the applicable DO

criteria under current loadings of nutrients and organic matter. As indicated in the TMDL (IDEQ and ODEQ, 2004), water quality in the project area depends highly on the condition of source waters, which currently have high loadings of phosphorus and organic matter. These loadings would be slowly reduced as the TMDL is implemented and could be reduced at a faster rate by Idaho Power implementing upstream phosphorus trading measures, which could include restoring conditions in tributaries. All of these reductions in loadings of phosphorus and organic matter would have the potential to improve water quality in the project area, including the Oxbow bypassed reach.

Idaho Power proposes to increase mixing of water in the deep pool at RM 271.3 by installing and operating a destratification system. This measure would provide oxygen supplementation, as recommended by Interior. Based on Idaho Power's (2007a) preliminary design of this system, it would include an air compressor, 0.55-inch flexible PVC composite pipe that sinks in water, and two self-cleaning 9-inch diameter flexible membrane diffusers that produce 500 to 3,000 micron bubbles. The compressor would be powered with an electrical power line, and would be capable of running continuously without oil. Idaho Power (2007a) states that the system would be capable of exchanging all the water in the pool about three times each day, which it believes is sufficient to prevent thermal stratification. We would expect that mixing of the water in the pool would prevent anoxic conditions that currently occur deep in the pool. However, it is not clear whether it would fully satisfy the applicable DO criteria. Although this would improve the DO regime, the warm inflows to the Oxbow reservoir, which are passed through, would continue to prevent attainment of the water temperature criteria in the Oxbow bypassed reach during much of the year.

We discuss the effects of increasing Oxbow dam flow releases on aquatic resources in section 3.6.2.5, *Oxbow Bypassed Reach Flows*. Developing a plan to establish a conservation flow for the Oxbow bypassed reach, as recommended by Interior, would provide a way to consider any benefits to aquatic organisms and ensure that Idaho Power satisfies the water quality standards.

3.5.2.6 Effects of Other Measures on Water Quality

Below, we discuss the effects that measures developed to address other resources would have on water quality.

Sediment Transport Measures

In section 3.4.2.2, *Sediment Augmentation and Monitoring*, we discuss the effects that measures proposed and recommended to stabilize and restore sandbars would have on sediment transport. Sandbar maintenance and restoration has the potential to produce secondary effects on water quality. In the section 10(j) meeting, Idaho Power stated that Commission staff should consider implementation of Forest Service condition no. FS-4 as part of Idaho Power's proposal. The goal of this measure would be to restore and maintain 14 acres of sandbars on or adjacent to National Forest System lands, based on their distribution and area existing in 1975. In its justification of this 4(e) condition, the Forest Service indicated that this could be accomplished by using cargo boat(s) to transfer sand in batches of about 5 cubic yards to beaches outside the peak recreation season (mid-June through August), and then distribute the sand at elevations between the 50,000- and 100,000-cfs levels. Idaho Power would limit the potential for increasing turbidity by placing clean sand, with minimal silt and clay, at levels that would be reached at recurrence intervals of 2.3 to 30 years or more. Using cargo boats and other machinery to transport and distribute the sand would slightly increase the risk of spilling petroleum products in the river and on the beaches.

Terrestrial Resource Measures

In sections 3.7.2.2 through 3.7.2.8, we discuss the effects that proposed and recommended terrestrial resource measures would have on plants and wildlife. Some of these measures could

potentially produce secondary effects on water quality. Increasing the extent of woody plants and other riparian plants along the shoreline of the project reservoirs, Snake River, and islands in the Snake River could result in a slight reduction in water temperatures in and around shaded areas along the shoreline. Idaho Power also indicates that this would probably increase DO levels, although we conclude that it is unlikely that measurable differences in DO concentrations would occur in most cases.

O&M activities for the transmission line have the potential to increase sediment loading and turbidity in surface waters. These risks would be limited by including best management practices (BMPs) in the transmission line O&M plan.

An integrated wildlife habitat management program is expected to include managing livestock grazing, which could reduce livestock access to the shoreline and thereby reduce contamination of surface waters from livestock fecal matter. Management of livestock grazing also likely would result in more stable banks along the shoreline, and thereby, reduce sediment loading and turbidity in these areas.

Cultural Resource Measures

The cultural resource effects of stabilizing archeological sites and doing data recovery of archeological sites are discussed in subsections *Stabilization* and *Mitigation*, respectively, in sections 3.9.2.2, *Site Treatment*. Since both of these actions would require movement of sediment and/or establishment of vegetation near the project reservoirs or Snake River downstream of Hells Canyon dam, they could result in localized short-term increases in turbidity during these activities. However, these effects could be minimized through the implementation of appropriate BMPs. Subsequently, there would be localized long-term reductions in turbidity associated with more stable conditions at the sites.

Recreation Measures

In section 3.10.2.3, *Recreation Site Improvements*, we discuss the effects that proposed and recommended recreation facility improvement measures (table 86) would have on recreation. Many of these measures also have the potential to produce secondary effects on water quality. Actions that would affect water quality can be broken into two categories: (1) ground-disturbing activities in upland areas, and (2) ground-disturbing activities below the normal high water level.

Construction and maintenance of recreation facilities (e.g., roads, trails, parking areas, campgrounds, day-use areas) that would require ground-disturbing activities in upland areas would increase the potential for erosion, loadings of sediments, and turbidity during and shortly after the construction period. Ground-disturbing activities below the normal high water level (e.g., constructing/ improving boat launches and removing sediment buildup around docks and in-reservoir pumps) may require in-water construction, which would incrementally add to the potential to increase erosion, loadings of sediments, and turbidity. In addition, in-water work could re-suspend sediments and any contaminants associated with them into the water column. We anticipate that the largest risk of this effect would result from removal of sediments around docks and in-reservoir pumps, as recommended by the Oregon Parks and Recreation Department (OPRD) (OPRD-2 and -3). By implementing appropriate BMPs, adverse water quality effects of all of these upland and in-water ground-disturbing activities should be limited to reasonable levels and short periods that occur primarily during the construction period.

Recreation Waste Disposal

The recreational use of the project by thousands of visitors could potentially result in human feces contaminating waters in the project area. Recreational measures proposed by Idaho Power, including continuing its recreation waste disposal program to prevent waste from contaminating the river, continuing to fund the existing litter and sanitation program, and enhancing the program by providing additional portable and vault toilets at appropriate dispersed recreational sites would reduce the

concentration of fecal coliform and disease-causing organisms in the near-shore environment and, thereby, reduce any associated contamination of project waters. Recommendations by the Oregon State Marine Board (OSMB), ODFW, Interior, and the Forest Service, including installation of toilet facilities at dispersed recreation sites, installation of floating toilets on each reservoir, installation of boat toilet dump stations in the project area, construction and maintenance of a gray water disposal system and a sanitary cleaning system capable of cleaning portable human waste carry out systems within the Hells Canyon reservoir area, and sanitation measures consistent with provisions of the Baker County Settlement Agreement, dated October 3, 2003, would likewise reduce possible sources of water contamination.

3.5.3 Cumulative Effects

Land management practices that have reduced shading of the Snake River and its tributaries have increased water temperature compared to what would occur under without-project conditions. Diverting water away from the river for irrigation and other uses causes the river to be more thermally sensitive to the river's inflows, whether cold or warm. Comparison of existing water temperatures to estimated historical water temperatures (Idaho Power, 2007a) shows that flow regulation upstream of Brownlee reservoir has increased the temperature of inflows to the reservoir throughout most of the year, but particularly in May through September. Large impoundments like Brownlee reservoir result in thermal stratification in the reservoirs and a delay in seasonal warming and cooling downstream. Operation of Dworshak dam, which is located on the North Fork Clearwater River, can alter the Snake River's thermal regime downstream of the confluence with the Clearwater River (RM 140). Since 1992, Dworshak dam has been operated for flow augmentation and cooling of the lower Snake River. Implementation of Proposed Operations would result in minor to negligible effects on temperatures in the lower Snake River. The cumulative effects of the aforementioned actions would result in continued thermal stratification in Brownlee reservoir and continued delay of spring and early summer warming and fall cooling downstream of Brownlee dam. With installation and operation of a thermal control structure, the thermal regime of Brownlee discharges and downstream reaches could be a little warmer in spring and early summer and cooler in the fall. Installation and operation of a Brownlee reservoir upwelling system could result in somewhat cooler Brownlee discharges in the fall.

IDEQ and ODEQ (2004) indicate that degradation of water quality in the project area is caused by numerous human-caused factors including mining, industrial activities, agricultural practices, municipal waste, urbanization, flood control, flow modifications, hydroelectric activities, and impoundments. Historical mining activity in the basin has increased loadings of sediments that are rich in metals and phosphorus. Although some mining still occurs, most of the mines have not been operational since the 1950s. Municipalities have historically and continue to contribute pollutants via sewage treated to varying standards, urban runoff, and residential and commercial sources. The Boise River, which flows primarily through Ada and Canyon counties (Boise metropolitan area), consistently had the highest phosphorus concentrations and fecal coliform population densities in a statewide study (Hardy et al., 2005). Industrial activities have historically and continue to discharge pollutants either directly or indirectly into the Snake River. However, the primary sources of pollutant loading are from nonpoint source loads to the mainstem Snake River and its tributaries. Cropland and range practices, as well as urbanization, increase loadings of sediments, nutrients, and legacy pesticides (e.g., DDT). Aquaculture and wastewater developments also contribute sediment and nutrient loadings. Most of these sediments are deposited in large reservoirs, including Brownlee reservoir. Motorized recreational boating on the Snake River and project reservoirs contributes antifreeze, gas, oil, and other pollutants to the water.

The combination of extremely nutrient-rich water flowing into Brownlee reservoir and the reservoir environment results in algae blooms in the transition zone of the reservoir. Decay of this material and other organic matter accumulated on the bottom of Brownlee reservoir has increased oxygen demand, which reduces DO concentrations to anoxic and hypoxic conditions in the hypolimnion, part of the metalimnion, and the transition zone. Anoxic conditions at the sediment/water interface increases

concentrations of ammonia, metals, and phosphorus in the water. These conditions also lead to elevated bioaccumulation of mercury, DDT/DDE, and dieldrin in fish.

Implementation of TMDLs for the Snake River and its tributaries and any tributary restoration efforts conducted by Idaho Power would result in a slow, long-term decline in loadings of sediments and nutrients. This would gradually reduce the frequency and magnitude of algae blooms and result in less deposition of organic material in Brownlee reservoir, which would reduce the oxygen demand associated with the reservoir's sediments. The combination of these factors would result in corresponding higher DO concentrations and lower loadings of ammonia, metals, and phosphorus from the sediments. Implementation of Idaho Power's proposed reservoir DO supplementation would further increase DO concentrations around RM 325, but have little to no effect near and downstream of Brownlee dam. The extent of increases in DO concentrations downstream of the project dams would depend on which, if any, of the recommended aeration measures for project dams/power plants are implemented. Cumulative effects of the aforementioned actions would result in incremental improvements in DO levels following installation of aeration/oxygenation facilities, and a slow improvement in water quality in Brownlee reservoir and the Snake River downstream of Brownlee dam that is expected to continue through any license term.

Elevated TDG levels are caused by spill at the project dams. Spill at Brownlee dam currently results in TDG levels of up to at least 128 percent of saturation downstream of the dam. Oxbow and Hells Canyon dams reduce velocities and natural rates of degassing, which indirectly cause TDG levels to remain higher than if the impoundments did not exist. In some cases, this results in elevated TDG levels all the way through both Oxbow and Hells Canyon reservoirs. The resulting high TDG levels at the Hells Canyon forebay (greater than 120 percent of saturation in some cases) contribute to causing even higher TDG levels (up to at least 136 percent of saturation in some cases) downstream of Hells Canyon dam than would occur from spill at Hells Canyon dam alone.

Implementation of Idaho Power's proposed preferential use of the upper spillway gates at Brownlee dam and construction of deflectors on Hells Canyon and Brownlee dam spillways would reduce TDG levels downstream of these dams. We anticipate that Oxbow dam deflectors, if constructed, or other TDG abatement measures implemented at the Oxbow facility, would reduce TDG levels in the Oxbow bypassed reach, Hells Canyon reservoir, and potentially downstream of Hells Canyon dam. The cumulative effects of the aforementioned actions would be a long-term reduction in TDG levels downstream of Brownlee, Oxbow, and Hells Canyon dams, compared to current conditions.

3.5.4 Unavoidable Adverse Effects

Under Idaho Power's proposal, low DO concentrations would continue to occur in the three project reservoirs and downstream of Hells Canyon dam, trace metals (including methyl-mercury) and ammonia would continue to be created in the anoxic reservoir waters, and increases in TDG may occur at the dams under extremely high flows. However, the TDG abatement measures proposed by Idaho Power should reduce the frequency of high TDG levels under most spill conditions. Depending on the nature of DO measures that are ultimately implemented, the frequency and severity of anoxic conditions may be reduced as well.

3.6 AQUATIC RESOURCES

3.6.1 Affected Environment

3.6.1.1 Aquatic Habitat Conditions

The location and drainage area of the principal tributaries to the Snake River within the reach that was historically accessible to anadromous fish are listed in table 29. Our description of aquatic habitats will focus on the mainstem Snake River and its tributaries downstream from Swan Falls dam.

Swan Falls Dam to Brownlee Reservoir

This 118-mile segment of the Snake River extends from Swan Falls dam at RM 458 to the headwaters of Brownlee reservoir at RM 340 (figure 35). The uppermost 13.7 miles of this reach are relatively high gradient and the river is confined within a steep-walled canyon. After the river leaves the canyon, it becomes lower in gradient, and the remainder of the reach comprises primarily shallow, low-velocity run habitat, with numerous braided channels and island complexes. Several large tributaries enter this reach, including the Owyhee, Boise, Malheur, Payette, Weiser, and Burnt rivers. The quantity and quality of water that is delivered from these tributaries is heavily influenced by municipal development and by development to support irrigated agriculture, livestock grazing, and confined animal-feeding operations. Three large multi-purpose reservoirs control flows in the Boise River System, and five major municipal wastewater facilities discharge into the lower Boise River (Hoelscher and Myers, 2003).

Severely degraded water quality, primarily due to high nutrient loads delivered from the tributaries listed above, currently limits aquatic resources in this reach. In summer, algae blooms are common and phosphorus levels are typically double the target concentration identified in the Snake River-Hells Canyon TMDL (Idaho Power 2003b). Water temperatures in the Snake River upstream of Brownlee reservoir can reach 27°C during the late summer months. The Swan Falls-Brownlee reach contains a large amount of potential sturgeon habitat, but it is underused due to its poor water quality. It also includes about 40 percent of the most important historical production area for fall Chinook salmon. Evermann (1896) considered the reach extending from Huntington (RM 328) to Auger Falls (RM 606.7) to be the most important fall Chinook spawning area in Idaho.

Brownlee Reservoir

Brownlee dam impounds the Snake River from RM 284.6 to RM 340, forming a 55-mile-long reservoir (figure 35). The reservoir's average depth is 105 feet with a maximum depth of about 300 feet near the dam. Shoreline areas are typically steep and consist of bedrock or mixtures of boulders, sand, and gravel substrate. The reservoir has a surface area of 14,600 acres and a volume of 1,400,000 acre-feet at full pool. Reservoir levels fluctuate seasonally as a result of operations to provide flood control, to meet seasonal peaks in power demand, and to stabilize flows downstream of Hells Canyon dam during the fall Chinook spawning season. Flood control drawdowns of up to 100 feet occur during high flow years. Between 1995 and 2001, storage was also used to provide up to 237,000 acre-feet of water during the summer for flow augmentation to assist with the outmigration of juvenile salmon and steelhead from the lower Snake River under an energy exchange agreement with the Bonneville Power Administration. At the maximum drawdown of 100 feet, the reservoir's surface is 6,410 acres, a 56 percent reduction from the surface area at full pool. The volume at maximum drawdown is 444,744 acre-feet, a 68 percent reduction from the volume at full pool.

Table 29. Principal tributaries to the Snake River that historically supported anadromous fish, with the location of Brownlee, Oxbow and Hells Canyon dams shown for reference.

Snake River Mile	Tributary	Basin Area (square miles)[a]
615 to 550	Rock Creek basins (Clover, Billingsley, Cedar Draw, Rock, Deep, and Mud creeks)	2,208
587	Salmon Falls Creek	2,106
494	Bruneau River	3,372
396.7	Owyhee River	11,108
396.4	Boise River	4,031
368.5	Malheur River	4,719
365.6	Payette River	3,309
351.6	Weiser River	1,686
327.5	Burnt River	1,100
296	Powder River	1,705
288	Brownlee Creek	61
284.6	Brownlee dam	NA
283.3	Wildhorse River	177
273	Oxbow dam	NA
271.3	Indian Creek	40
271	Pine Creek	301
247.6	Hells Canyon dam	NA
239	Granite Creek	33
229	Sheep Creek	41
191.6	Imnaha River	871
188.2	Salmon River	13,923
168.7	Grande Ronde River	4,000
140	Clearwater River	9,645
62	Tucannon River	503
59.5	Palouse	3,303

[a] Basin areas for streams upstream of Hells Canyon dam are from Chandler and Chapman (2003a), basin areas for Granite and Sheep creeks are from Chandler et al. (2003a), and basin areas for downstream tributaries are from NPCC's (2005) subbasin plans.

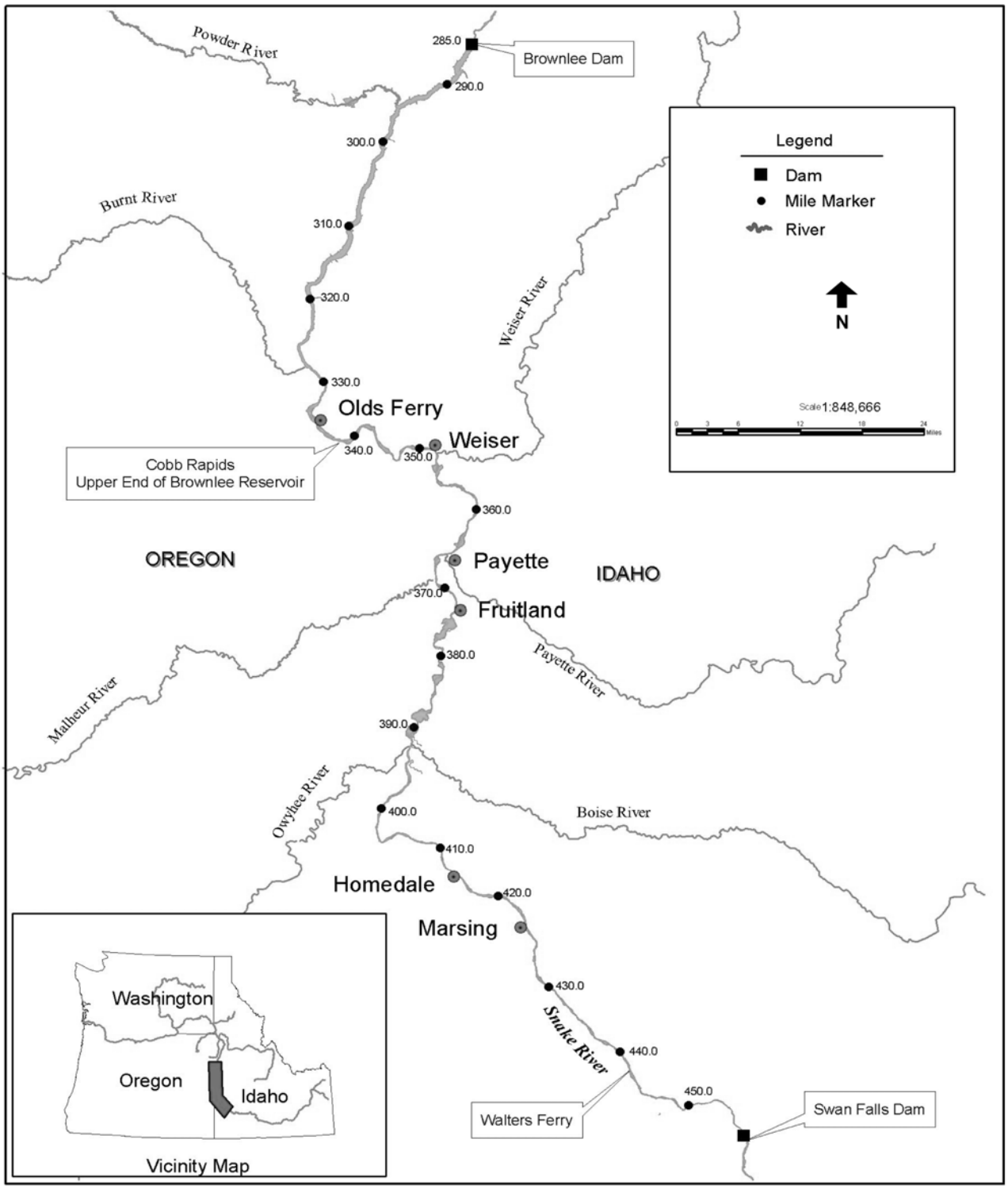

Figure 35. Map of the Swan Falls to Brownlee reach of the Snake River. (Source: (Idaho Power, 2003b)

The Powder River enters the reservoir on the Oregon side, approximately 11 miles upstream from Brownlee dam. Approximately 5 miles of the Powder River is inundated by Brownlee reservoir, forming the Powder River arm. The Burnt River enters Brownlee reservoir in the upper third of the reservoir. Both of these tributaries are heavily diverted to support irrigated agriculture (Hoelscher and Myers, 2003).

Water temperatures in the surface waters of Brownlee reservoir during July and August can range from 24 to 31°C (Idaho Power, 2003b). Because of the high nutrient load contributed primarily from tributaries upstream of the reservoir, algae blooms are common, and much of the reservoir's volume becomes anoxic during low water years, especially in the transition zone at the head of the reservoir. Isolated fish kills, typically of small fish during the summer, are periodically reported. A major anoxia event that occurred in 1990 killed at least 28 adult white sturgeon, and dead fish observed throughout the upper reach of the reservoir included white sturgeon, catfish, crappie, and suckers (Idaho Power, 2003b).

Brownlee reservoir supports an important recreational fishery that targets primarily warmwater species, including smallmouth bass, black crappie, white crappie, and channel catfish. It also supports a stocked fishery for rainbow trout, and limited numbers of wild rainbow trout. Additional information on the fishery in all three project reservoirs is provided in section 3.6.1.6, *Reservoir Fisheries*.

Oxbow Reservoir and Bypassed Reach

Oxbow dam impounds the Snake River from RM 272.5 upstream to Brownlee dam, forming a narrow, 12.1-mile-long reservoir with maximum depths approaching 100 feet (figure 36). Shoreline areas are primarily basalt outcrops and talus, except where small tributaries have deposited alluvium. The project passes flow through tunnels constructed through a natural rock ridge at a bend in the Snake River, creating a 2.5-mile-long bypassed reach. The reservoir has a surface area of 1,150 acres and a volume of 58,385 acre-feet at full pool. Reservoir levels fluctuate by about 5 feet during normal operations with a maximum drawdown of 10 feet. The Wildhorse River enters the Snake River in the upstream end of the reservoir, about a mile downstream of Brownlee dam. A smaller tributary, Indian Creek, enters the middle of the bypassed reach. In addition to flows contributed from Indian Creek, a minimum flow of 100 cfs is released from Oxbow dam into the head of the bypassed reach. Most of the bypassed reach is backwatered when the Hells Canyon reservoir is at full pool.

Oxbow reservoir supports a warmwater fishery similar to Brownlee reservoir, and it provides overwintering habitat for redband and bull trout that spawn in the Wildhorse River. The reservoir may contain a very small remnant population of white sturgeon. The bypassed reach provides overwintering habitat for redband and bull trout that spawn and rear in Pine and Indian creeks. During July and August of low flow years, most of the deeper water in the reservoir becomes anoxic as a result of water with low DO levels being discharged from Brownlee reservoir.

Hells Canyon Reservoir

Hells Canyon dam impounds the Snake River from RM 247.6 upstream to Oxbow dam, forming a narrow, 22-mile-long reservoir (figure 36). Shorelines in the reservoir are generally very steep, and substrates consist primarily of basalt outcrops and talus. The maximum depth approaches 240 feet near the dam. The reservoir has a surface area of 2,412 acres and a volume of 167,720 acre-feet at full pool. Reservoir levels typically fluctuate about 5 feet as a result of daily peaking operations, with a maximum drawdown of 10 feet. Pine Creek enters the Snake River near the head of the reservoir, about 1.5 miles downstream from Oxbow dam.

Hells Canyon reservoir supports a warmwater fishery similar to Brownlee reservoir, but it also provides overwintering habitat for redband and bull trout that spawn and rear in Pine and Indian creeks. The reservoir also contains a very small remnant population of white sturgeon. During July and August of low flow years, most of the deeper water in the reservoir becomes anoxic because of the persistence of low DO levels in waters discharged from Brownlee reservoir.

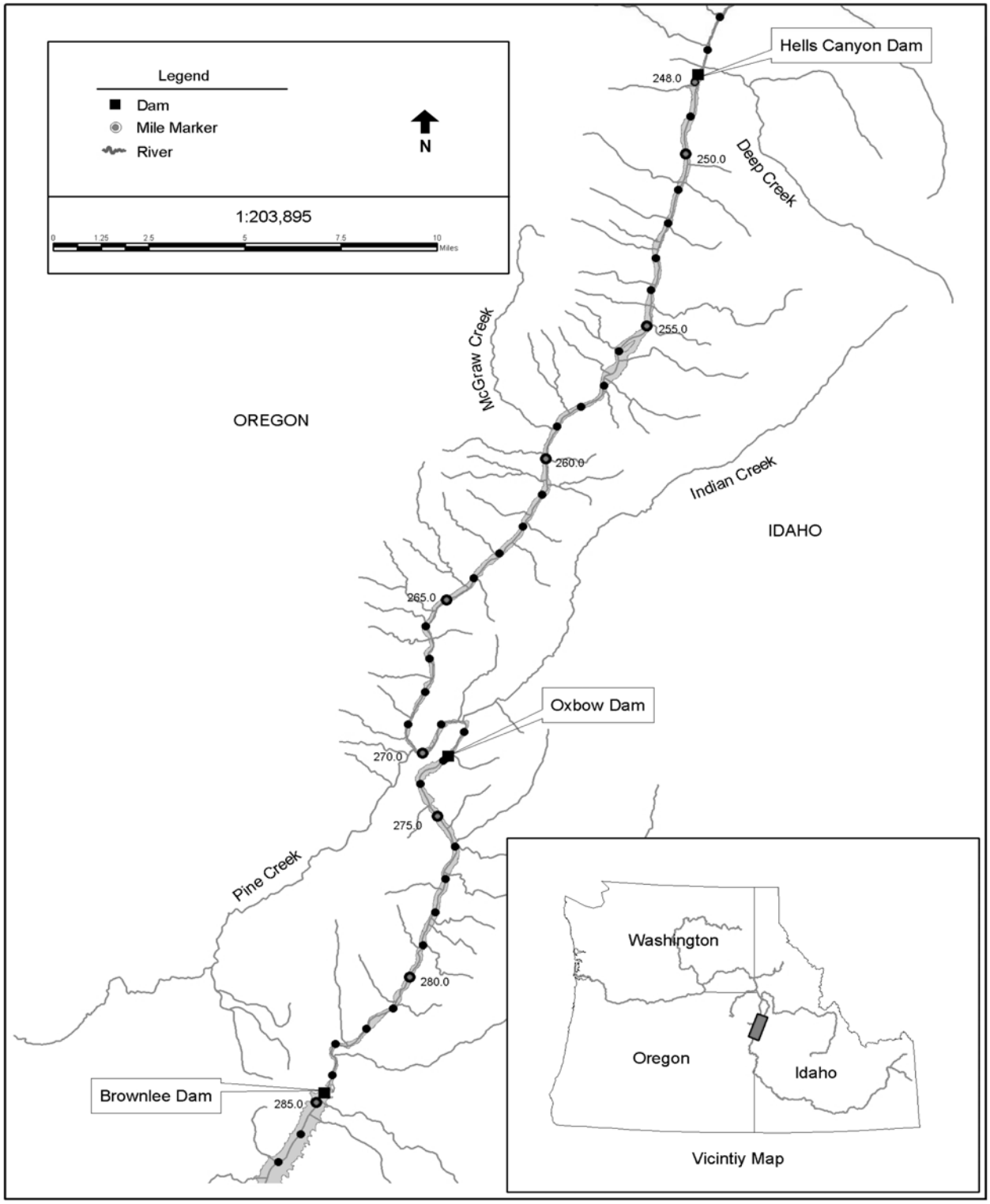

Figure 36. Map of the Brownlee to Hells Canyon reach of the Snake River. (Source: Idaho Power, 2003b)

Hells Canyon Dam to Lower Granite Reservoir

The Hells Canyon reach of the Snake River flows through a deep canyon, creating a series of turbulent rapids and runs intermixed with many deep pools. The Snake River in this reach flows freely for 107 miles. Lower Granite dam, located at RM 107.5, impounds the river for about 32 miles. Several major tributaries including the Imnaha, Salmon, and Grande Ronde rivers join the Snake River upstream of Lower Granite reservoir, and the Clearwater River enters the Snake River near the head of Lower Granite reservoir (figure 37). The Salmon and Clearwater River basins are relatively undeveloped and have a substantial influence on the flow and temperature regimes in the lower Snake River. The Salmon River, which enters the Snake River at RM 188.2 has a mean annual flow of 10,744 cfs and a mean August flow of 5,278 cfs (table 18). The Clearwater River, which enters the Snake River at RM 140, has a mean annual flow of 14,530 cfs and a mean August flow of 8,795 cfs. Together, these tributaries contribute more flow than the Snake River basin upstream of Hells Canyon dam, where the mean annual flow of the Snake River is 19,768 cfs and the mean flow during August is 11,817 cfs. Dworshak dam, a federal dam located at RM 1.9 on the North Fork Clearwater River, plays an important role in providing cool water to augment river flows during the smolt outmigration season. Dworshak reservoir has a usable storage capacity of 2,016,000 acre-feet.

The Hells Canyon reach provides the majority of the fall Chinook spawning habitat that is currently accessible to anadromous fish in the Snake River basin, and the lower part of the reach is part of the migration corridor for anadromous fish migrating to and from the Grande Ronde, Salmon, and Imnaha River basins, including salmon and steelhead produced by Idaho Power's hatcheries, which are released into the Salmon River basin and at Hells Canyon dam. Adult spring Chinook salmon and steelhead that migrate to Hells Canyon dam are collected in trapping facilities at the dam and are transported to Idaho Power's hatcheries, and releases of hatchery smolts from these facilities contribute to commercial and Tribal fisheries, as well as recreational fisheries in the Hells Canyon reach and in the Salmon River basin. Additional information about anadromous fish species, recreational fisheries in the Hells Canyon reach, and Idaho Power's hatchery system is provided in section 3.6.1.3, *Anadromous Fish*, section 3.6.1.7, *Hells Canyon Riverine Fishery*, and in 3.6.1.8, *Hatchery Operations*, respectively.

The Hells Canyon reach also provides overwintering habitat for redband and bull trout that spawn and rear in the Imnaha and Grande Ronde River basins, and in several of the smaller tributaries, including Granite and Sheep creeks (Chandler et al. 2003a). The reach contains a large population of white sturgeon, which supports both recreational catch-and-release and Tribal harvest fisheries. Additional information about these resources is provided in section 3.6.1.4, *Native Resident Salmonids*, and section 3.6.1.5, *White Sturgeon*.

3.6.1.2 Primary Production and Aquatic Macroinvertebrates

Idaho Power conducted two macroinvertebrate surveys: a general survey and a targeted survey focused on detecting listed, rare, or sensitive mollusks. Both surveys involved sampling in all three project reservoirs and in the Snake River between Hells Canyon dam and the confluence with the Salmon River. The general survey also included sampling upstream of the project, from Swan Falls dam to the headwaters of Brownlee reservoir. The results of the general survey indicate that Ephemeroptera (mayflies), Trichoptera (caddisflies), Diptera (true flies), Oligochaeta (worms) and Gastropoda (snails) dominate the invertebrate community upstream of Brownlee reservoir (Myers and Foster, 2003). Ephemeroptera were consistently the most abundant taxon in this reach, and the genus *Trichorythodes* composed 75 percent of this group on average. Within this reach, Oligochaetes increased from less than 1 percent in upstream areas to approximately 13 percent of the invertebrate community downstream of RM 360. Surveyors located the federally listed endangered Idaho springsnail (*Pyrogulopsis idahoensis*) in a single reach between RM 365 and RM 370, about 25 miles upstream from the headwaters of Brownlee reservoir. Surveyors also found the invasive New Zealand mudsnail (*Potamopyrgus antipodarum*) in several reaches upstream of Brownlee reservoir, including the reach where Idaho springsnails were found.

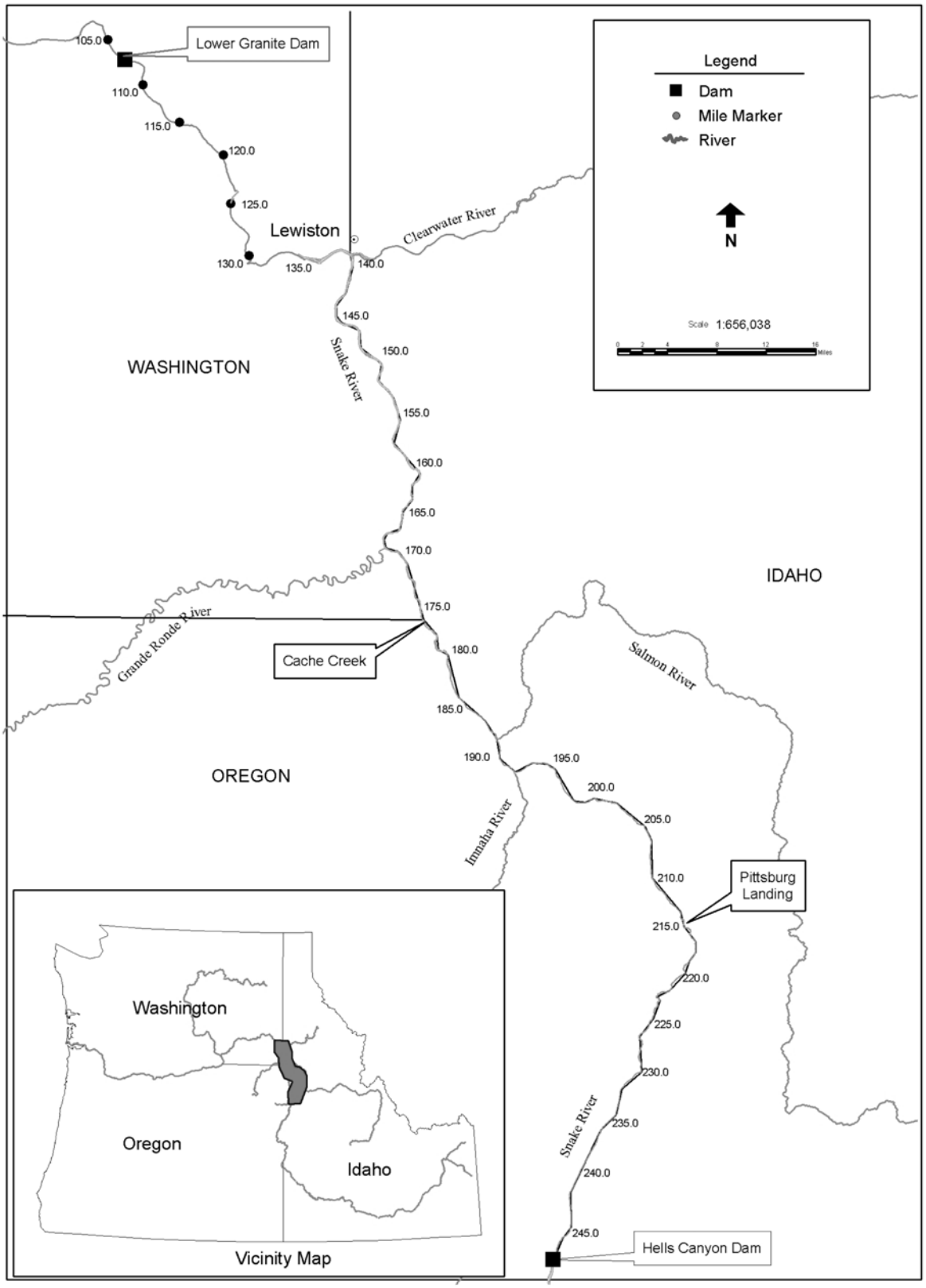

Figure 37. Map of the Hells Canyon to Lower Granite reach of the Snake River. (Source: Idaho Power, 2003b)

In the project reservoirs, the results of the general survey indicated that the abundance of Oligochaetes was relatively high, and surveyors detected no Trichoptera, Plecoptora (stoneflies), or *Tricorythodes*. Fewer taxa were found in Brownlee samples during all seasons compared to Oxbow and Hells Canyon reservoirs (Myers and Foster, 2003). Bivalves (clams and mussels) were present in Oxbow and Hells Canyon reservoirs, but none were found in Brownlee reservoir during the general survey. In the targeted mollusk survey, several California floater (*Anodonta californiensis*) shells, one of which still had a dead mussel inside, were found in the section of the Burnt River that is often inundated by the reservoir (Richards et al. 2005). Idaho Power concluded that a colony of this species, which is a federal species of concern (BLM Type 3-regional/state imperiled species), probably exists somewhere in the area.

In the reach downstream of Hells Canyon dam, Platyhelminthes (flatworms), bivalves (*Corbicula* sp.), and gastropods were found to be very common within the first 6 miles downstream of the dam during the general survey (Myers and Foster, 2003). Surveyors found New Zealand mudsnails in half (14) of the 1-mile subreaches that were sampled. In the general survey, one snail that was field-identified as a Bliss Rapids snail (*Taylorconcha serpenticola*), a federally listed threatened species, was collected near RM 227, about 20 miles downstream of Hells Canyon dam. A follow-up survey of this area conducted in 2002 resulted in the collection of three more individuals that were field-identified as Bliss Rapids snail, but efforts to verify their taxonomy were inconclusive. In the targeted mollusk survey, surveyors found a species of *Taylorconcha* to be fairly abundant in the reach downstream of RM 234 (Richards et al. 2005-AR-2). Genetic analysis of specimens collected during the targeted survey indicates that the *Taylorconcha* that inhabit the Hells Canyon reach may represent a new species that is distinct from the listed Bliss Rapids snail. Other special status species that were identified downstream of Hells Canyon dam during the targeted mollusk survey include the California floater and the great Columbia River limpet or shortface lanx (*Fisherola nuttalli*), which is a BLM Type 2 (rangewide/globally imperiled) species. Two invasive species, the New Zealand mudsnail and the Asiatic clam (*Corbicula fluminea*) were the most abundant and widespread species of mollusk observed downstream of Hells Canyon dam.

3.6.1.3 Anadromous Fish Species

This section provides an overview of the historical and current distribution of anadromous fish in the project vicinity and describes the life history of anadromous fish species that occur in the Snake River basin. Additional information on the listing status and recent trends in abundance of Endangered Species Act (ESA)-listed species, including fall and spring/summer Chinook salmon, sockeye salmon, and steelhead trout is provided in section 3.8, *Threatened and Endangered Species*.

Historical Distribution and Abundance

The historical production area of anadromous fish in the Snake River basin included 615 miles of the mainstem Snake River extending upstream to Shoshone Falls, and portions of 13 major tributary basins and many smaller basins (table 29). Major tributaries that historically produced anadromous fish upstream of the current site of Hells Canyon dam (RM 247.6) include Salmon Falls Creek and the Bruneau, Owyhee, Boise, Malheur, Payette, Weiser, Burnt, and Powder rivers. Smaller tributaries within this reach include the Wildhorse River, Indian Creek, and Pine Creek, as well as a group of small creeks that are referred to collectively as the Rock Creek basins. Major anadromous fish producing tributaries downstream of Hells Canyon dam include the Imnaha, Salmon, Grande Ronde, Clearwater, and Tucannon rivers.

Fall Chinook salmon historically used the entire mainstem of the Snake River downstream of Shoshone Falls, as well as the lower sections of several of the larger tributaries, for spawning and rearing. Evermann (1896) considered the spawning areas between Huntington (RM 328) and Auger Falls (RM 606.7) to be the most important in Idaho, although he did not explore areas downstream of Huntington. Historical accounts given in Pratt et al. (2003a–n) indicate that spring/summer Chinook

salmon and steelhead probably spawned in every major tributary, and sockeye salmon spawned and reared in Payette Lake and in several small lakes in the headwaters of the Salmon River basin.

Idaho Power estimated that the Snake River basin upstream of Hells Canyon dam produced between 1 and 1.7 million adult salmon and steelhead annually in the pre-development era (prior to 1860). This estimate includes an estimated 0.76 to 1.19 million spring/summer Chinook salmon; 135,000 to 214,000 fall Chinook salmon; 117,000 to 225,700 steelhead; and 14,400 to 57,400 sockeye salmon (Chapman and Chandler, 2003). In an analysis appended to its January 20, 2006, filing, NMFS notes an apparent error in Idaho Power's estimate of the number of fall Chinook salmon produced upstream of Hells Canyon dam,[57] and provides its own estimate, which is considerably higher than the Idaho Power estimate. The NMFS estimate is based on the distribution of historical fall Chinook habitat described in Dauble et al. (2003), which estimates that 52 percent of the historical fall Chinook salmon spawning habitat in the Columbia basin occurred in the Snake River, and that 58 percent of the fall Chinook spawning habitat in the Snake River was located upstream of Hells Canyon dam. NMFS states that this assessment corroborates the statement made by Waple et al. (1991) that the great majority of fall Chinook salmon spawned in the mainstem Snake River upstream of the Hells Canyon Project. Applying these percentages to a historical estimate of 800,000 to 1,250,000 fall Chinook salmon returning to the Columbia River, NMFS estimates the historical return of adult fall Chinook salmon to the Snake River upstream of Hells Canyon was between 241,280 and 377,000 fish.

Over a period of approximately 70 years, anadromous fish above the present-day site of Hells Canyon dam were gradually extirpated from much of their historical range by the construction of federal and private dams and from habitats being degraded by multiple land uses. Habitat losses began primarily with placer mining, which took place throughout the entire basin, followed by development of the basin for agricultural production, timber harvest, and livestock production.

Idaho Power estimated that by the time that the Hells Canyon Project was constructed, anadromous fish runs to the area upstream of Hells Canyon dam had been reduced to approximately 16,000 fall Chinook salmon, 1,900 spring Chinook salmon, and 7,500 steelhead (Chapman and Chandler, 2003). Based on its review of historical records, Idaho Power concluded that the production of spring/summer Chinook salmon and steelhead upstream of the Hells Canyon dam site was primarily limited to the Weiser River, Eagle Creek (a tributary to the Powder River), the Wildhorse River, Pine Creek, and Indian Creek. Although large areas in the Malheur and Burnt rivers and the lower portion of the Boise were accessible to anadromous fish, Idaho Power concluded that these rivers no longer supported anadromous salmonids, with the exception of a few runs of steelhead remaining in the Burnt River (Idaho Power, 2003a, section E.3.1.1.2.2.1).

Historically, Pacific lamprey occurred throughout the Columbia and Snake River basins, mirroring the range of migrating salmon (Close et al. 1995). Pacific lamprey were documented in large numbers throughout the Snake River, and were harvested by Native Americans at traditional fishing areas within the Snake River basin, areas that included the Tucannon, Grande Ronde, and Powder rivers (Close and Bronson, 2001). Pacific lamprey were reported to ascend the Snake River upstream to Shoshone Falls, and probably occurred in nearly all of its tributaries. Within the project area, accounts given in Pratt et al. (2003a–n) indicate that they occurred in at least the Boise, Payette, Powder, and Wildhorse rivers.

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[57] NMFS states that Idaho Power's estimate was calculated assuming that 36 percent of fall Chinook salmon returning to the Columbia River spawned in the Snake River, and that 60 percent of the fish spawning in the Snake River spawned upstream of Hells Canyon dam.

Loss of Access from Dam Construction

The construction and operation of both private and federally owned dams have substantially reduced anadromous fish access to habitat in the Snake and Columbia River basins. The construction of 13 mainstem dams on the Snake River downstream from Shoshone Falls, 4 mainstem dams on the Lower Columbia River (figure 1 and table 3), and numerous tributary dams and diversions has affected access in the Snake River basin. Although the lowermost four dams on the Snake River and the four Lower Columbia River dams are equipped with fish passage facilities, migration losses associated with these dams and their reservoirs have contributed to the decline of Snake River salmon and steelhead, all of which are now protected under the ESA.

Swan Falls dam, which was constructed in 1901 at RM 458, was the first dam on the mainstem of the Snake River[58] to substantially reduce the distribution of anadromous fish in the Snake River basin. Although a fish ladder was installed during initial construction, it was not functional for salmon and blocked access to much of the spring-influenced habitat in the middle Snake River. The section of the river blocked by Swan Falls dam was probably the most productive habitat for fall Chinook salmon in the basin. Inflow of spring water near Thousand Springs (RM 584) created a thermal regime that was well suited for the production of fall Chinook salmon, with warm temperatures in the winter and early spring that promoted early emergence and rapid growth (Chandler et al., 2003b; Connor and Burge, 2003).

The next downstream barrier constructed on the Snake River was Brownlee dam, which was constructed at RM 284.6 in 1958. The diversion tunnel used during construction was completed in 1956, along with temporary fish passage facilities to move adult fish around the construction area. When Brownlee reservoir filled in May 1958, adult fish collection was moved downstream to the Oxbow dam construction site (RM 272.5) and then, in 1966, to below Hells Canyon dam (RM 247.6). In addition, Idaho Power deployed a large collection net in Brownlee reservoir in an attempt to collect downstream migrating smolts for transport to the river downstream of the project.

Although efforts to trap and transport adult salmon and steelhead around the dams were generally successful,[59] within several years it became clear that efforts to collect downstream migrating smolts were not successful enough to maintain anadromous fish runs upstream of the project.[60] In December 1963, the Federal Power Commission (predecessor to the Federal Energy Regulatory Commission) ordered Idaho Power to abandon the downstream collection efforts prior to the outmigration of 1964, which led to the development of hatchery mitigation efforts. Because of these events, Hells Canyon dam became the terminus for production of anadromous fish, eliminating access to 210 miles of mainstem habitat, as well as the tributaries that enter the Snake River between Hells Canyon and Swan Falls dams.

During the same general period as construction of the Hells Canyon Project, four federally owned dams were constructed on the lower Snake River. Ice Harbor dam was constructed in 1962, Lower

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[58] Anadromous fish access to the Bruneau River was eliminated in 1890 when a dam was constructed 1.5 miles from its mouth. Historical accounts indicate that the dam was constructed without a fishway, and blocked access of anadromous fish into the basin (Pratt et al., 2001g). Although the dam washed out several times, it was rebuilt each time.

[59] An exception occurred in the late summer of 1958, when failure of a cofferdam at the temporary fish collection facility downstream of Oxbow dam, allowed adult fall Chinook and steelhead to enter and become trapped in the bypassed reach. An estimated 3,497 fall Chinook and 771 steelhead were killed in the "Oxbow incident," which constituted approximately 20 percent of the run of fall Chinook and 15 percent of the run of steelhead for that year.

[60] Failure of the collection net was attributed to mechanical failures, fish passing under the net, and losses of smolts as they passed through approximately 54 miles of impounded water upstream of the net, which was deployed about 1 mile upstream of Brownlee dam.

Monumental and Little Goose dams were constructed in 1969 and 1970, respectively, and Lower Granite dam was constructed in 1975. Combined, these dams inundated 135 miles of the mainstem Snake River, 54 percent of the mainstem habitat downstream of Hells Canyon dam. Two of the four federally owned dams on the lower Columbia River—The Dalles and John Day dams—were also constructed in the same period. The date of construction and location of each of these dams is listed in table 3. Although all of the federal dams on the lower Snake and lower Columbia rivers are equipped with fish passage facilities, the cumulative losses of fish passing these dams are substantial, especially during the smolt outmigration. However, as the result of ongoing efforts to reduce mortality in the migration corridor, the overall rate of juvenile survival is, at present, reported to be equivalent to that observed in the 1960s when only four dams were present (Williams et al., 2005).

Current Distribution

Within the Snake River basin, the distribution of anadromous fish is currently limited to the mainstem Snake River and portions of its tributaries downstream of Hells Canyon dam. The 107-mile segment from Hells Canyon dam to the head of Lower Granite reservoir contains most of the fall Chinook spawning and rearing habitat that is still accessible, although fall Chinook spawning also occurs in the lower reaches of the Imnaha, Salmon, Grande Ronde, Clearwater, and the Tucannon rivers. All of these tributaries also continue to support limited numbers of spring/summer Chinook salmon and summer steelhead. Idaho Power operates two major hatcheries in the Salmon River basin and two hatcheries on the Snake River upstream of Hells Canyon dam that produce steelhead, spring Chinook salmon, summer Chinook salmon, and in the last few years, fall Chinook salmon. Most of the fish produced in the Idaho Power hatchery system are released into the Salmon River or its tributaries or into the Snake River downstream of Hells Canyon dam. Redfish Lake, in the headwaters of the Salmon River basin, supports the only remaining population of Snake River sockeye salmon, and this population is the subject of an intensive conservation hatchery supplementation program. A small number of adult Pacific lamprey continue to migrate past Lower Granite dam, and probably spawn in tributaries to the Hells Canyon reach. The number of adult lamprey that have been counted migrating past Lower Granite dam over the past decade have ranged from 27 fish in 2001 to 1,122 fish in 1997 (FPC, 2005).

Life History of Anadromous Fish in the Snake River[61]

Fall Chinook Salmon

Snake River fall Chinook salmon spawn in the mainstem Snake River and in the lower portions of some of its larger tributaries. Spawning generally occurs in October, November, and early December. Emergence timing varies and can extend from early March to June, depending on the location and spawn timing. Fall Chinook salmon rear in mainstem environments that are generally associated with low-gradient, low-velocity shorelines. Most fall Chinook salmon rear for a few months in freshwater environments before they migrate to the ocean as subyearlings. In the mid-1990s most juvenile fall Chinook salmon migrated past Lower Granite dam from June through August, but in recent years the migration has occurred earlier, with most juvenile fall Chinook salmon passing Lower Granite dam by the middle of July (figure 38). Williams (2005) reports that the average length of wild juvenile fall Chinook salmon passing Lower Granite dam has decreased from 140 mm in 1996 and 131 mm in 1997 to 113, 113, and 110 mm in 2002, 2003, and 2004, respectively. Because factors such as water temperatures and river flows have not changed substantially over this time period, NMFS concludes that the most plausible explanation for these recent changes in migration timing and fish size is that density-dependent mechanisms (e.g., competition for food and space) are beginning to manifest themselves because the number of juvenile fish is approaching the carrying capacity of the habitat.

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[61] Information in this section comes from Idaho Power's license application (Idaho Power, 2003a) unless otherwise noted.

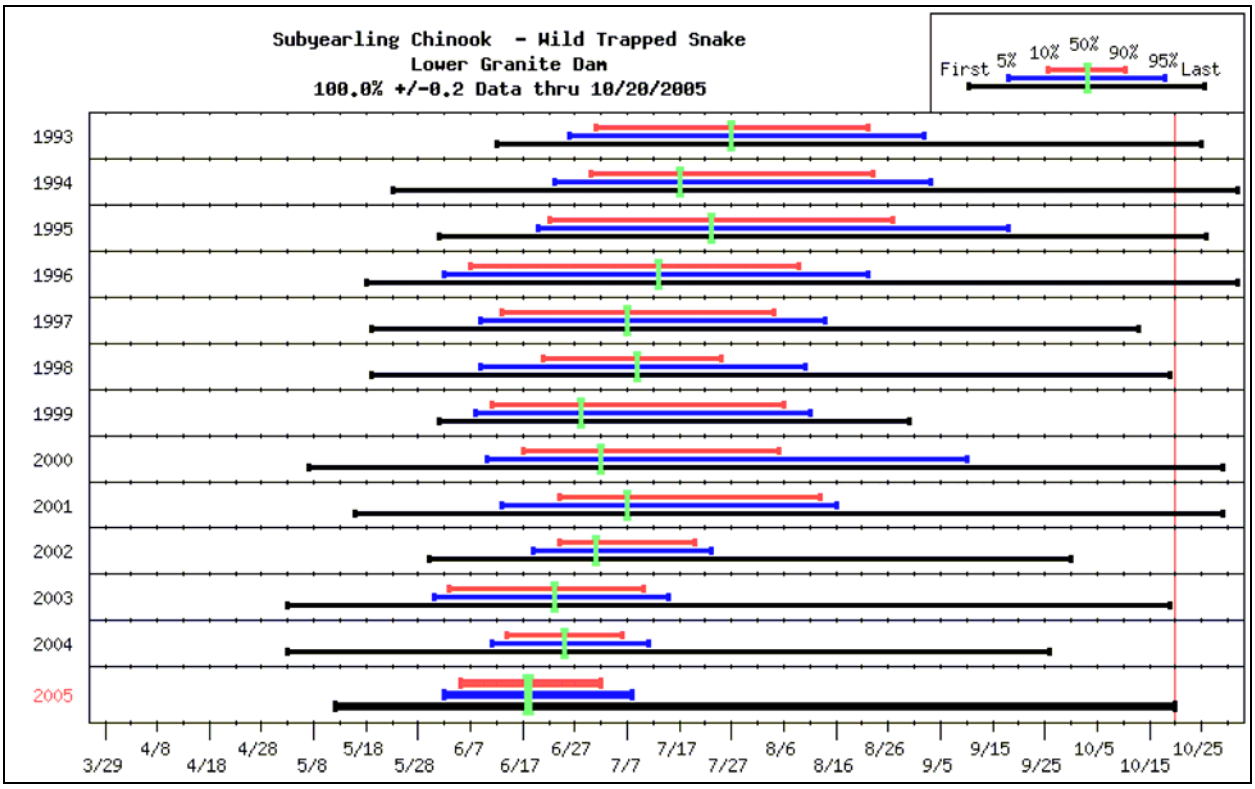

Figure 38. Passage timing of wild subyearling fall Chinook salmon smolts (PIT-tagged in the upper and lower Hells Canyon reaches) at Lower Granite dam. (Source: NMFS letter dated January 24, 2006.)

Adult fall Chinook salmon return to the Snake River at ages 2 to 5, although age 4 is the most common age for spawning. Adults generally arrive at the spawning areas from mid-August to November, with peak periods ranging from mid-September to the first week in October. Some fall Chinook salmon outmigrate through the lower Snake River as yearlings, but most of these fish originate from the Clearwater River.

Spring/Summer Chinook Salmon

Snake River spring/summer Chinook salmon spawn in tributary habitats from mid-August to mid-September. The distinction between spring and summer Chinook salmon is not always clear, and within the Snake River basin, NMFS has designated these fish as a single stock. Fry emerge in the spring and rear in freshwater for a year before they outmigrate in April, May, and June. Adults spend 2 to 3 years in the ocean and then return to fresh water. Adult spring/summer Chinook salmon return to the Snake River from May through July.

Steelhead Trout

Steelhead are the anadromous form of rainbow trout. The Snake River steelhead is a summer-run stock, which enters rivers earlier than winter runs, completing sexual maturation in the freshwater environment. The Snake River run is further divided into an A-run, which passes Bonneville dam between June and August 25, and a B-run, which enters fresh water from late August through October. A-run steelhead mostly spend 1 year in the ocean, while the B-run fish spend 2 years in the ocean environment. In the Snake River downstream of Hells Canyon dam, the A-run predominates. The

composition of ocean-age returns to basins that historically produced steelhead upstream of Hells Canyon dam is unknown.

Steelhead enter the Snake River from September through November, and typically hold over during the winter months until they move into tributaries to spawn during March and April. Unlike the Pacific salmon species, steelhead are capable of repeat spawning, although the frequency of repeat spawning is probably low for inland stocks. Fry emerge from the gravel from the late spring to early summer, and most juveniles rear in freshwater for 1 to 3 years before outmigrating during the spring. Some degree of crossover between resident rainbow trout and steelhead populations is common, and hatchery steelhead smolts may fail to migrate and remain in the streams and rivers in which they are stocked.

Sockeye Salmon

Production areas of sockeye salmon are associated with lake environments. Although spawning occurs in both stream and lake habitats, juvenile rearing occurs almost exclusively in lake habitats. Some sockeye salmon, referred to as kokanee, may spend their entire life cycle within fresh water. As with steelhead, the resident form is capable of producing anadromous offspring and vice versa. Sockeye salmon generally spawn from late summer into the fall. Juvenile sockeye salmon rear in lake environments for 1 to 3 years before migrating to the sea, where they spend 2 to 4 years before returning to their natal lake system. Juvenile sockeye salmon generally migrate past Lower Granite dam from April through June. Adult sockeye pass Lower Granite dam between the end of June and the first part of August.

Pacific Lamprey

In the Columbia River basin, Pacific lamprey migrate upstream to spawn from May to September. Most lamprey hide under stones and overwinter until the following spring, after which they resume their migration into tributaries, where they spawn when temperatures reach between 10 and 15°C. Adult lamprey build nests in sandy gravel. Larvae (ammocoetes) hatch within 2 to 3 weeks and leave their natal substrate 2 to 3 weeks later, drifting downstream into slower pools and eddies. The larvae spend 4 to 6 years burrowing into fine sediments where they filter-feed on algae, diatoms, and detritus. Transformation from an ammocoete to a juvenile (macropthalmia) generally occurs from July through October, prior to a late fall to spring outmigration. Developing juvenile and young adult lamprey initially leave the substrate and migrate during the night in the lower portions of the water column. Lamprey generally spend between 1 and 3.5 years in the ocean, where they become parasitic feeders. Pacific lamprey are the only species of lamprey that are known to occur in the Snake River basin. The species is a federal species of concern and is classified as an endangered species by the state of Idaho.

3.6.1.4 Native Resident Salmonids

Native resident salmonids in the project area include bull trout, Columbia River redband trout, and mountain whitefish. Redband trout are classified as a species of special concern in Idaho, and as a vulnerable species in Oregon. Bull trout are federally listed as threatened, as a species of special concern by the state of Idaho, and as a critical species by the state of Oregon. Because of their special state and federal status, Idaho Power's studies and our analysis of project effects on native resident salmonids focuses on redband and bull trout.

Redband Trout

Redband trout are a poorly defined subspecies of inland rainbow trout (*Oncorhynchus mykiss*) that occurs in the Columbia, Fraser, and Sacramento River basins, as well as the ancient lake basins in the northern Great Basin (Behnke, 1992). Redband trout populations display a range of life history strategies,

including anadromous (migrates to rear in the ocean), fluvial (migrates between large rivers and tributaries), adfluvial (migrates between a lake and tributaries), and resident (non-migratory) forms. The anadromous form (steelhead trout) is present in the Snake River and its tributaries downstream of Hells Canyon dam and is heavily supplemented through hatchery propagation (see section 3.6.1.8, *Hatchery Operations*).

Idaho Power used multiple techniques to assess the distribution and life history of redband trout in the project area, including electrofishing, gillnetting, hook and line sampling, the use of weir traps to collect trout emigrating from tributaries, genetics analysis, and radio telemetry studies (Chandler et al., 2003a). Idaho Power found that redband trout were distributed throughout the project reservoirs and in nearly every tributary that had adequate year-round discharge and no barrier preventing upstream movement. All of the major tributaries contained redband trout populations, although several streams also contained hybrids of redband trout with coastal rainbow trout. Sampling conducted at outmigrant traps installed on five tributaries in the project area[62] indicate that redband trout tended to move downstream from tributaries during the fall when water temperatures began to drop below 8 to 10°C. Radio-tagged adult redband trout made numerous and extensive movements into tributaries, presumably to spawn, primarily during April and May.

Within the project reservoirs and in the Snake River downstream of Hells Canyon dam, hatchery-produced rainbow trout (which are primarily from coastal rainbow stock) were 3 to 10 times more abundant than wild redband trout, yet wild redband trout were more abundant than hatchery rainbow trout in tributary streams throughout the study area. IDFG and ODFW stock large numbers of fingerling and smaller numbers of catchable rainbow trout in project reservoirs, especially in Brownlee reservoir and several of the tributaries in the project area (table 30). In addition, IDFG stocks surplus adult hatchery steelhead into Hells Canyon reservoir and into the Boise and Payette rivers when returns are sufficient (Abbott and Stute, 2003).

Bull Trout

Bull trout (*Salvelinus confluentus*) are a native species of char that is unique to western North America. Their historical range extends from the McCloud River in northern California and the Jarbridge River in Nevada north to the headwaters of the Yukon River in Canada (Haas and McPhail, 1991). Bull trout require colder water than most other salmonids for incubation, juvenile rearing, and spawning. Spawning and rearing areas are often associated with the coldest streams in a watershed. Throughout their lives, bull trout require complex forms of cover, including large woody debris, undercut banks, boulders, and pools.

Bull trout exhibit both resident and migratory life-history strategies. Resident bull trout complete their entire life cycle in the tributary streams in which they spawn and rear. Migratory bull trout spawn in tributary streams where juvenile fish rear for 1 to 4 years before migrating to either a lake (adfluvial form), river (fluvial form), or in certain coastal areas to saltwater (anadromous form). Resident and migratory forms may be found together, and either form may give rise to offspring exhibiting either resident or migratory behavior (Rieman and McIntyre, 1993).

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[62] Outmigrant weirs were installed at four sites upstream of Hells Canyon dam (Brownlee Creek, Wildhorse River, Pine Creek, and Indian Creek) and one site downstream of Hells Canyon dam (Sheep Creek). Redband trout were collected at each of these sites.

Table 30. Number of rainbow trout stocked by IDFG and ODFW at project reservoirs and at major tributaries from 1987 to 1997. (Source: Chandler et al., 2003a)

	Species/Strain									
	Rainbow			Kamloops		Steelhead		Kamloops X Steelhead Hybrid	Rainbow X Cutthroat Hybrid	
Location	**Catchable**	**Fingerling**	**Fry**	**Catchable**	**Fingerling**	**Adults**	**Fingerling**	**Fingerling**	**Fingerling**	**Grand Total**
Brownlee reservoir	388,364	4,009,642	--	155,840	745,745	--	373,140	441,460	--	6,114,191
Hells Canyon reservoir	45,772	368,780	48,000	--	30,140	3,761	--	--	139,380	635,833
Oxbow reservoir	154,687	653,631	--	--	30,140	--	--	--	60,600	899,058
Malheur River	66,552	2,152,229	88,839	--	--	--	--	--	--	2,307,620
Burnt River	53,081	1,203,214	--	--	--	--	--	--	--	1,256,295
Powder River	413,599	2,640,367	5,293	--	--	--	--	--	--	3,059,259
Wildhorse River	6,017	--	--	--	--	--	--	--	--	6,017
Pine Creek	55,542	12,000	13,130	--	--	--	--	--	--	80,672
Grand Total	1,183,614	11,039,863	155,262	155,840	806,025	3,761	373,140	441,460	199,980	14,358,945

Note: According to Behnke (1992), the Kamloops strain is the form of redband rainbow trout native to the upper Columbia and Frasier River basins.
IDFG – Idaho Department of Fish and Game
ODFW – Oregon Department of Fish and Game

The results of extensive fisheries surveys conducted by Idaho Power indicate that bull trout populations in the project area upstream of Hells Canyon dam were restricted to Indian Creek, Pine Creek, and the Wildhorse River drainages (Chandler et al., 2003a). All drainages upstream of Hells Canyon dam that contained bull trout also had resident brook trout and hybridized individuals between bull trout and brook trout. Hybrids were particularly abundant in Indian Creek and in the Wildhorse River. Surveyors found no bull trout or bull trout hybrids in Brownlee reservoir or its tributaries, although bull trout are known to occur in the headwaters of the Powder River Watershed. Downstream of Hells Canyon dam, only pure bull trout were present in the Snake River and in several of the major tributaries (Imnaha River, Grande Ronde River, Salmon River, Sheep Creek, and Granite Creek).

Brownlee, Oxbow, and Hells Canyon dams impede connectivity among bull trout populations in tributaries by blocking upstream migration past the dams and impeding migration within inundated habitat due to adverse water quality conditions that occur for extended time periods in the reservoirs, primarily during the summer and early fall. Idaho Power modeled seasonal trends in the suitability of water temperatures and DO levels in the project reservoirs for several fish species including bull trout. Suitability indices were calculated using suitability curves to rate the average water temperatures and DO levels throughout the entire volume of each reservoir. A composite index was also calculated by multiplying the temperature and DO suitability indices. The modeling effort was conducted for proposed and run-of-river full pool scenarios. The results generally indicate only minor differences between scenarios in terms of temperature and DO suitability.

For a representative extreme low flow year (1992), high water temperatures caused the temperature suitability index to diminish to levels less than 0.5 from mid-June through October in Brownlee reservoir, while the temperature suitability index in Oxbow and Hells Canyon reservoir dropped to levels below 0.5 from mid-July through October (figures 39 through 41). The DO suitability index diminished to levels below 0.5 from June through October in Brownlee reservoir, and dropped to levels below 0.5 from mid-June through November in Oxbow and Hells Canyon reservoirs. The composite (temperature x DO) index dropped to levels below 0.5 from June through mid-November in Brownlee reservoir, from mid-June through November in Oxbow and Hells Canyon reservoirs.

For a representative medium flow year (1995), high water temperatures caused the temperature suitability index to diminish to levels less than 0.5 from July through early October in Brownlee and Oxbow reservoirs, while the temperature suitability index in Hells Canyon reservoir dropped to less than 0.5 from early July through October (figures 42 through 44). The DO suitability index diminished to less than 0.5 from mid-August through early October in Brownlee reservoir, and from August through October in Oxbow and Hells Canyon reservoirs. The composite (temperature x DO) index dropped to levels less than 0.5 from early June through October in Brownlee reservoir, from July through October in Oxbow reservoir, and from July through mid-November in Hells Canyon reservoir.

For a representative extreme high flow year (1997), the temperature suitability index diminished to less than 0.5 from June though mid-October in all three reservoirs (figures 45 through 47). The DO suitability index dropped slightly below 0.5 from mid-August through early September in Brownlee reservoir, and dropped below 0.5 from August through early September in Oxbow and Hells Canyon reservoirs. The composite (temperature x DO) index dropped to levels near below 0.5 from June through early October in all three reservoirs.

Idaho Power also modeled DO and temperature suitability downstream of Hells Canyon dam for the 3 representative years. DO suitability for salmonids for the 3 years is shown in figures 48 through 50 and temperature suitability for bull trout is shown in figures 51 through 53. The modeling results indicate that sub-optimal DO levels extend for a considerable distance downstream from Hells Canyon dam, especially in the extreme low flow year of 1992. However, these periods of low DO suitability coincide with periods in which water temperatures are also sub-optimal for bull trout.

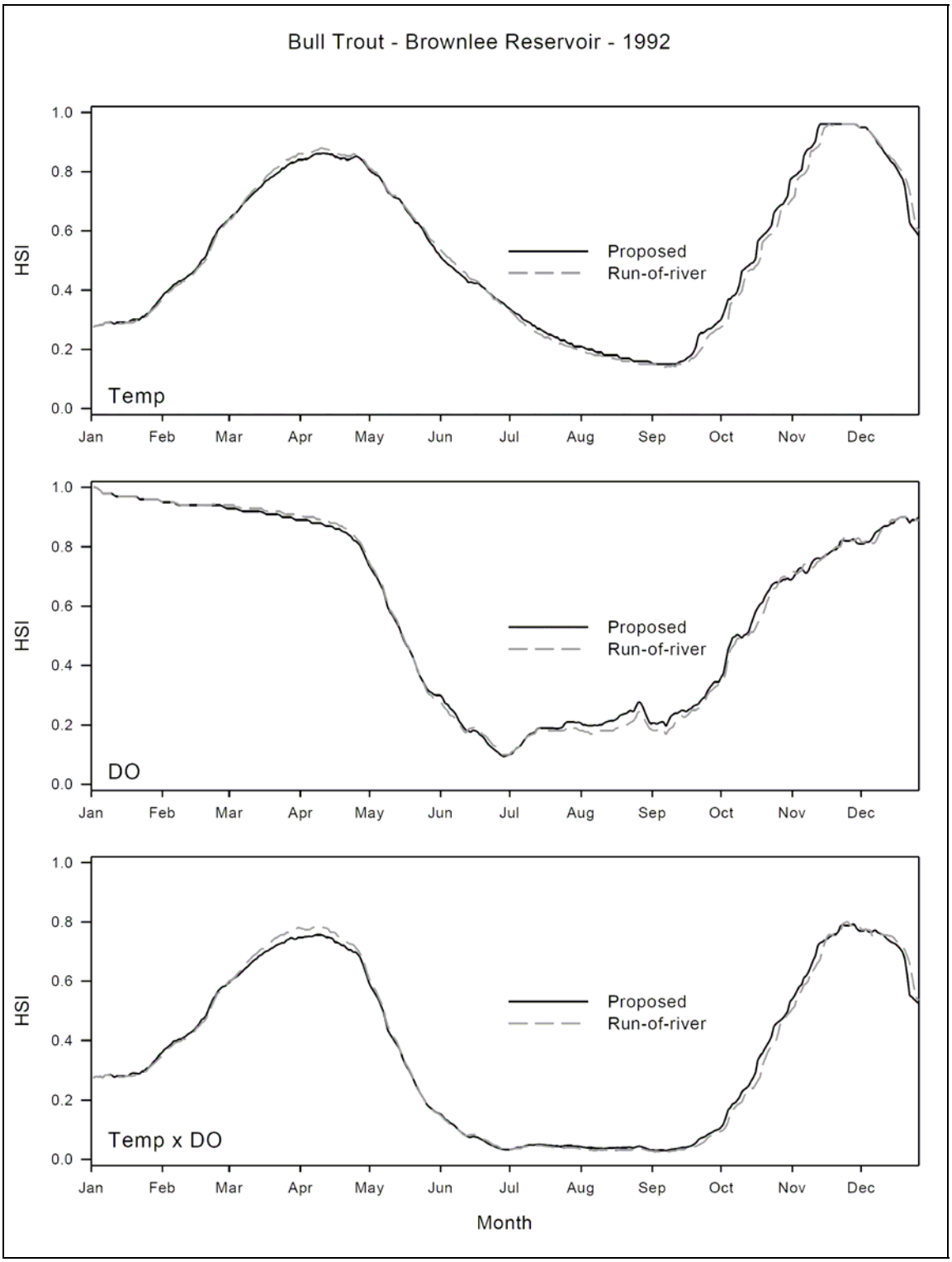


Figure 39. Time series of bull trout habitat suitability indices for temperature, dissolved oxygen and a composite score for temperature and dissolved oxygen at Brownlee reservoir during an extreme low flow hydrologic year (1992) and two operational scenarios (proposed and run-of-river full pool). (Source: Chandler, 2004)

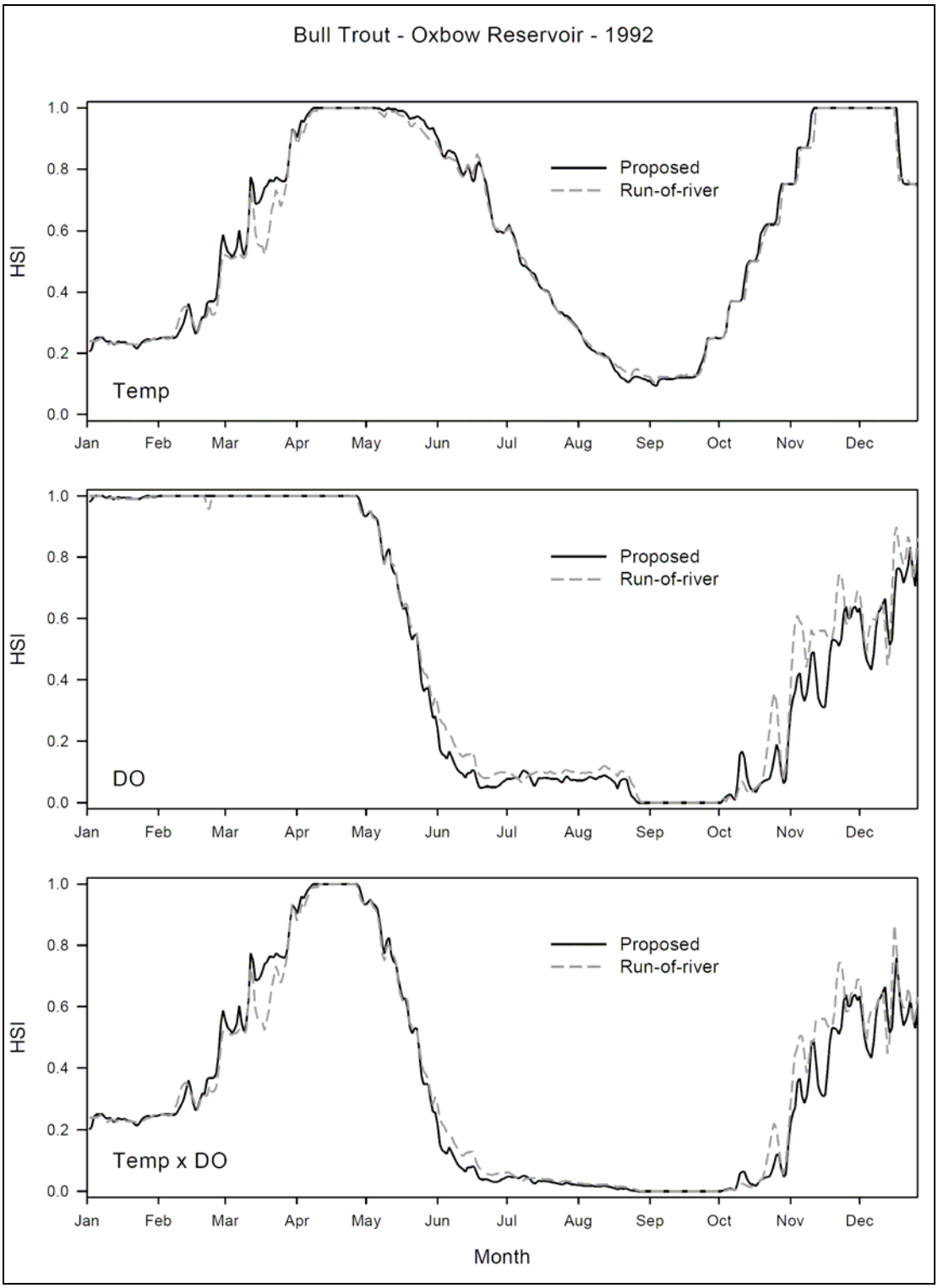


Figure 40. Time series of bull trout habitat suitability indices for temperature, dissolved oxygen and a composite score for temperature and dissolved oxygen at Oxbow reservoir during an extreme low flow hydrologic year (1992) and two operational scenarios (proposed and run-of-river full pool). (Source: Chandler, 2004)

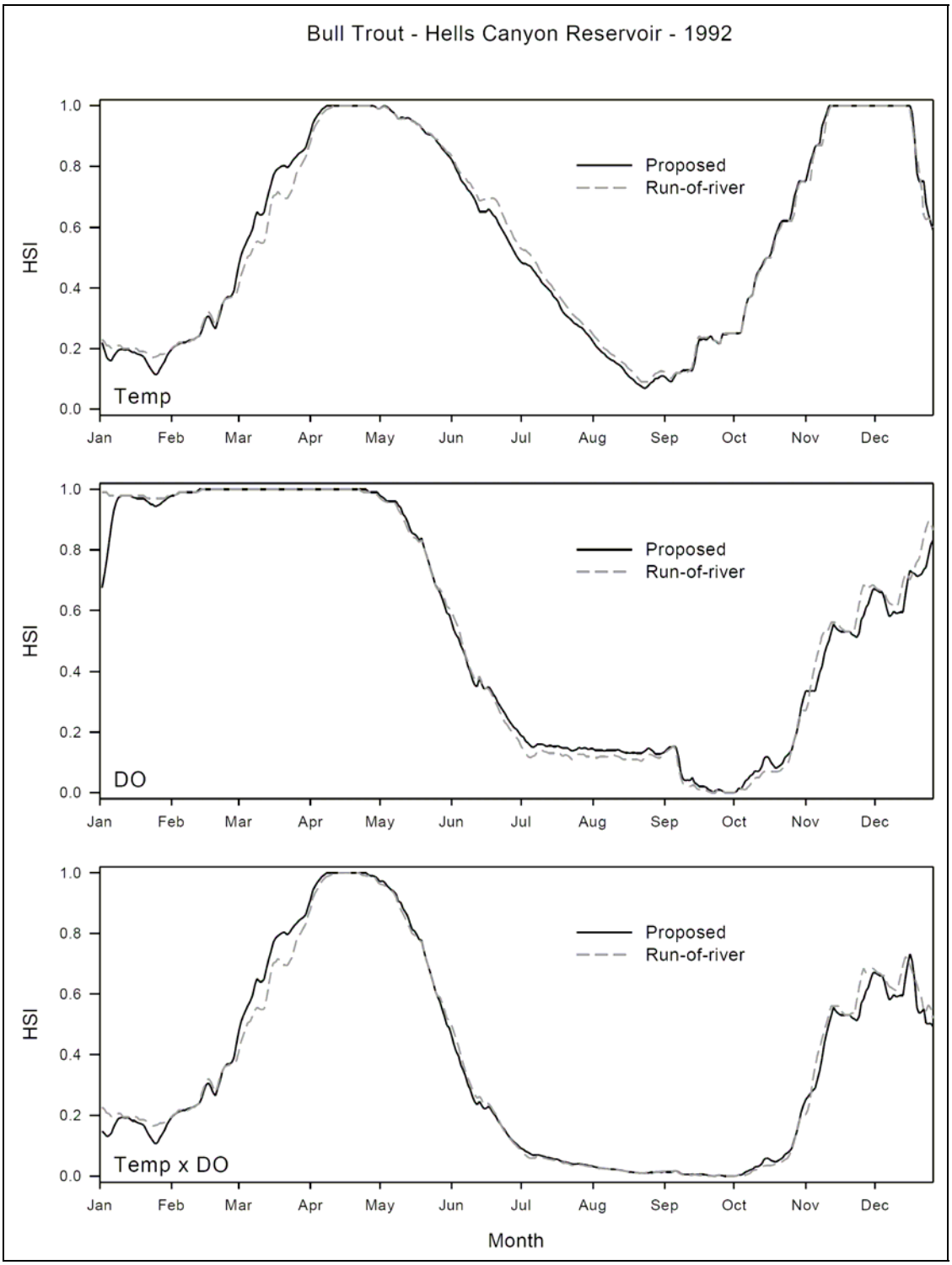


Figure 41. Time series of bull trout habitat suitability indices for temperature, dissolved oxygen and a composite score for temperature and dissolved oxygen at Hells Canyon reservoir during an extreme low flow hydrologic year (1992) and two operational scenarios (proposed and run-of-river full pool). (Source: Chandler, 2004)

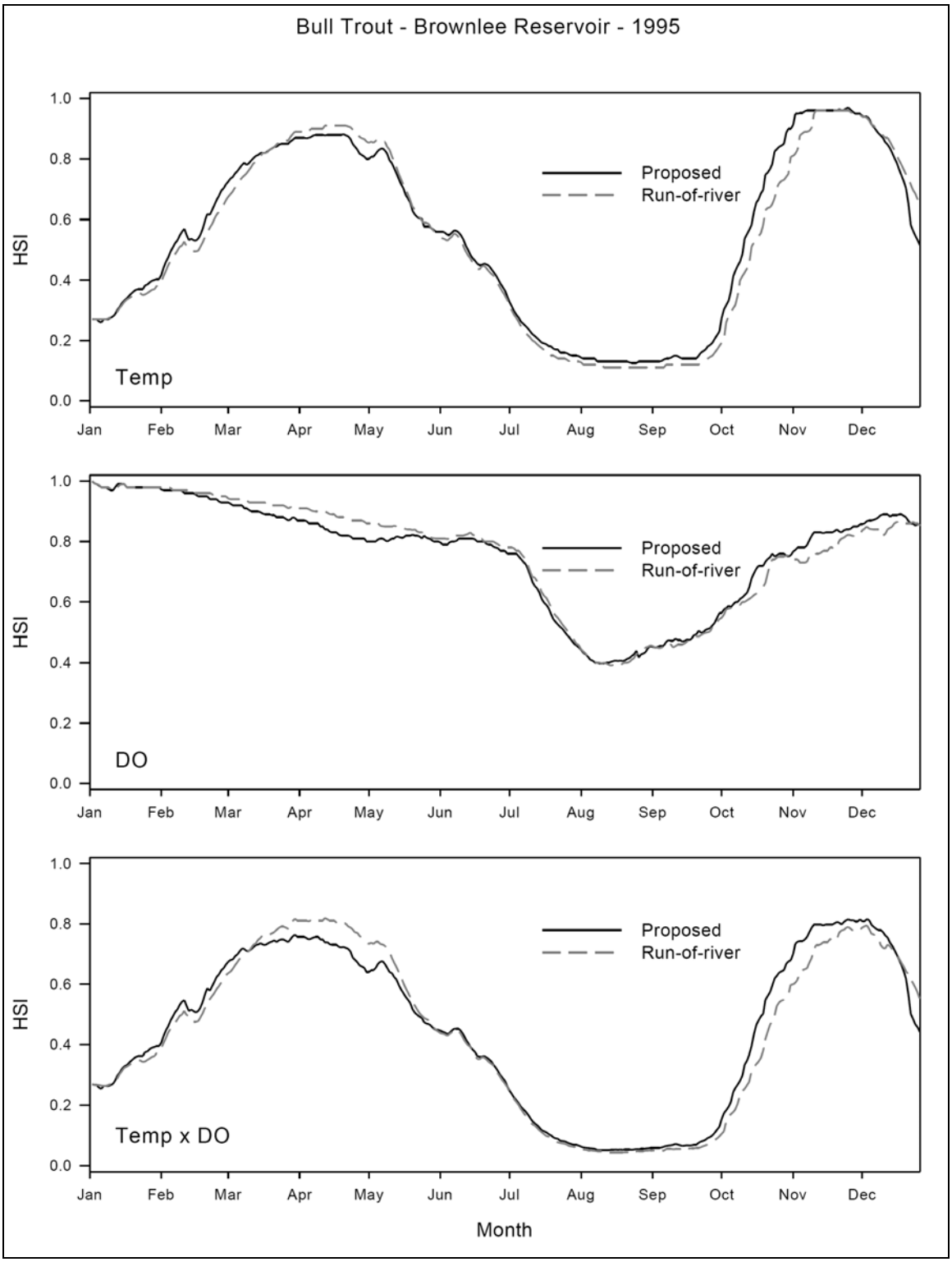


Figure 42 Time series of bull trout habitat suitability indices for temperature, dissolved oxygen and a composite score for temperature and dissolved oxygen at Brownlee reservoir during a medium flow hydrologic year (1995) and two operational scenarios (proposed and run-of-river full pool). (Source: Chandler, 2004)

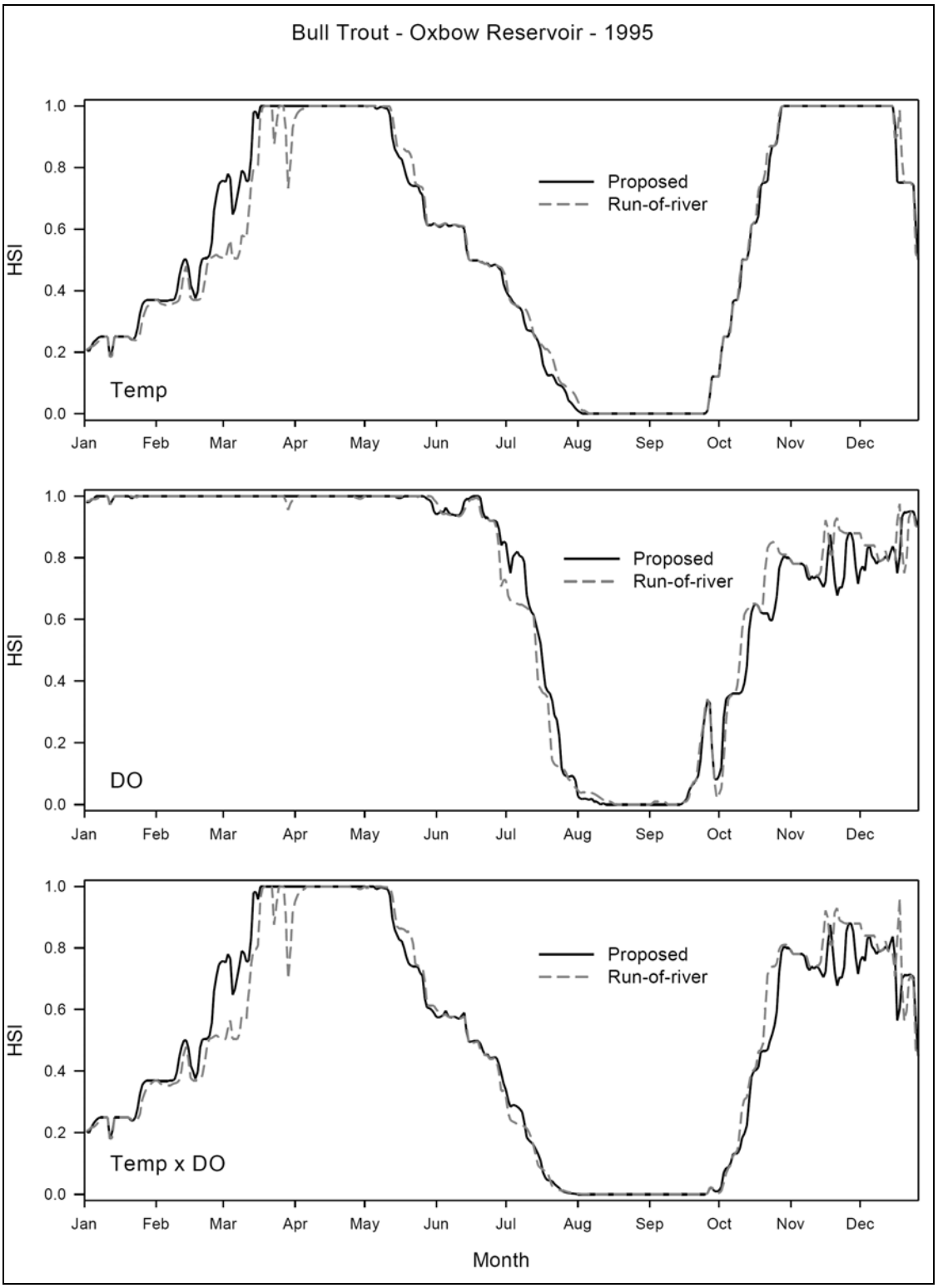


Figure 43. Time series of bull trout habitat suitability indices for temperature, dissolved oxygen and a composite score for temperature and dissolved oxygen at Oxbow reservoir during a medium flow hydrologic year (1995) and two operational scenarios (proposed and run-of-river full pool). (Source: Chandler, 2004)

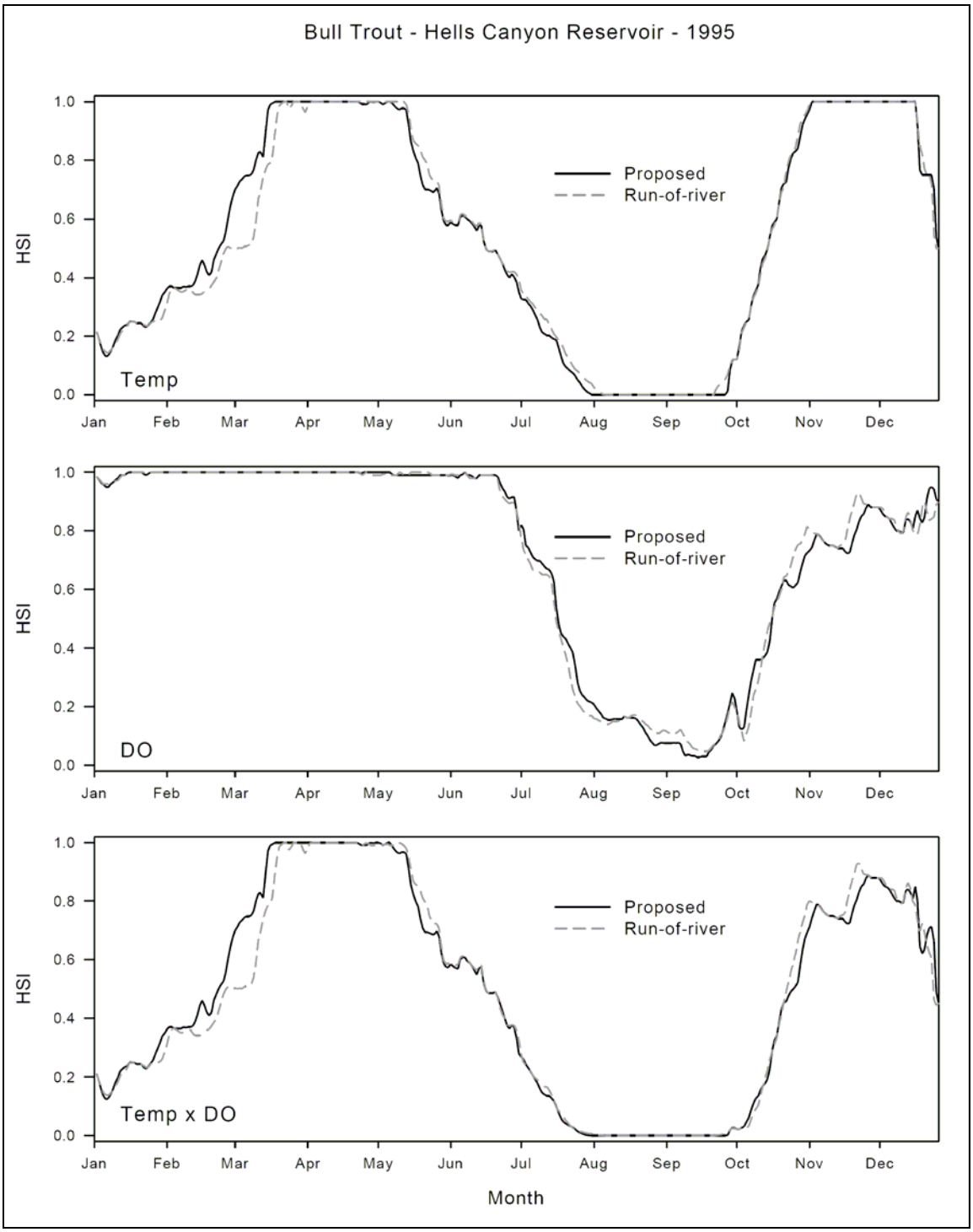


Figure 44. Time series of bull trout habitat suitability indices for temperature, dissolved oxygen and a composite score for temperature and dissolved oxygen at Hells Canyon reservoir during a medium flow hydrologic year (1995) and two operational scenarios (proposed and run-of-river full pool). (Source: Chandler, 2004)

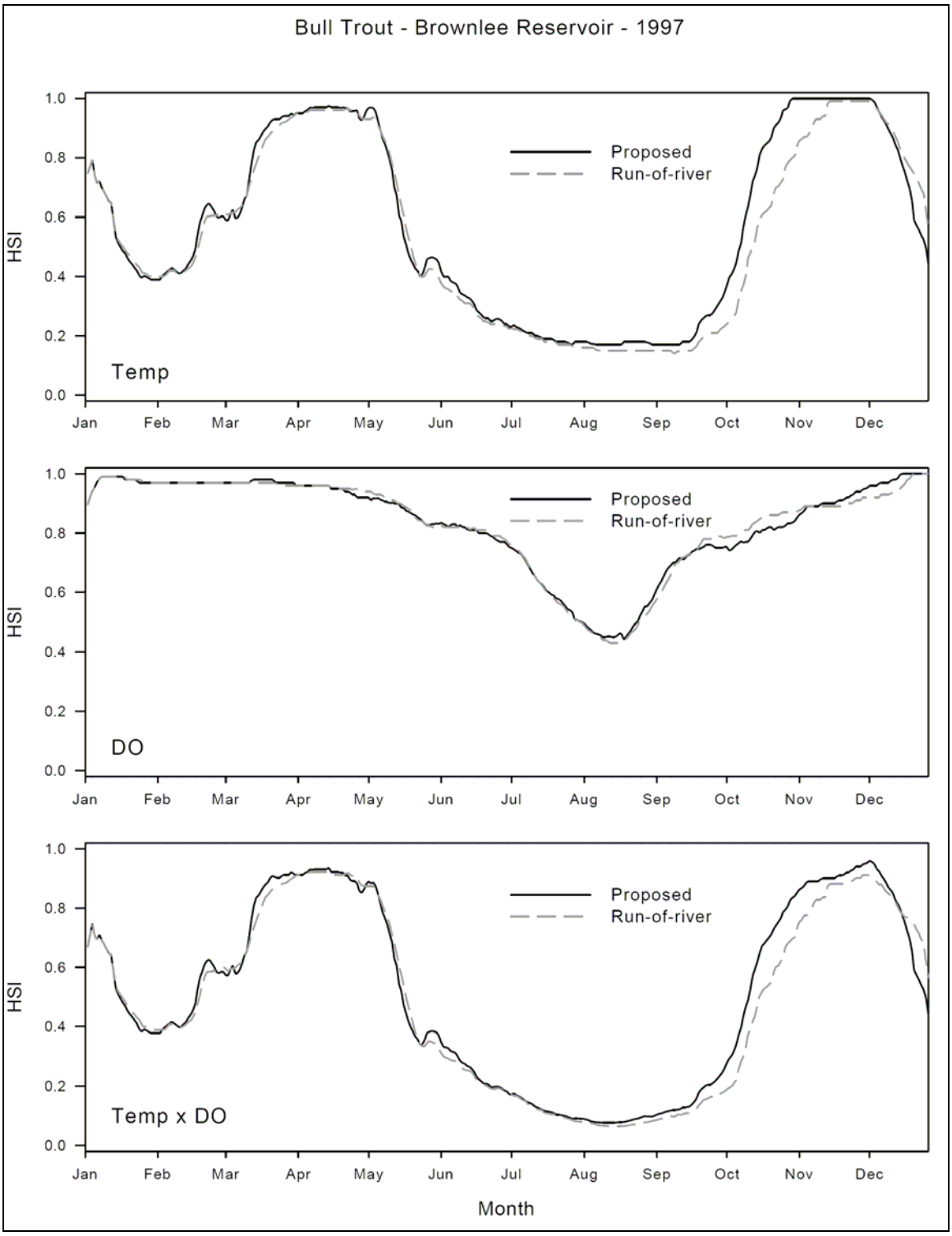


Figure 45. Time series of bull trout habitat suitability indices for temperature, dissolved oxygen and a composite score for temperature and dissolved oxygen at Brownlee reservoir during an extreme high flow hydrologic year (1997) and two operational scenarios (proposed and run-of-river full pool). (Source: Chandler, 2004)

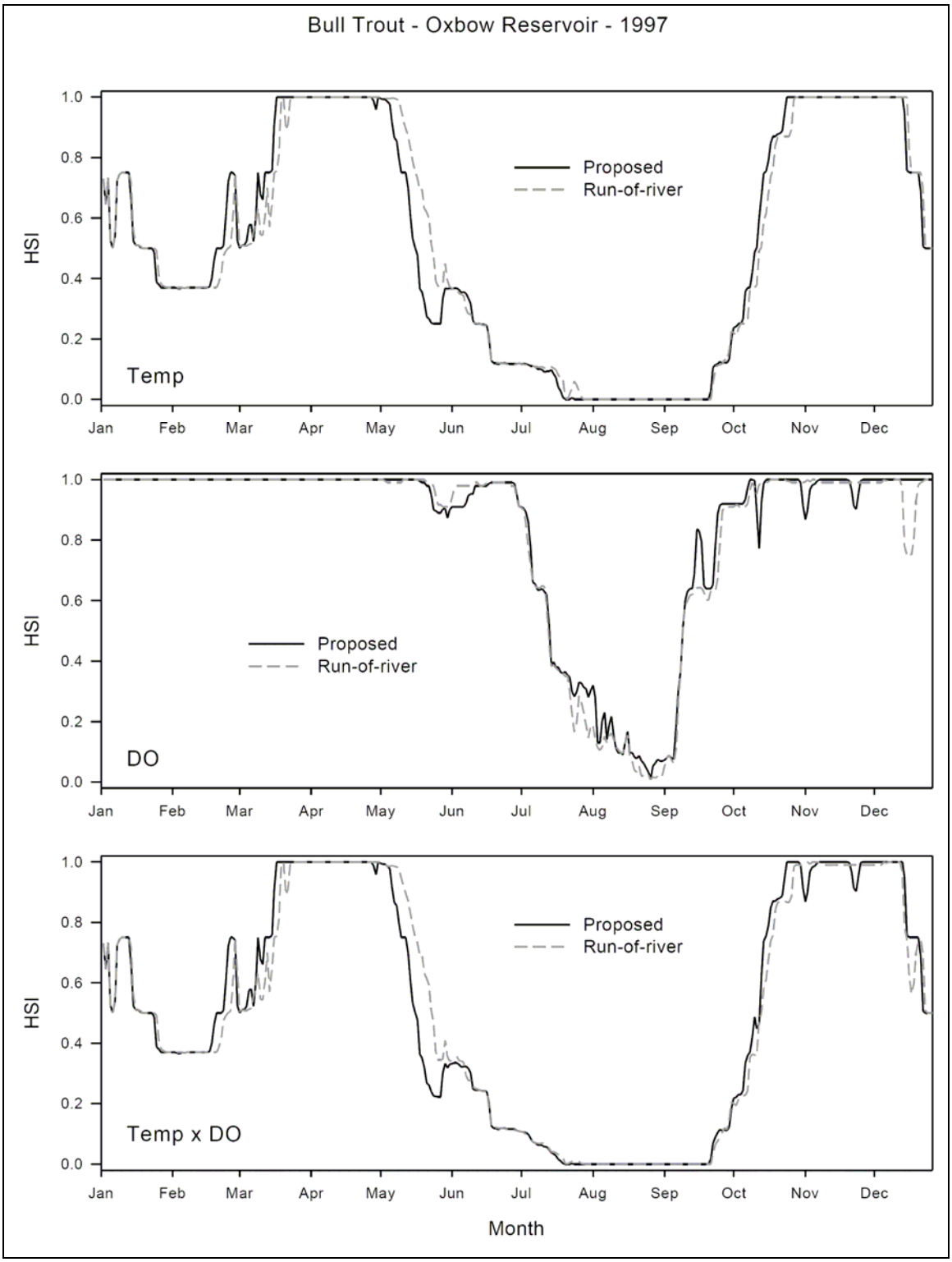


Figure 46. Time series of bull trout habitat suitability indices for temperature, dissolved oxygen and a composite score for temperature and dissolved oxygen at Oxbow reservoir during an extreme high flow hydrologic year (1997) and two operational scenarios (proposed and run-of-river full pool). (Source: Chandler, 2004)

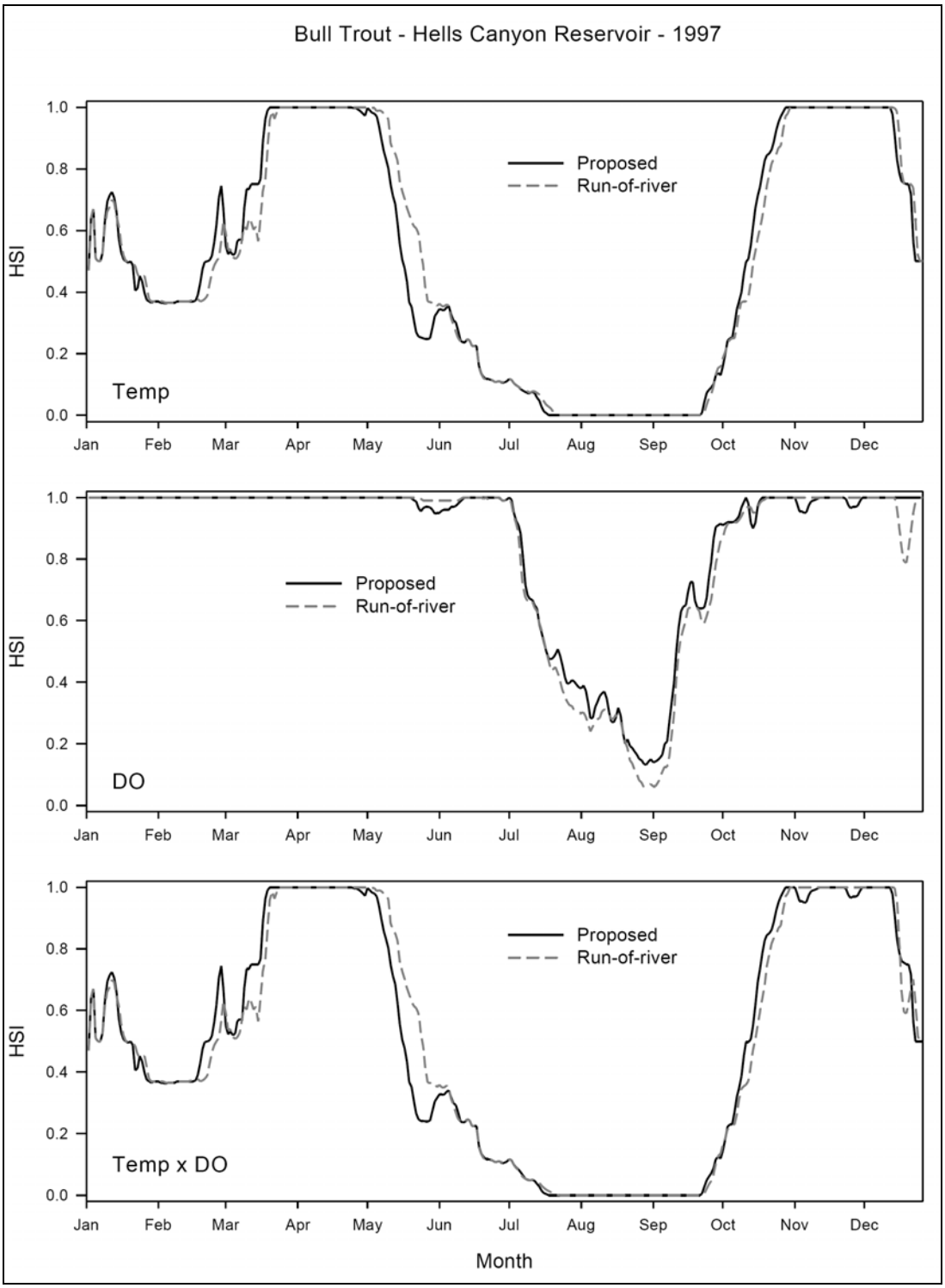


Figure 47. Time series of bull trout habitat suitability indices for temperature, dissolved oxygen and a composite score for temperature and dissolved oxygen at Hells Canyon reservoir during an extreme high flow hydrologic year (1997) and two operational scenarios (proposed and run-of-river full pool). (Source: Chandler, 2004)

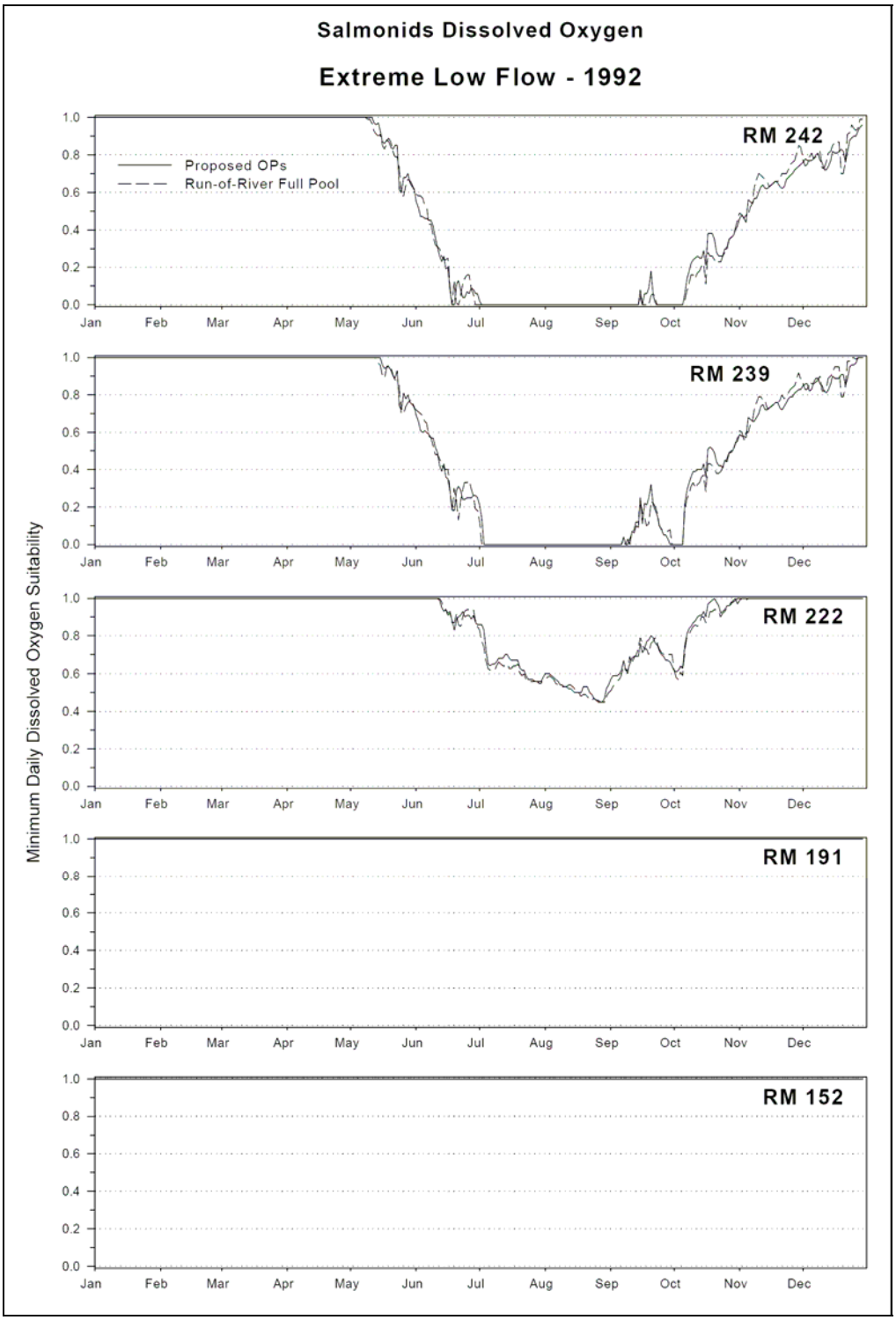


Figure 48. Dissolved oxygen suitability for all salmonids during the extreme low flow year of 1992 modeled under proposed operations and run-of-river full pool operations. Suitability time series are shown for RM 242 (near Hells Canyon dam), RM 239 (below Granite Rapids), RM 222, (near Salt Creek), RM 191 (above Salmon River), and RM 152 (near Asotin) of the Hells Canyon reach. (Source: Chandler, 2004)

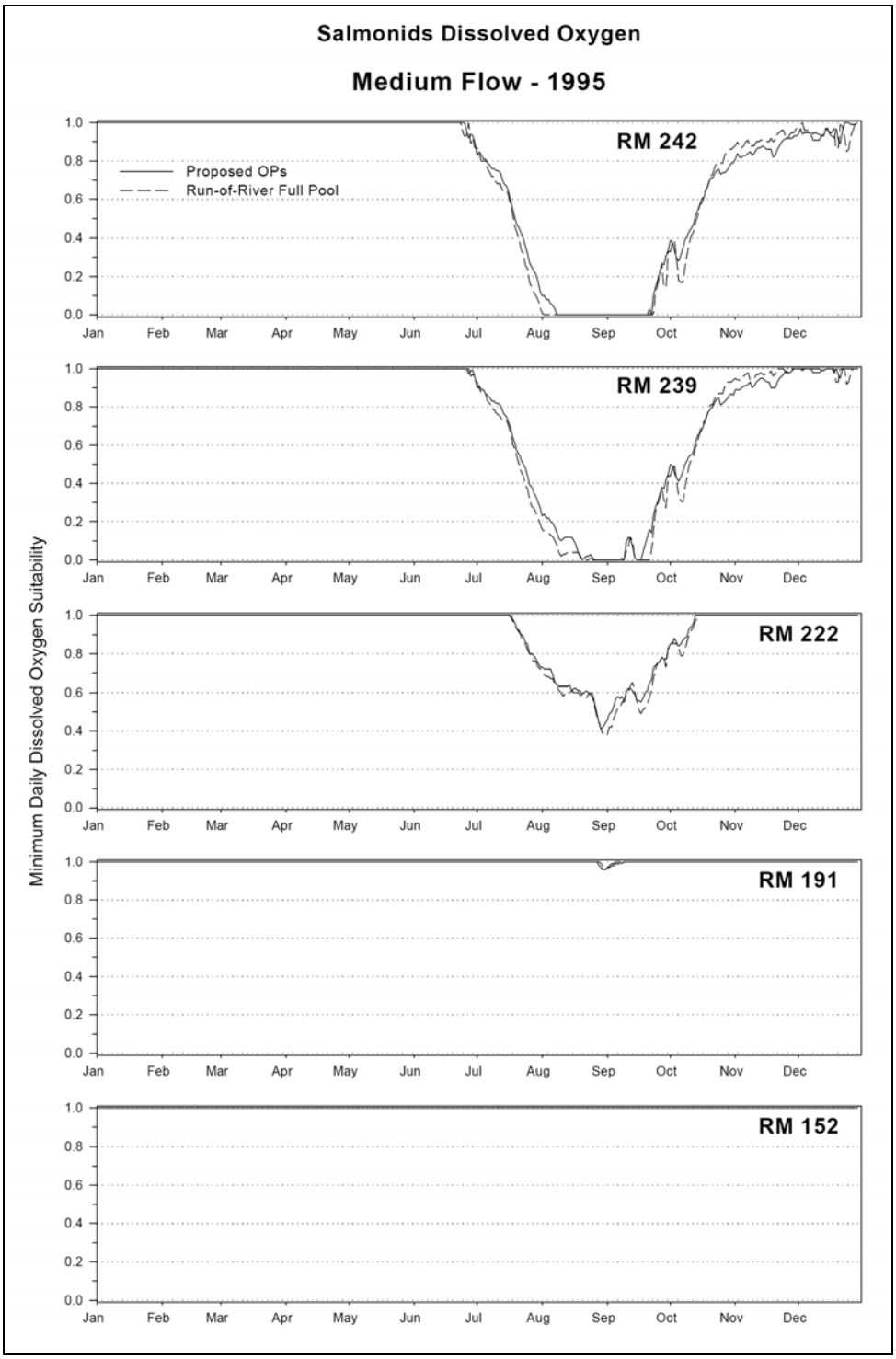


Figure 49. Dissolved oxygen suitability for all salmonids during the medium flow year of 1995 modeled under proposed operations and run-of-river full pool operations. Suitability time series are shown for RM 242 (near Hells Canyon dam), RM 239 (below Granite Rapids), RM 222, (near Salt Creek), RM 191 (above Salmon River), and RM 152 (near Asotin) of the Hells Canyon reach. (Source: Chandler, 2004)

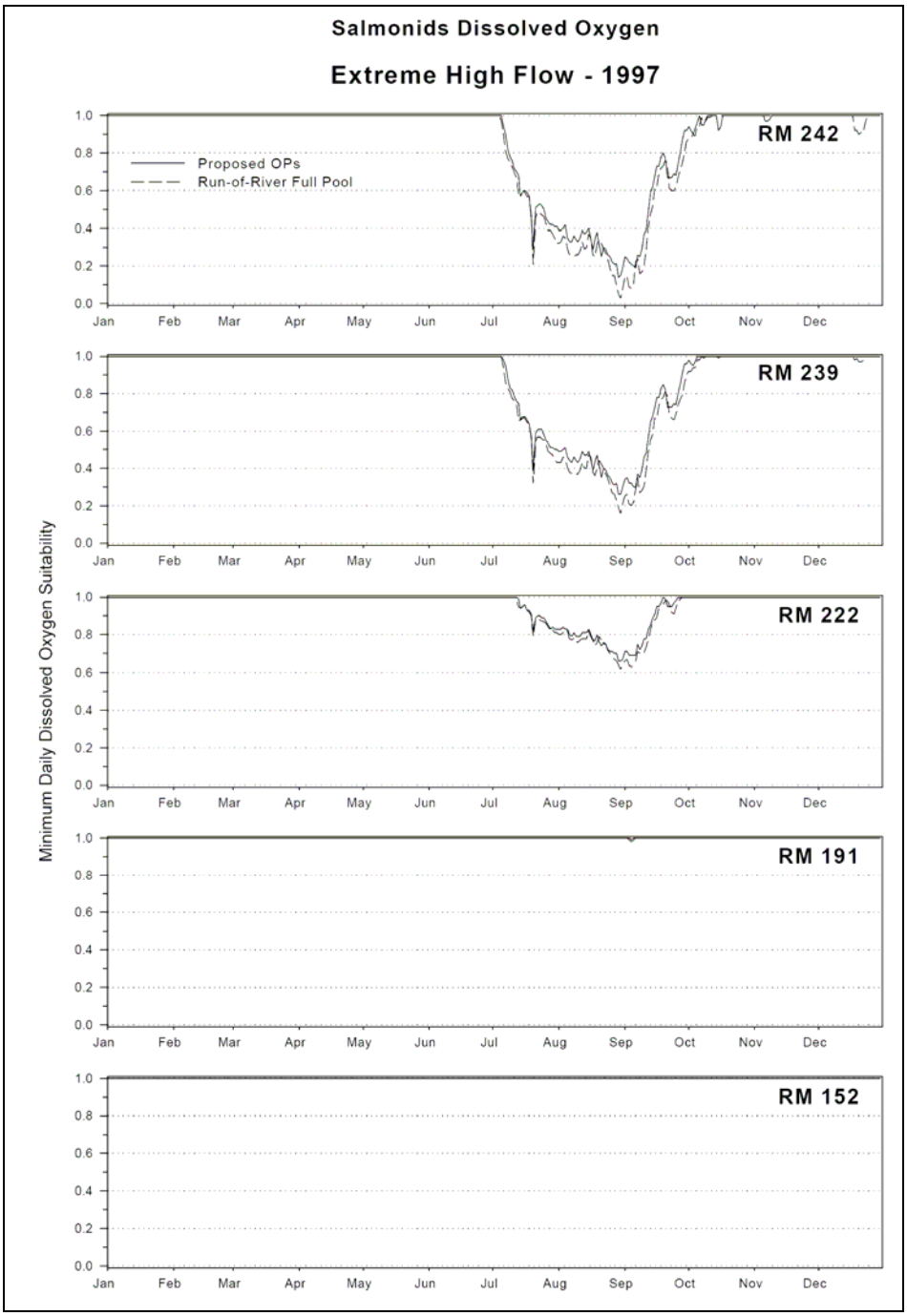


Figure 50. Dissolved oxygen suitability for all salmonids during the extreme high flow year of 1997 modeled under proposed operations and run-of-river full pool operations. Suitability time series are shown for RM 242 (near Hells Canyon dam), RM 239 (below Granite Rapids), RM 222, (near Salt Creek), RM 191 (above Salmon River), and RM 152 (near Asotin) of the Hells Canyon reach. (Source: Chandler, 2004)

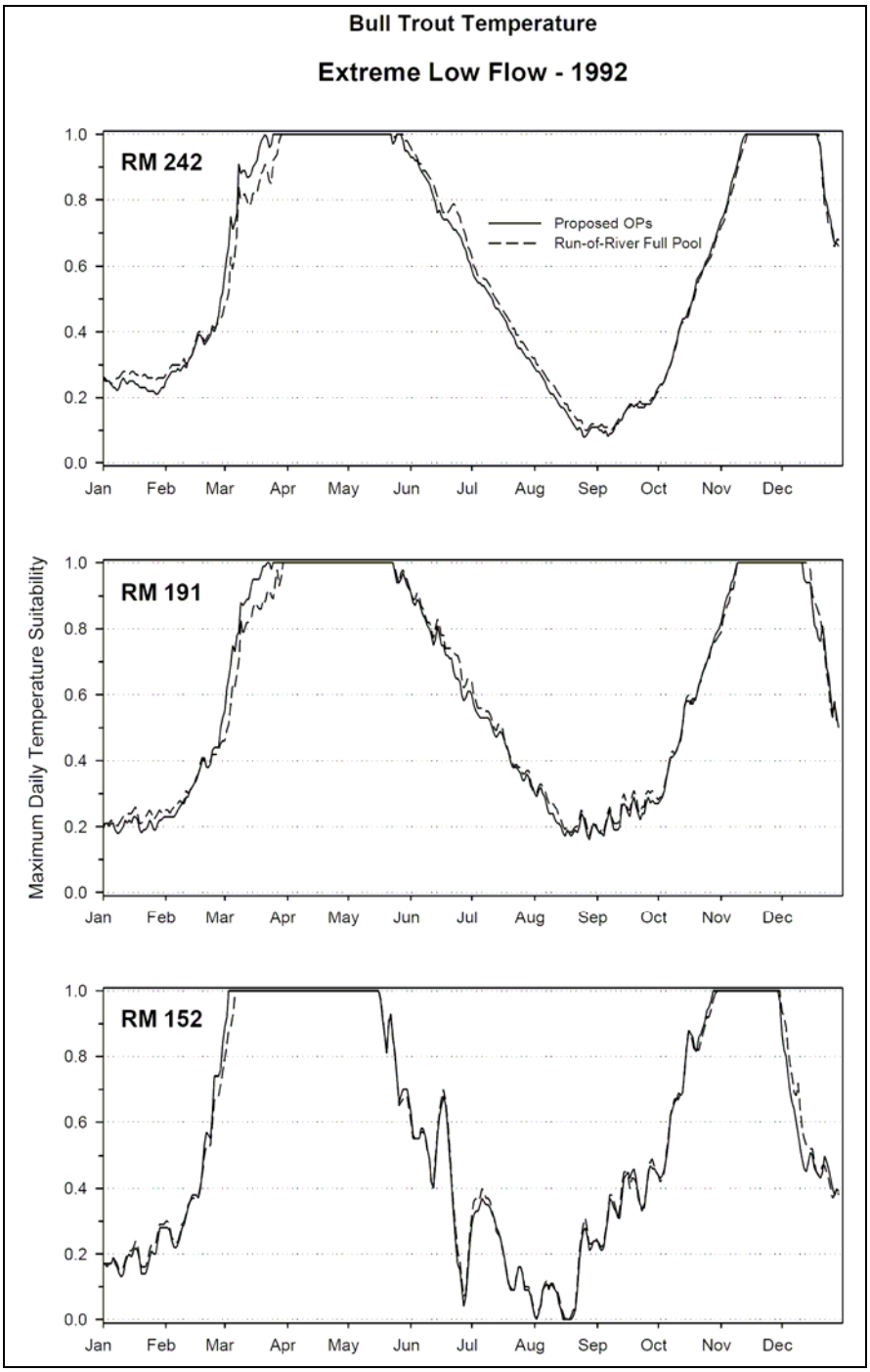


Figure 51. Time series of temperature suitability for bull trout during the extreme low flow year of 1992 modeled under proposed operations and run-of-river full pool operations. Suitability times series are shown for RM 242 (near Hells Canyon dam) RM 191 (above Salmon River), and RM 152 (near Asotin) of the Hells Canyon reach. (Source: Chandler, 2004)

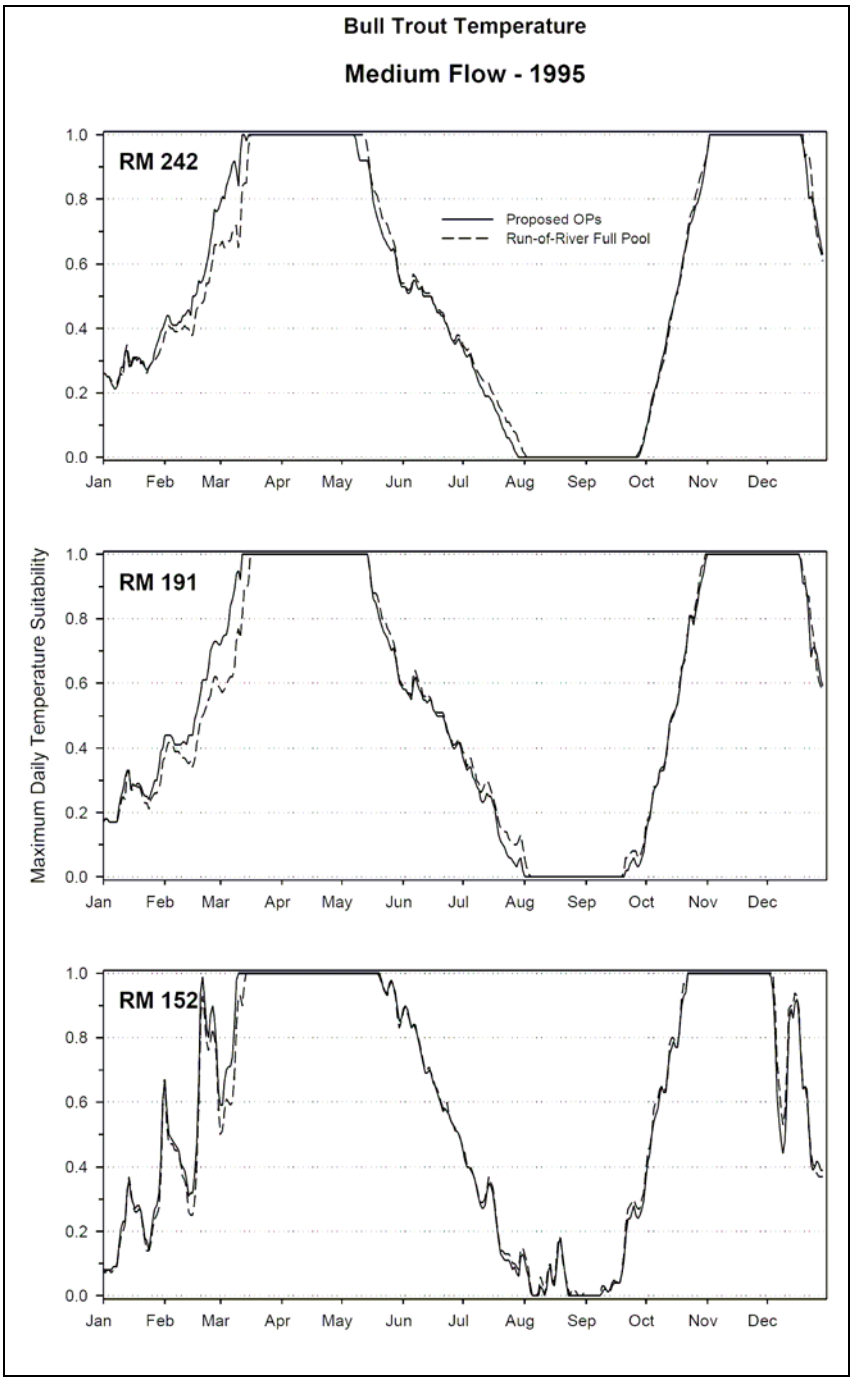


Figure 52. Time series of temperature suitability for bull trout during the medium flow year of 1995 modeled under proposed operations and run-of-river full pool operations. Suitability times series are shown for RM 242 (near Hells Canyon dam) RM 191 (above Salmon River), and RM 152 (near Asotin) of the Hells Canyon reach. (Source: Chandler, 2004)

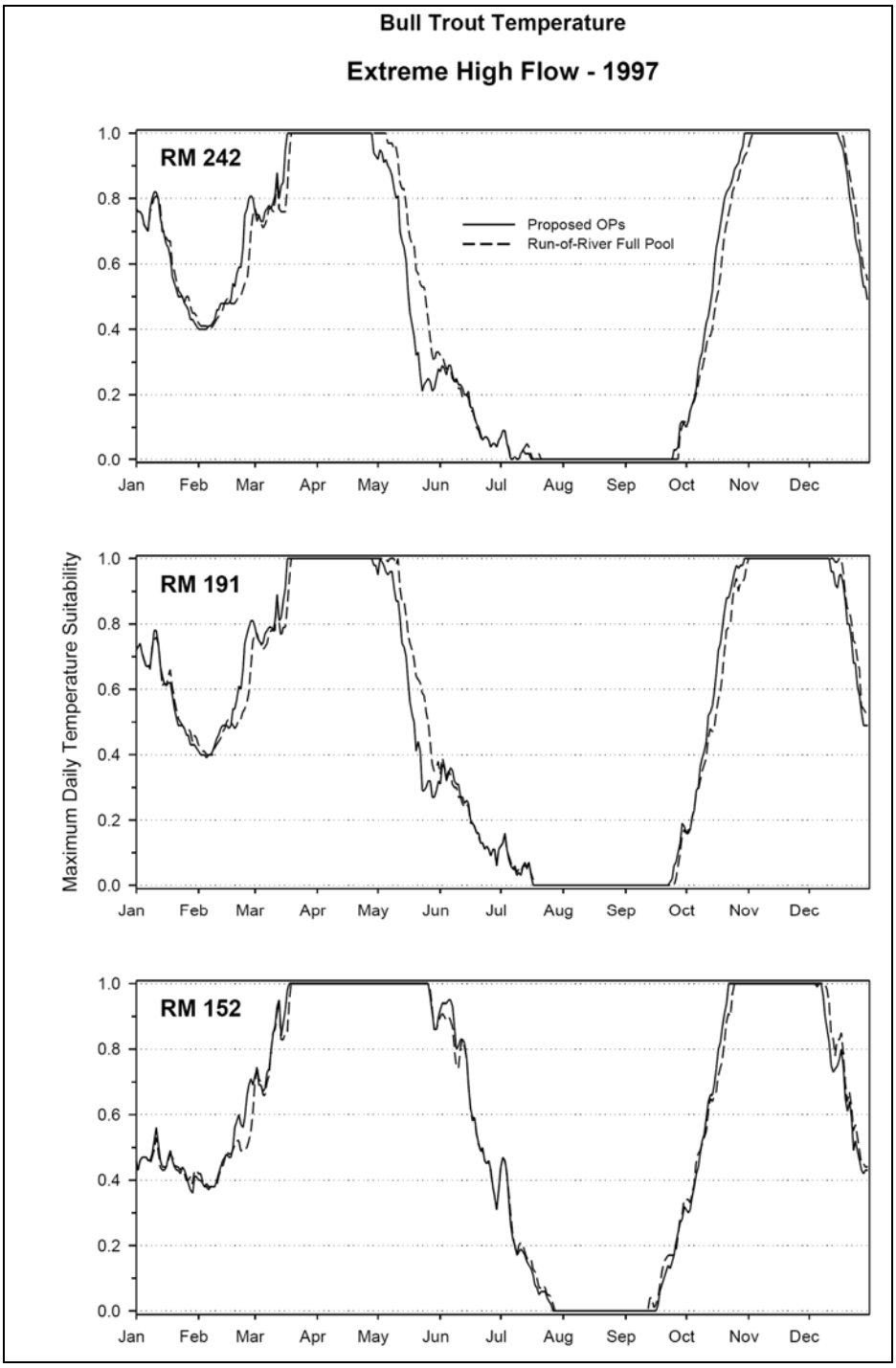


Figure 53. Dissolved oxygen suitability for all salmonids during the extreme high flow year of 1997 modeled under proposed operations and Run-of River Full Pool operations. Suitability time series are shown for RM 242 (near Hells Canyon dam), RM 239 (below Granite Rapids), RM 222, (near Salt Creek), RM 191 (above Salmon River), and RM 152 (near Asotin) of the Hells Canyon reach. (Source: Chandler, 2004)

Radio-telemetry and outmigrant trapping studies that Idaho Power conducted indicated that some bull trout in Indian and Pine creeks continue to exhibit a fluvial life history (Chandler et al., 2003a). The fluvial form appears to be less prevalent in the Wildhorse River, where only a single hybridized bull trout was collected during outmigrant trapping conducted in the fall of 2001. Electrofishing and radio-telemetry data indicate that bull trout used the Oxbow bypassed reach and Hells Canyon reservoir primarily during the late fall and winter, and migrated to tributaries between April and early June, presumably to oversummer and then spawn in the fall. Radio-tagged bull trout downstream of Hells Canyon dam exhibited classic fluvial behavior during both years of study, with many making spring migratory movements downstream to the Imnaha River after wintering in the Snake River. However, two bull trout tagged at the Sheep Creek trap moved into the Snake River and remained in the mainstem near the Sheep Creek confluence through the month of August. More detailed information on the habitat use and the status of bull trout populations in the project area can be found in Chandler et al. (2003d) and Chandler et al. (2003a), respectively.

Radio telemetry studies conducted by Chandler et al. (2003a) also provide some insight into the potential for bull trout to suffer mortality from entrainment through the turbines at the Brownlee, Oxbow, and Hells Canyon developments. Idaho Power used radio-tagged fish to monitor the movement of six bull trout within the project area upstream of Hells Canyon dam, including three bull trout collected within the Oxbow bypassed reach, two bull trout collected in the outmigrant trap on Indian Creek, and one captured in Hells Canyon reservoir just upstream of Hells Canyon dam. The movement of these fish was monitored for an average of 167.3 days (range: 37 to 285 days). None of the fish were detected downstream of Hells Canyon dam, indicating that the potential for entrainment mortality of bull trout that use Hells Canyon reservoir may be relatively limited.

Although no bull trout were radio-tagged and released upstream of Brownlee or Oxbow dams, some inference on entrainment potential is possible from the movements of radio-tagged redband trout that were tagged and released in all three reservoirs. A total of 27 radio-tagged redband trout were released upstream of Brownlee dam (captured in the Brownlee creek weir), 37 redband trout were released in the Oxbow reservoir (collected in the Wildhorse River weir and in Oxbow reservoir), and 68 redband trout were released between Hells Canyon and Oxbow dams (collected in the Indian Creek weir, the Oxbow bypassed reach or in Hells Canyon reservoir). A total of seven (5.3 percent) of these fish were subsequently detected in a downstream reservoir or river reach. Four fish released into Oxbow reservoir were later detected in the Oxbow bypassed reach, and three fish released into Hells Canyon reservoir were later detected downstream of Hells Canyon dam. All of these movements occurred during periods when the respective projects were spilling water, indicating that the fish most likely passed over the project spillways and were not entrained through the project powerhouses.

3.6.1.5 White Sturgeon

The white sturgeon (*Acipenser transmontanus*) is a large, long-lived, late-maturing fish that historically migrated between estuaries along the Pacific coast and large river systems, including the Fraser, Columbia, San Joaquin, and Sacramento rivers. Although white sturgeon may use the marine environment, they do not require access to salt water to complete their life cycle (PSMFC, 1992). White sturgeon inhabit 615 miles of the Snake River downstream of Shoshone Falls, and at least two of its major tributaries, the Salmon and Clearwater rivers. The white sturgeon is classified as a species of special concern by the state of Idaho.

Within the Snake River, some river segments have healthy, reproducing populations of white sturgeon, while others have no detectable recruitment. Many factors have contributed to the sturgeon's current status, including altered habitat, pollution, historical exploitation, and populations fragmented by dams. Snake River sturgeon populations in Idaho began declining as early as the late 1930s (Idaho Power, 2003b). At that time, three dams had been built on the Snake River downstream of Shoshone Falls (Swan Falls, Lower Salmon Falls, and Upper Salmon Falls). Overharvest was believed to be the

primary factor responsible for the decline, so fishing regulations were implemented beginning in 1943. Nine additional dams were constructed on the Snake River downstream of Shoshone Falls between the late 1940s and the mid-1970s, and these dams further divided the river habitat into smaller segments, several of which lacked free-flowing river habitat. With the exception of a small harvest fishery by the Nez Perce tribe, sturgeon in the Snake River have been managed as a catch-and-release fishery since 1972 (Idaho Power, 2003b).

Between 1991 and 2001, Idaho Power conducted extensive field studies to evaluate the population status and limiting factors affecting white sturgeon populations in a 427-mile-long reach of the Snake River extending from Shoshone Falls downstream to the confluence with the Salmon River. Studies of populations upstream of Swan Falls dam were completed as part of the pre-filing studies for four Idaho Power projects[63] located between Shoshone Falls and Swan Falls dam,[64] and studies of populations between Swan Falls dam and the Salmon River were conducted as part of the pre-filing studies associated with the Hells Canyon Project.

Idaho Power conducted more than 100,000 hours of sampling effort, primarily using setlines, to determine the status of sturgeon populations in each of nine inter-dam river segments extending from Shoshone Falls to Lower Granite dam. The number of sturgeon captured was sufficient to estimate the size of sturgeon populations in five out of the nine reaches (table 31). Of the nine populations that were studied, only the Bliss-C.J. Strike and Hells Canyon-Lower Granite reaches exhibited a balanced population structure indicative of a self-sustaining population with significant recruitment. Although sturgeon more than 70 cm long were relatively abundant in the Shoshone Falls-Upper Salmon Falls reach, 95 percent of the fish sampled in this reach were judged to be of hatchery origin.[65] Similarly, large sturgeon were relatively abundant in the C.J. Strike-Swan Falls reach, but few juvenile sturgeon were found, suggesting that the population in the C.J. Strike-Swan Falls reach may be supported primarily by the downstream movement of sturgeon produced in the Bliss-C.J. Strike reach. Idaho Power (2003b) estimated that approximately 2 percent of the population in the Bliss-C.J. Strike reach migrated downstream each year.

Table 31. Abundance estimates for white sturgeon populations in Snake River reaches from Shoshone Falls to Lower Granite dam. (Source: Idaho Power, 2003b)

Reach	Year	Number of Fish Sampled[a]	Population Estimate (95% Confidence Interval)	Density[b] (fish/km)
Shoshone Falls–Upper Salmon Falls	2001	224	777 > 70 cm (574–1,201)[c]	18
	1980–1981	14	--	<6
Upper Salmon Falls–Lower Salmon Falls	1980–1981	0	--	--
Lower Salmon Falls–Bliss	1993	38	--	--
	1980–1981	11	--	--

[63] The four upstream projects are Upper Salmon Falls (Project No. 2777), Lower Salmon Falls (Project No. 2061), Bliss (Project No. 1975), and C.J. Strike (Project No. 2055).

[64] We include information on the upstream populations to support our analysis of cumulative effects on white sturgeon, and of measures proposed in Idaho Power's Snake River White Sturgeon Conservation Plan.

[65] Idaho Power (2003b) reports that IDFG and the Nez Perce Tribe stocked 1,208 juvenile white sturgeon in the Shoshone Falls-Upper Salmon Falls reach and 1,774 juvenile sturgeon upstream of Shoshone Falls between 1989 and 1997.

Reach	Year	Number of Fish Sampled[a]	Population Estimate (95% Confidence Interval)	Density[b] (fish/km)
Bliss–C.J. Strike	2000	128	--	--
	1991–1993	669	2,662 > 80 cm (1,938–4,445)	30
	1979–1981	905	2,192 (1,479–4,276)	25
C.J. Strike–Swan Falls	2001	138	--	--
	1994–1996	330	726 > 90 cm (473–1,565)	17
Swan Falls–Brownlee	1996–1997	42	155 > 70 cm (70–621)[d]	7[d]
Brownlee–Oxbow	1998	0	--	--
Oxbow–Hells Canyon	1998	4	--	--
	1992	7	--	--
Hells Canyon–Lower Granite	1997–2000[e]	1,423	3,625 > 70 cm (3,050–4,536)	17
	1982–1984	331	3,955	23
	1972–1975	881	8,200–12,250	--

Notes: cm – centimeter
km – kilometer

[a] Not including recaptures.

[b] Density based on preliminary estimates of kilometers of usable habitat.

[c] 95% artificially propagated fish.

[d] Represents the segment of river from Swan Falls dam (RM 458) to Walters Ferry (RM 444).

[e] Population data combined from the 1997–2000 Idaho Power and Nez Perce Tribe sturgeon surveys.

In the vicinity of the Hells Canyon Project, the reach downstream of Hells Canyon dam supports the only substantial, self-sustaining population of white sturgeon. Although previous studies of this reach produced higher population estimates than Idaho Power's surveys (table 31), these previous surveys used dissimilar gear and sampling protocols and cannot be accurately compared. All three stock assessments have indicated positive and consistent recruitment trends, with juveniles dominating the population. Idaho Power's survey indicates that the abundance of larger fish has responded positively to implementation of catch-and-release regulations in 1972.

The reach between Swan Falls and Brownlee dams appears to be of sufficient length and includes the types of habitat that are needed to support white sturgeon spawning, recruitment, and rearing, but there are indications that sturgeon production in this reach may be water quality limited. These indications include a documented kill of at least 28 adult sturgeon in 1990, which was associated with high water temperatures and extremely low DO conditions in the upstream end of Brownlee reservoir (Idaho Power, 2003b). Sturgeon populations in the segments between Brownlee and Oxbow dams and between Oxbow and Hells Canyon dams appear to be limited by a lack of spawning habitat, and these reaches may not be of sufficient length to retain larvae during the drift phase that occurs shortly after hatching.

3.6.1.6 Reservoir Fisheries

Idaho Power conducted a series of electrofishing and angler surveys to assess the status of fisheries in the project reservoirs and in the Snake River upstream of Brownlee reservoir. Electrofishing surveys involved sampling six randomly selected 100-meter lengths of shoreline during the spring and fall in each reservoir and in the Snake River upstream of Brownlee reservoir. Sampling was conducted

between 1991 and 2000. Brownlee reservoir was sampled in all 10 years, and both Oxbow and Hells Canyon reservoirs were sampled annually from 1993 through 2000. The reach above Brownlee reservoir was sampled in 1995, 1996, 1997, and 2000. Fish population sampling was not conducted downstream of Hells Canyon dam to avoid the potential for injuring ESA-listed species in this reach.

Surveyors collected a total of 31 species during the electrofishing surveys, including 14 native and 17 non-native species (table 32). In all three of the reservoirs, smallmouth bass, white crappie and black crappie showed the highest average catch per unit effort (figure 54). Smallmouth bass showed the highest average catch per unit effort in Brownlee reservoir, while white crappie had the highest catch per unit effort in Oxbow and Hells Canyon reservoirs. Upstream of Brownlee reservoir, smallmouth bass had the highest average catch per unit effort, followed by largescale sucker and common carp.

Idaho Power conducted annual creel surveys in all three project reservoirs from 1994 through 1998, and again in 2000. The estimated average annual angler effort expended in each reservoir, as well as the estimated annual average catch and harvest by species, is given in table 33. On average, anglers spent an estimated 459,654 hours each year fishing in Brownlee reservoir, 71,145 hours fishing in Oxbow reservoir, and 85,907 hours fishing in Hells Canyon reservoir.

Crappie and bass were the most commonly caught species in all three reservoirs. The total estimated catch of bass averaged 528,548 fish annually, of which 391,341 fish were caught in Brownlee reservoir. The total estimated catch of crappie averaged 375,929 fish annually, about half of which were caught in Brownlee reservoir. Crappie comprised about half of the harvest in all three reservoirs, with an estimated average annual harvest of 173,024 fish. Catfish had the next highest harvest, with an estimated average harvest of 97,106 fish per year, of which an average of 77,173 fish were harvested from Brownlee reservoir. Among anglers interviewed, catfish was the primary target for 83 percent of the anglers in the upstream half of Brownlee reservoir, 31.7 percent of anglers in lower Brownlee reservoir, 29.6 percent of anglers in Oxbow reservoir, and 25.8 percent of the anglers in Hells Canyon reservoir (Brown, 2003a). Crappie were identified as the primary target of 5, 22.8, 27.5, and 28 percent of the anglers in upper and lower Brownlee, Oxbow, and Hells Canyon reservoirs, respectively.

3.6.1.7 Hells Canyon Riverine Fishery

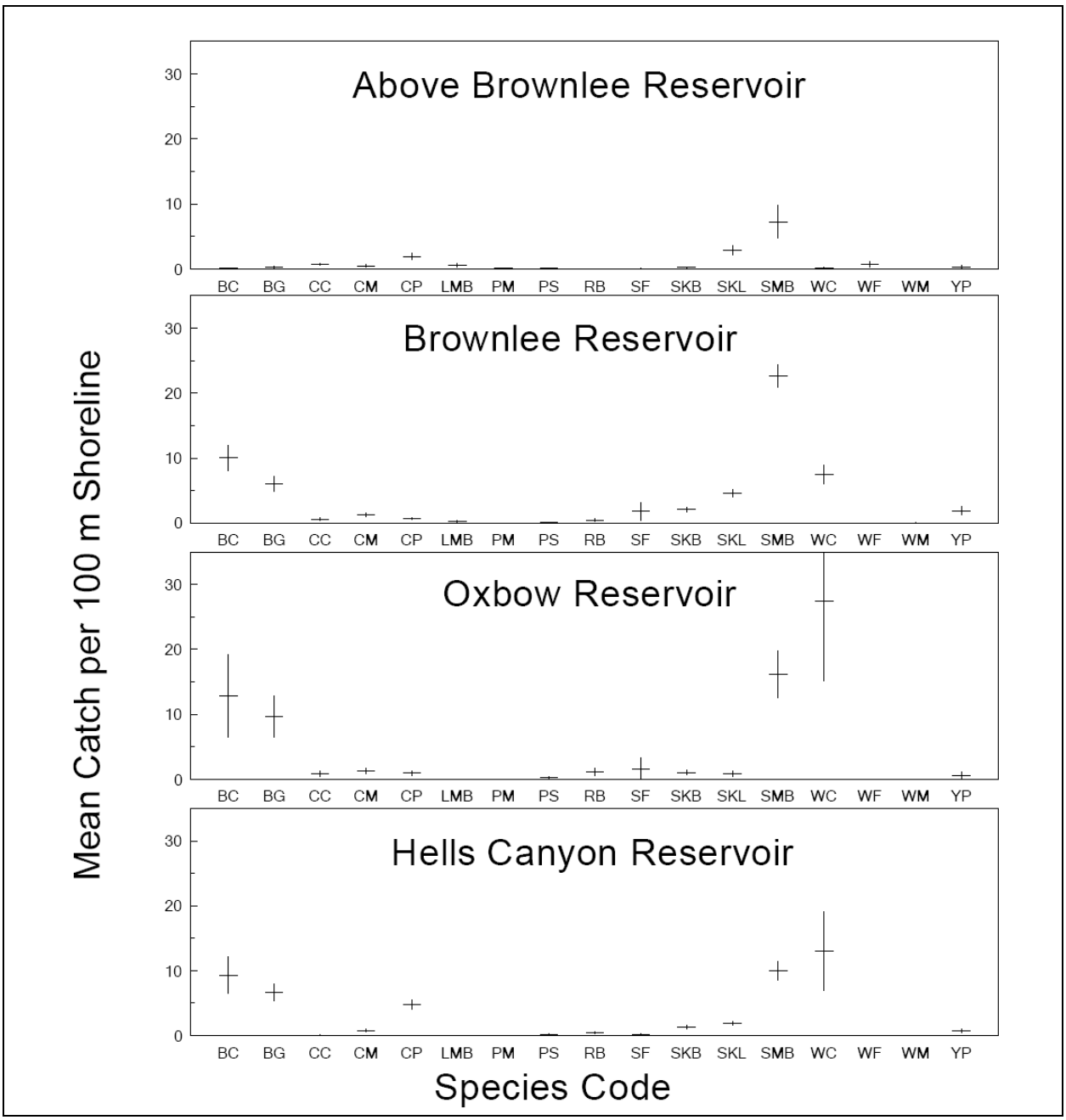
Idaho Power estimated that boat anglers that accessed the Hells Canyon reach from the three most heavily used boat ramps (Cache Creek, Hells Canyon Creek, and Pittsburg Landing) spent 183,000 hours angling in the Hells Canyon reach in 1994 (Brown, 2003b). The types of fish that were most commonly targeted by anglers fishing in the Hells Canyon reach were bass, which were mentioned as a target by 56 percent of the anglers surveyed, followed by trout (45 percent), steelhead (36 percent), white sturgeon (27 percent), “anything” (18 percent), catfish (11 percent) and crappie (4 percent). Anglers that accessed the Snake River at Hells Canyon dam, who primarily fished from the bank, spent an average of 15,356 hours angling each year between 1994 and 1997. The majority (65.9 percent) of the anglers that accessed the river from Hells Canyon dam targeted steelhead. The estimated catch of steelhead from this access point was 532 fish in 1995, 104 fish in 1996, and 1,021 fish in 1997 (Brown, 2003a).

Although Idaho Power did not provide an estimate of the number of steelhead caught by anglers that accessed the Hells Canyon reach from the three downstream boat ramps, they reported that 51,614 hours of fishing effort were directed at steelhead during 1999. Based on the angler effort, catch, and harvest rates presented in Brown (2003b), we estimate that anglers that accessed the Snake River from the Cache Creek, Hells Canyon Creek, and Pittsburg Landing boat ramps in 1999 caught approximately 10,000 steelhead, of which approximately 4,200 fish were harvested.

Table 32. Fish sampled in project reservoirs listed by species code, common and scientific names, and native or nonnative status. (Source: Richter and Chandler, 2003)

Code[a]	Common Name	Scientific Name	Status in Snake River
BK	Banded killifish	*Fundulus diaphanus*	Nonnative
BC	Black crappie	*Pomoxis negromacularus*	Nonnative
BLC	Blue catfish	*Ictalurus furcatus*	Nonnative
BG	Bluegill	*Lepomis macrochirus*	Nonnative
EB	Brook trout	*Salvelinus fontinalis*	Nonnative
BHB	Brown bullhead	*Ictalurus nebulosus*	Nonnative
CC	Channel catfish	*Ictalurus punctatus*	Nonnative
CM	Chiselmouth	*Acrochelius alutaceus*	Native
CO	Coho salmon	*Oncorhynchus kisutch*	Native
CP	Common carp	*Cyprinus carpio*	Nonnative
DB	Bull trout	*Salvelinus confluentus*	Native
DS	Dace spp.	*Rhinichthys* spp.	Native
FHC	Flathead catfish	*Pylodictis olivaris*	Nonnative
LMB	Largemouth bass	*Micropterus salmoides*	Nonnative
MFH	Fathead minnow	*Pimephales promelas*	Nonnative
MS	Mottled sculpin	*Cottus bairdi*	Native
MT	Tadpole madtom	*Noturus gyrinus*	Nonnative
PM	Peamouth	*Mylocheilus caurinus*	Native
PS	Pumkinseed	*Lepomis gibbosus*	Nonnative
RB	Rainbow trout	*Oncorhynchus mykiss*	Native
SF	Northern pikeminnow	*Ptychocheilus oregonensis*	Native
SKB	Bridgelip sucker	*Catostomus columbianus*	Native
SKL	Largescale sucker	*Catostomus macrocheilus*	Native
SMB	Smallmouth bass	*Micropterus dolomieui*	Nonnative
TC	Tui chub	*Gila bicolor*	Native
WC	White crappie	*Pomoxis annularis*	Nonnative
WF	Mountain whitefish	*Prosopium williamsoni*	Native
WM	Warmouth	*Lepomis gulosus*	Nonnative
UC	Utah chub	*Gila atraria*	Native
CL	Oriental weatherfish	*Misgurnus anguillicaudatus*	Nonnative
YP	Yellow perch	*Perca flavescens*	Nonnative

[a] These species codes are used in figure 54.



Note: See table 32 for scientific and common names for each species code.

Figure 54. Mean catch per unit effort for all years combined and selected species. (Source: Richter and Chandler, 2003)

Table 33. Estimated average annual angling effort, catch and harvest rates by species for 1994 through 1998, and 2000. (Source: Brown, 2003a, as modified by staff)

		Average Catch						
Location	**Effort (hours)**	**Bass**	**Bluegill**	**Catfish**	**Crappie**	**Yellow Perch**	**Trout**	**Total Catch**
Brownlee Total	459,654	391,341	18,022	97,683	189,503	19,610	1,480	716,159
Upper Brownlee	194,429	28,913	137	68,535	15,496	1,868	102	114,949
Lower Brownlee	265,225	362,428	17,885	29,149	174,007	17,742	1,378	601,210
Oxbow	71,145	80,681	3,484	13,034	65,950	3,516	4,092	166,664
Hells Canyon	85,907	56,526	14,460	19,641	120,476	17,639	2,536	228,741
	616,706	528,548	35,965	130,359	375,929	40,764	8,108	1,111,564

		Percentage of Total Catch						
Location	**% of Effort**	**Bass**	**Bluegill**	**Catfish**	**Crappie**	**Yellow Perch**	**Trout**	**Total Catch (%)**
Brownlee Total	74.5	54.6	2.5	13.6	26.5	2.7	0.2	100.0
Upper Brownlee	31.5	25.2	0.1	59.6	13.5	1.6	0.1	100.0
Lower Brownlee	43.0	60.3	3.0	4.8	28.9	3.0	0.2	100.0
Oxbow	11.5	48.4	2.1	7.8	39.6	2.1	2.5	100.0
Hells Canyon	13.9	24.7	6.3	8.6	52.7	7.7	1.1	100.0
	100.0	47.5	3.2	11.7	33.8	3.7	0.7	100.0

		Average Harvest						
Location	**Effort (hours)**	**Bass**	**Bluegill**	**Catfish**	**Crappie**	**Yellow Perch**	**Trout**	**Total Harvest**
Brownlee Total	459,654	24,060	13,024	77,173	96,729	7,181	1,138	218,167
Upper Brownlee	194,429	3,059	94	55,696	10,217	199	59	69,264
Lower Brownlee	265,225	21,001	12,931	21,477	86,512	6,982	1,079	148,902
Oxbow	71,145	2,147	2,196	7,647	27,543	1,522	1,818	41,056
Hells Canyon	85,907	3,660	9,976	12,285	48,752	12,471	1,345	87,143
	616,706	29,866	25,197	97,106	173,024	21,174	4,301	346,366

		Percentage of Total Harvest						
Location	**% of Effort**	**Bass**	**Bluegill**	**Catfish**	**Crappie**	**Yellow Perch**	**Trout**	**Total Catch (%)**
Brownlee Total	74.5	11.0	6.0	35.4	44.3	3.3	0.5	100.0
Upper Brownlee	31.5	4.4	0.1	80.4	14.8	0.3	0.1	100.0
Lower Brownlee	43.0	14.1	8.7	14.4	58.1	4.7	0.7	100.0
Oxbow	11.5	5.2	5.3	18.6	67.1	3.7	4.4	100.0
Hells Canyon	13.9	4.2	11.4	14.1	55.9	14.3	1.5	100.0
	100.0	8.6	7.3	28.0	50.0	6.1	1.2	100.0

3.6.1.8 Hatchery Operations

The management plans created by the fishery co-managers identified in the treaty fishing rights case *United States v Oregon* (NPCC, 2004) includes hatchery production programs for the upper Columbia sub-basins. The parties to *United States v Oregon* include the Yakama Nation, and the Warm Springs, Umatilla, and Nez Perce tribes, as well as NMFS, FWS, and the states of Oregon, Washington, and Idaho. The Shoshone-Bannock Tribes is admitted as a party for purposes of production and harvest in the upper Snake River only. These parties jointly develop harvest sharing and hatchery management plans that are entered as orders of the court, which are binding on the parties.

Idaho Power funds the operation of four hatcheries that produce steelhead and spring, summer and fall Chinook salmon. The hatchery system was constructed by Idaho Power between 1961 and 1967 to sustain anadromous fish runs after efforts to provide fish passage through the project were abandoned. The hatcheries were initially constructed to accommodate production levels based on the maximum counts of adult salmon and steelhead at Brownlee and Oxbow dams from 1957 to 1959. Production levels for the hatcheries were expanded in a 1980 settlement agreement between Idaho Power and the states of Idaho, Oregon, and Washington and NMFS. The 1980 Hells Canyon Settlement Agreement specifies the following annual smolt production targets: 1 million fall Chinook salmon, 4 million spring Chinook salmon, and 400,000 pounds of steelhead smolts. In 1985, IDFG modified the 4 million spring Chinook salmon target to 3 million spring Chinook salmon and 1 million summer Chinook salmon, in accordance with terms of the settlement agreement.

The four hatcheries are located on the mainstem of the Snake River upstream of Hells Canyon dam and on two tributaries in the Salmon River basin (figure 55). Adult fish are collected in traps located at Hells Canyon dam, on the Rapid River 1.5 miles downstream of the Rapid River fish hatchery, and at the lower Pahsimeroi hatchery facility. IDFG operates all four of the hatcheries.

The Hells Canyon upstream migrant fish trap is immediately downstream of Hells Canyon dam on the Oregon side of the Snake River. Hatchery-produced adult spring Chinook salmon and steelhead are captured at the trap and transported to the Oxbow fish hatchery. As a condition of the 1980 Hells Canyon Settlement Agreement, a floating barge trap is also maintained at Hells Canyon dam, which serves as a backup to the permanent trap and supplements the collection of adult spring Chinook salmon and steelhead. Since the permanent trap was constructed in 1983, the barge trap has not been used.

The Oxbow fish hatchery is located at the confluence of Pine Creek and Hells Canyon reservoir, just downstream of the Oxbow powerhouse. Spring Chinook salmon caught at the Hells Canyon trap are kept at the Oxbow fish hatchery temporarily, and then are transported to the Rapid River hatchery for spawning, incubation, and rearing. Adult steelhead are kept at the Oxbow fish hatchery until spawning. After spawning, half of the eggs are incubated through the fry stage and then are transferred to the Niagara fish hatchery for rearing. The other half of the inventory is transferred as eyed eggs.

The Rapid River hatchery is located approximately 3 miles upstream of the confluence of the Rapid and Little Salmon rivers. Spring Chinook salmon captured at the Rapid River and Hells Canyon fish traps are spawned at this hatchery, and the eggs are incubated and the fry reared to the smolt stage before they are released into the Rapid River and the Snake River downstream of Hells Canyon dam.

The Niagara Springs hatchery is used to rear steelhead to the smolt stage before they are released into the Snake River downstream of Hells Canyon dam, into the Pahsimeroi River near the Pahsimeroi fish hatchery, and into other streams as directed by IDFG.

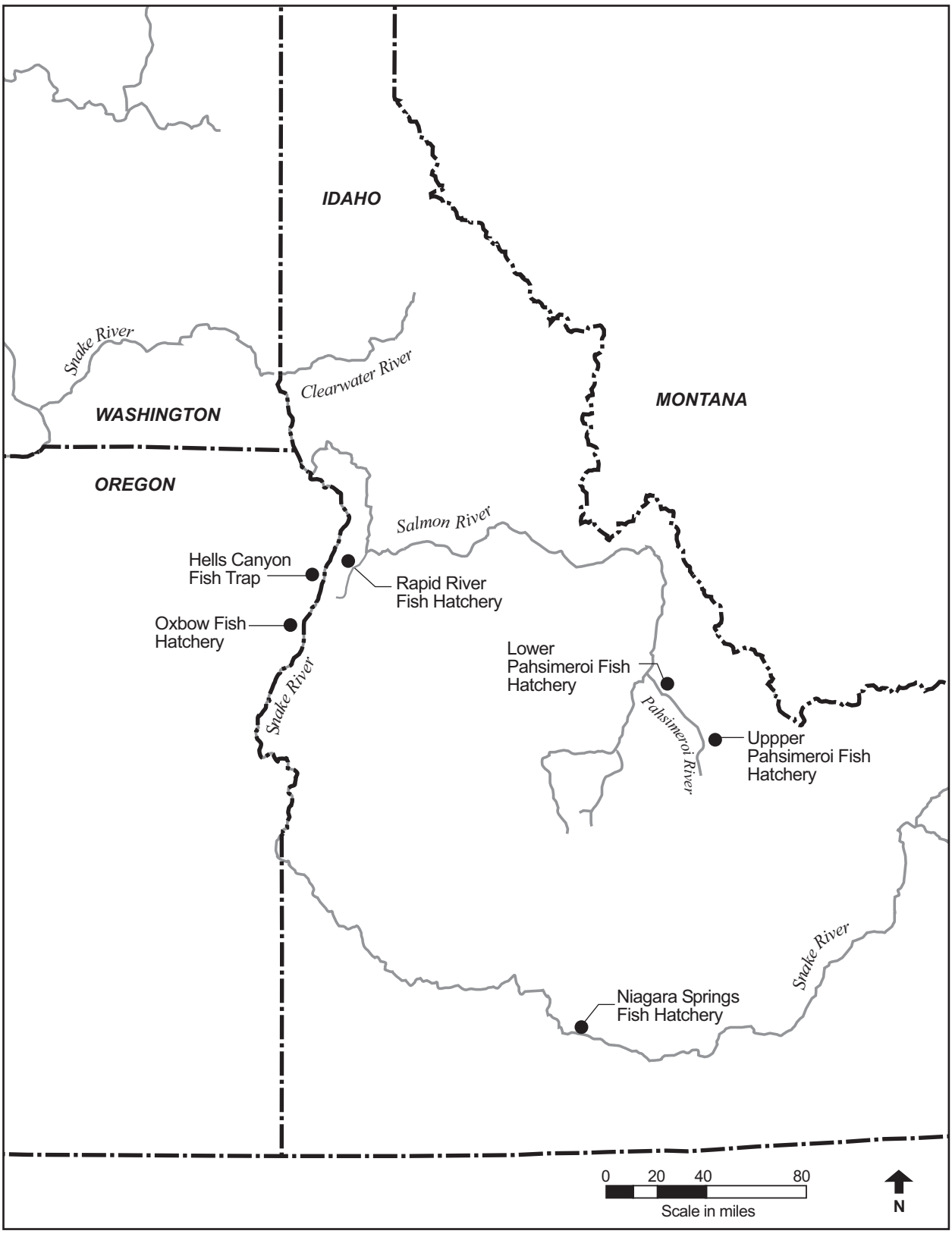


Figure 55. Location of Idaho Power hatchery facilities. (Source: Abbott and Stute, 2003)

The Pahsimeroi hatchery consists of two facilities located about 13 miles apart on the Pahsimeroi River. The hatchery has facilities to trap, spawn, and incubate steelhead and summer Chinook salmon. To limit the effects of whirling disease on fish reared at the hatchery, summer Chinook eggs produced there are incubated to the eyed stage on pathogen-free well water and then are transferred to IDFG's Sawtooth fish hatchery near Stanley, Idaho, for hatching and early rearing on well water. Summer Chinook salmon are then returned to the Pahsimeroi hatchery for final rearing before they are released into the Pahsimeroi River. The eggs from steelhead spawned at the Pahsimeroi hatchery are incubated at the Oxbow hatchery and reared at the Niagara Springs hatchery before they are released into the Pahsimeroi River at the lower facility, about 1 mile upstream of its confluence with the Salmon River.

Steelhead production from the Niagara Springs hatchery has generally been close to, and in some years, has exceeded the 400,000 pound production target specified in the 1980 Hells Canyon Settlement Agreement (table 34). From 1980 through 1999, the mean annual steelhead smolt production was 369,642 pounds or 1,819,621 fish (Abbott and Stute, 2003). During the early years of operation most of the steelhead smolts were released into the Pahsimeroi River, while in recent years almost half of the steelhead smolts have been stocked in the Snake River to improve the recreational steelhead fishery downstream of Hells Canyon dam.

Table 34. Distribution of steelhead smolts produced at Niagara Springs hatchery for brood years 1965 through 1999. (Source: Abbott and Stute, 2003)

Brood Year	Snake River[a]	Pahsimeroi River	Salmon River and Tributaries above the Middle Fork	Salmon River and Tributaries below the Middle Fork	Resident Stocking	Research	Total Number Produced	Total Pounds Produced
1966	616,913	1,292,402	72,440	0	0	0	1,981,755	153,552
1967	342,144	1,544,325	120,000	0	0	349,839	2,356,308	208,570
1968	109,200	1,665,117	0	0	0	0	1,774,317	184,186
1969	1,143,400	1,608,000	0	0	4,508	0	2,755,908	299,235
1970	670,960	1,630,002	0	0	208,069	0	2,509,031	204,803
1971	215,625	1,555,050	0	0	0	0	1,770,675	235,375
1972	848,700	1,543,349	2,159,964	0	0	4,171	4,556,184	163,839
1973	0	1,605,898	354,480	0	3,720	10,429	1,974,527	187,494
1974	0	1,331,280	0	0	0	536	1,331,816	166,640
1975	40,977	1,610,350	80,040	0	0	505	1,731,872	248,708
1976	126,000	1,448,681	0	0	0	1,622	1,576,303	251,835
1977	281,208	1,266,025	0	0	0	0	1,547,233	154,829
1978	344,944	1,372,454	0	0	0	100	1,717,498	244,887
1979	897,207	1,097,060	0	0	0	0	1,994,267	314,100
1980	612,760	862,494	0	0	0	0	1,475,254	316,330
1981	354,150	995,205	0	0	0	0	1,349,355	374,350
1982	92,750	496,140	546,250	0	0	0	1,135,140	181,150
1983	628,700	980,995	0	0	0	0	1,609,695	310,000
1984	952,912	878,530	394,651	0	61,100	0	2,287,193	313,450

Brood Year	Snake River[a]	Pahsimeroi River	Salmon River and Tributaries above the Middle Fork	Salmon River and Tributaries below the Middle Fork	Resident Stocking	Research	Total Number Produced	Total Pounds Produced
1985	1,150,015	614,038	246,440	0	0	0	2,010,493	339,885
1986	839,995	712,200	299,700	0	0	0	1,851,895	419,000
1987	1,281,400	665,800	206,300	0	0	0	2,153,500	405,515
1988	735,500	508,300	415,200	7,200	0	0	1,666,200	406,800
1989	947,200	501,600	401,800	655,700	0	0	2,506,300	476,170
1990	912,000	475,000	381,000	0	0	0	1,768,000	484,025
1991	660,964	504,300	0	282,300	0	0	1,447,564	305,286
1992	660,507	761,800	0	222,560	47,098	0	1,691,965	366,165
1993	609,115	379,948	334,941	214,092	0	0	1,538,096	350,101
1994	614,560	829,277	0	257,772	160,000	0	1,861,609	380,060
1995	630,152	799,220	0	304,123	157,600	0	1,891,095	352,750
1996	660,651	830,654	0	262,348	149,040	0	1,902,693	347,970
1997	653,276	801,541	0	199,007	0	0	1,653,824	361,745
1998	657,665	829,199	0	356,336	183,924	0	2,027,124	444,455
1999	601,907	830,316	0	372,312	760,889	0	2,565,424	457,626

[a] Includes fish stocked in Grande Ronde River (brood year 1966) and Clearwater River (brood year 1972).

The estimated adult contribution from steelhead produced at the Niagara Springs hatchery is shown in table 35. The average number of adult steelhead produced was estimated to be 12,552, and the top four categories of adult contribution were to Salmon River sport harvest (35 percent), Pahsimeroi hatchery rack (24 percent), Columbia River gillnet (21.3 percent) and Hells Canyon trap (11.9 percent). Abbott and Stute (2003) did not estimate the harvest of hatchery-produced steelhead in the Snake River upstream of the Salmon River. However, based on the angler effort and steelhead catch rates presented in Brown (2003b), anglers that accessed the Snake River from the Cache Creek, Hells Canyon Creek, and Pittsburg Landing boat ramps in 1999 caught approximately 10,000 steelhead, of which approximately 4,200 fish were harvested. Given the large number of smolts that are planted each year at Hells Canyon dam, it is likely that most of these steelhead were hatchery fish produced from the Niagara Springs hatchery.

Spring Chinook smolts are produced at the Rapid River (table 36) and Pahsimeroi hatcheries (table 37). Since 1992 when Pahsimeroi summer Chinook salmon were listed as threatened by NMFS, IDFG has operated the Pahsimeroi hatchery in a conservation mode aimed at species recovery. The combined production of spring and summer Chinook salmon at the Pahsimeroi and Rapid River hatcheries has averaged 2,892,649 smolts from 1981 through 1998, 72 percent of the production target of 4,000,000 smolts specified in the 1980 Hells Canyon Settlement Agreement. Summer Chinook salmon produced at the Pahsimeroi hatchery are released into the Pahsimeroi River. Most of the spring Chinook smolts have been released into the Rapid River, with a smaller number released into the Snake River downstream of Hells Canyon dam (table 36).

Table 35. Estimated adult contribution of steelhead produced at Niagara Springs hatchery from 1979 through 1998. (Source: Abbott and Stute, 2003)

Run Year	Coastal Gill Net	Columbia River Gill Net	Columbia River Sport	Commercial Seine	Estuary Sport	Foreign Research Vessel	Freshwater Sport	Hatchery Rack	Mixed Net and Seine	Ocean Sport	Ocean Trawl By-Catch	Ocean Troll	River Trap	Test Fishery Net	Treaty Ceremonial	Treaty Subsistence	Pahsimeroi Rack	Salmon River Harvest	Hells Canyon Rack	Snake River Harvest[a]	Run Year Total
1979	0	82	152	0	0	0	0	0	0	0	0	0	0	0	0	0	195	2,047	23	--	2,499
1980	0	76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,620	1,634	339	--	3,669
1981	0	1,448	71	0	0	0	152	15	19	0	0	0	46	0	0	0	3,491	3,347	158	--	8,746
1982	0	1,045	383	0	0	0	122	0	57	0	0	0	30	0	0	0	3,092	4,401	205	--	9,335
1983	0	935	290	0	0	0	1,387	28	33	21	0	0	21	0	28	113	4,651	10,171	872	--	18,550
1984	0	6,148	692	76	0	0	2,211	669	17	0	0	0	34	57	54	1,078	13,776	15,120	1,116	--	41,049
1985	0	4,126	17	0	0	0	69	138	0	0	0	0	0	0	0	612	4,237	4,569	1,343	--	15,111
1986	0	8,447	798	39	0	10	615	42	83	0	10	14	0	0	0	397	3,905	6,779	2,438	--	23,578
1987	0	9,099	1,000	0	0	0	62	62	0	0	0	0	0	0	0	0	5,274	11,691	3,209	--	30,397
1988	0	3,553	16	0	0	16	112	0	67	0	0	0	0	0	0	41	1,521	3,187	2,524	--	11,036
1989	0	4,175	587	0	0	0	0	0	0	0	0	0	0	0	0	0	1,760	4,774	2,729	--	14,025
1990	0	3,439	324	33	0	0	322	33	136	0	0	0	0	0	0	0	1,974	4,091	2,728	--	13,081
1991	0	882	0	37	0	0	147	0	33	0	0	0	0	0	0	152	693	318	1,151	--	3,413
1992	0	606	66	0	0	28	84	74	0	0	0	0	0	0	0	79	1,688	970	1,714	--	5,310
1993	0	3,882	875	0	0	0	197	72	0	0	0	0	0	9	0	0	2,756	2,246	1,259	--	11,295
1994	0	2,706	725	0	16	0	239	36	0	0	0	0	0	54	0	0	814	693	1,403	--	6,686
1995	16	1,156	280	0	0	0	320	226	33	0	0	0	0	0	19	0	1,401	1,259	1,597	--	6,306
1996	6	1,138	384	0	0	0	1,310	168	0	0	0	0	0	0	0	0	2,923	3,130	1,383	--	10,443
1997	0	415	212	0	0	0	747	83	0	0	0	0	0	0	0	0	2,182	3,730	1,270	--	8,640
1998	0	10	0	0	0	0	0	15	0	7	0	0	0	0	0	0	2,094	3,340	2,407	--	7,873
Total	22	53,368	6,872	185	16	54	8,096	1,661	478	28	10	14	131	120	101	2,472	60,047	87,497	29,868	--	251,042

[a] Idaho Power did not estimate angler harvest in the Snake River upstream of the Salmon River.

Table 36. Distribution of spring Chinook smolts released for mitigation purposes from the Rapid River hatchery for brood years 1964 through 1998. (Source: Abbott and Stute, 2003)

Brood Year	Females Spawned	Eggs Collected	Release Year	Smolts Released	
				Rapid River	Snake River
1964	197	887,616	1966	588,000	0
1965	133	603,800	1967	479,267	0
1966	621	2,296,000	1968	1,460,150	0
1967	518	2,055,000	1969	900,192	0
1968	1,809	6,640,000	1970	3,178,000	0
1969	1,415	5,171,697	1971	2,718,720	0
1970	3,520	14,560,280	1972	2,809,200	0
1971	1,722	6,038,785	1973	2,908,425	0
1972	3,825	15,072,604	1974	2,707,917	0
1973	3,454	13,510,465	1975	3,373,700	0
1974	1,756	6,890,186	1976	3,358,940	0
1975	2,184	8,503,606	1977	2,921,172	0
1976	3,055	11,492,878	1978	2,413,678	0
1977	3,781	14,160,330	1979	2,866,933	0
1978	2,350	10,026,888	1980	2,604,823	0
1979	1,141	5,648,722	1981	2,372,607	1,001,700
1980	543	1,756,827	1982	1,473,733	0
1981	1,666	6,122,273	1983	2,998,103	250,020
1982	1,883	7,482,330	1984	3,246,197	500,850
1983	859	3,449,471	1985	2,491,238	437,360
1984	821	3,125,911	1986	1,594,688	140,000
1985	2,962	11,082,369	1987	2,836,400	103,000
1986	2,451	10,673,138	1988	2,630,200	400,600
1987	1,310	5,656,145	1989	2,319,500	500,000
1988	1,645	7,905,702	1990	2,520,400	551,200
1989	1,082	4,478,045	1991	2,564,900	500,500
1990	1,063	4,217,103	1992	2,615,500	500,500
1991	657	2,553,218	1993	2,060,283	200,300
1992	1,177	4,534,400	1994	2,547,644	380,500
1993	1,737	7,103,037	1995	2,786,919	499,530
1994	116	490,249	1996	379,167	0

Brood Year	Females Spawned	Eggs Collected	Release Year	Smolts Released	
				Rapid River	Snake River
1995	35	132,001	1997	85,840	0
1996	329	1,171,610	1998	896,170	0
1997	1,138	4,472,573	1999	2,847,283	300,000
1998	723	3,409,130	2000	2,462,354	0
Total	53,678	213,374,389		79,018,243	6,266,060

Table 37. Distribution of summer and spring Chinook smolts released for mitigation purposes from the Pahsimeroi hatchery for brood years 1981 through 2000. (Source: Abbott and Stute, 2003)

Brood Year	Adults Trapped	Females Spawned	Eggs Collected	Eggs Received	Smolts Released
Summer Chinook					
1981	35	4	22,772	0	13,690
1982	39	13	75,402	0	55,803
1983	109	45	261,188	0	209,155
1984	37	4	23,999	0	12,095
1985	110	24	127,332	200,448	258,600
1986	345	106	476,281	374,041	598,500
1987	473	122	696,004	605,091	1,016,300
1988	838	164	1,053,536	317,272	1,058,000
1989	347	66	294,893	0	227,500
1990	470	151	662,641	0	605,900
1991	238	87	437,157	0	375,000
1992	131	35	172,139	0	130,510
1993	169	29	167,200	0	147,429
1994	36	0	0	0	0
1995	80	35	157,938	0	116,811
1996	89	18	85,660	0	65,648
1997	147	32	171,836	0	135,669
1998	127	13	74,105	0	53,837
1999	377	79	371,354	0	283,063
2000	459	123	633,906	0	0
Subtotal	4,656	1,150	5,965,343	1,496,852	5,363,510

Brood Year	Adults Trapped	Females Spawned	Eggs Collected	Eggs Received	Smolts Released
Spring Chinook					
1981	No data	0	0	616,823	437,332
1982	107	27	107,234	1,332,200	1,143,029
1983	232	75	279,398	0	178,782
1984	112	32	145,341	0	80,948
Subtotal	451	134	531,973	1,949,023	1,840,091
Grand Total	5,107	1,284	6,497,316	3,445,875	7,203,601

The estimated contribution of adult spring Chinook salmon produced from the Rapid River hatchery is shown in table 38. The average number of adult spring Chinook salmon produced was estimated to be 5,445, and the top four categories of adult contribution were to the Rapid River rack (62.6 percent), Nez Perce harvest (13.6 percent), Little Salmon sport fishery (8.8 percent) and Treaty ceremonial uses (5.5 percent). Because Chinook salmon smolts produced at the Pahsimeroi hatchery were not marked to differentiate them from wild fish in most years, Idaho Power was not able to estimate the adult contribution of spring and summer Chinook salmon produced at the Pahsimeroi hatchery.

Initial attempts to produce fall Chinook salmon at the Oxbow hatchery were impeded by high rates of pre-spawning mortality, and ultimately by low numbers of fish returning to the trap at Hells Canyon dam (table 39). In an effort to meet the annual production target of 1,000,000 fall Chinook smolts specified in the 1980 Hells Canyon Settlement Agreement, Idaho Power funded a portion of the construction cost of the Corps's Lyons Ferry Hatchery[66] in exchange for sufficient capacity within the hatchery to ensure the availability of 1.3 million eyed fall Chinook eggs annually. The agreement with the Corps included a provision that Idaho Power would not be entitled to any eggs until the hatchery had obtained 80 percent of its own egg quota. As a result of this provision and low numbers of fall Chinook salmon returning to the Snake River, Idaho Power did not receive any eggs from the Lyons Ferry hatchery until 2000, when 122,514 eggs were received, which were reared to produce 115,220 smolts (table 39).

3.6.2 Environmental Effects

3.6.2.1 Effects of Project Operations on Aquatic Resources

We describe Idaho Power's Proposed Operations in section 2.2.2, *Proposed Project Operations*, and we assess the effects of the proposed operation on reservoir levels and project outflows in section 3.3.2, *Effects of Project Operations on Water Quantity*. In section 3.3.2.2, we identify operation-related recommendations filed by agencies, tribes and other parties (table 9), and we describe three alternative operational scenarios that we use to assess the effects of the various operation-related recommendations. At our request, Idaho Power simulated project operations for these representative scenarios under various hydrologic conditions. Refer to section 3.3.2.2 for additional discussion of the scenarios and the modeling process used for the simulations. We use the results of these simulations to assess the effects of the operation-related recommendations.

[66] The Lyons Ferry hatchery was constructed in 1982 as part of the Lower Snake River Compensation Plan. It is located on the Snake River between Little Goose and Lower Monumental dams, near the confluence of the Palouse River.

Table 38. Estimated adult contribution of spring Chinook produced at the Rapid River hatchery from 1978 through 1998. (Source: Abbott and Stute, 2003)

Run Year	Ocean Troll	Columbia River Gill Net	Columbia River Sport	Test Fishery Net	Freshwater Sport	Hatchery Rack	Spawning Ground	River Trap	Treaty Ceremonial	Treaty Troll	Nez Perce Harvest	Little Salmon Sport	Rapid River Rack	Run Year Total
1978	0	0	0	0	121	26	0	0	0	0	0	1,309	5,769	7,225
1979	0	516	465	0	373	26	0	0	132	0	0	0	3,404	4,916
1980	0	0	0	0	0	13	0	0	20	0	0	0	1,960	1,993
1981	49	246	0	94	0	47	0	0	119	0	0	0	3,263	3,818
1982	0	107	221	117	0	0	0	0	58	0	0	0	3,676	4,179
1983	0	47	0	0	0	0	0	0	0	0	0	0	1,958	2,005
1984	0	87	0	41	0	0	0	0	53	0	100	0	2,356	2,637
1985	0	193	443	80	0	40	0	0	465	0	2,023	2,313	6,727	12,284
1986	0	296	390	130	0	0	0	0	723	0	1,855	1,430	6,723	11,547
1987	160	0	0	0	218	11	0	0	527	0	2,430	422	3,808	7,575
1988	24	2,226	1,350	111	0	88	6	0	892	0	3,520	692	3,780	12,689
1989	0	156	0	0	101	17	0	0	310	0	544	0	2,800	3,928
1990	0	29	435	33	54	0	0	0	383	0	970	565	2,606	5,076
1991	0	88	166	47	44	18	0	0	802	0	0	0	1,913	3,079
1992	0	54	153	0	72	38	0	0	265	0	643	499	2,466	4,190
1993	0	75	86	52	0	21	0	0	947	11	696	423	4,468	6,778
1994	0	48	0	0	0	0	0	0	33	0	0	0	265	346
1995	0	0	0	0	0	53	0	0	0	0	0	0	129	182
1996	0	0	0	0	13	59	0	0	76	0	0	0	1,412	1,560
1997	37	0	0	0	0	279	3	27	396	0	2,196	2,289	10,520	15,746
1998	0	28	0	0	0	92	13	0	77	0	618	172	1,591	2,591
Total	270	4,196	3,709	705	996	828	22	27	6,278	11	15,595	10,114	71,594	114,344

Table 39. Distribution of fall Chinook smolts produced at the Oxbow hatchery for brood years from 1961 through 2000. (Source: Abbott and Stute, 2003)

Brood Year	Adults Trapped	Adults Ponded	Prespawn Mortality (%)	Females Spawned	Eggs Collected	Number Eyed	Percent Eyed-up (%)	Eggs Distributed	Eggs Received	Smolts Released	Fry-to-Smolt Survival (%)
1961	6,658	2,022	63.0	398	1,668,900	1,466,752	87.89	329,552	0	601,636	52.91
1962	2,402	819	31.4	424	2,015,000	1,911,500	94.86	477,000	0	1,100,119	76.69
1963	945	614	54.6	202	774,000	558,100	72.11	0	0	495,540	88.79
1964	1,503	504	27.3	163	779,000	716,900	92.03	0	24,408	650,460	87.74
1965	1,584	1,576	63.8	119	545,200	497,000	91.16	0	0	214,720	43.20
1966	3,612	3,557	38.9	409	1,691,126	1,582,670	93.59	0	0	1,473,590	93.11
1967	1,249	1,235	64.7	217	821,890	798,900	97.20	0	0	202,350	25.33
1968	412	403	22.5	75	274,030	266,871	97.39	0	0	255,536	95.75
1969	50	50	No data	11	54,990	50,591	92.00	0	500,000	497,298	90.32
1970	48	12	100.0	0	0	0	NA	0	0	0	NA
1971	4	4	100.0	0	0	0	NA	0	0	0	NA
1972	7	2	100.0	0	0	0	NA	0	0	0	NA
1973	1	1	100.0	0	0	0	NA	0	0	0	NA
1974	15	0	NA	0	0	0	NA	0	0	0	NA
1975	13	0	NA	0	0	0	NA	0	0	0	NA
1976	0	0	NA	0	0	0	NA	0	0	0	NA
1977	4	0	NA	0	0	0	NA	0	0	0	NA
1978	1	0	NA	0	0	0	NA	0	0	0	NA
1979	8	0	NA	0	0	0	NA	0	0	0	NA
1980–1999[a]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2000	0	0	NA	0	0	0	NA	0	122,514	115,220	94.05

Note: NA – not applicable

[a] No production during this period.

In the following sections, we evaluate the effects of Idaho Power's Proposed Operations and of operation-related recommendations received from agencies, tribes and other parties on the following resources: (1) primary production and aquatic invertebrates; (2) anadromous fish spawning; (3) anadromous fish rearing; (4) anadromous fish migration; (5) native resident salmonids; (6) white sturgeon; and (7) warmwater fisheries.

Primary Production and Aquatic Macroinvertebrates

Flow fluctuations caused by project operations dewater aquatic habitats along the river margin, which may have adverse effects on periphyton and aquatic invertebrates, and could reduce the food base that is available to fish species including juvenile fall Chinook salmon, native resident salmonids, and white sturgeon. In this section, we evaluate the effects that proposed and alternative operations would have on primary production and aquatic macroinvertebrates based on differences in the timing and amount of aquatic habitat that would be dewatered.

Our Analysis

Numerous investigators have found that periphyton and invertebrate production can be greatly reduced in areas of the streambed that are subject to daily dewatering from load following operations (Gislason, 1985; Gersich, 1980; Brusven and Trihey, 1978; Fisher and LaVoy, 1972). Fisher and LaVoy (1972) reported a 35 percent decline in diversity and abundance (reduction to 65 percent of original numbers) of macroinvertebrates in habitats exposed only 13 percent of the time, reductions to 13 percent in habitats exposed 40 percent of the time, and reductions to 2 percent of the pre-exposure diversity and abundance when habitats were exposed for 70 percent of the time.

Brusven and Trihey (1978) found that insect colonization of newly inundated substrate required approximately 30 days to reach the standing crop of permanently submerged areas in the Clearwater River below Dworshak dam. Cumulative losses of invertebrates from continuous fluctuations can influence drift rates and overall density and diversity of the invertebrate community (Reiser et al., 2005).

To assess the proportion of the streambed that is subject to daily dewatering, we examined hourly plots of the total area of wetted streambed in the Hells Canyon reach and estimated the maximum percentage of streambed that was subject to dewatering under Proposed Operations, under the Year-round 2-Inches-Per-Hour Ramping Rate and Year-round 6-Inches-Per-Hour Ramping Rate sub-scenarios, and under the Flow Augmentation and Navigation scenarios. Plots of the wetted area of streambed upstream of the Salmon River modeled under three water year types are shown in figure 56 for Proposed Operations; figure 57 for Scenario 1b (Year-round 2-Inches-Per-Hour Ramping Rate); figure 58 for Scenario 1c (Year-round 6-Inches-Per-Hour Ramping Rate); figure 59 for the Flow Augmentation Scenario; and figure 60 for the Navigation Scenario. The same simulation results for the reach between the Salmon River and Lower Granite reservoir are shown in figures 61 through 65. The maximum percentage of the streambed that is subject to dewatering in each scenario, year and reach is summarized in table 40.

The maximum percentage of the streambed that was dewatered under Proposed Operations in the reach upstream of the Salmon River ranged between 7 percent in an extremely high water year and 12 percent in an extremely low water year. The maximum percentage of the streambed that was dewatered in the lower reach was typically 1 or 2 percent less than in the upper reach. The percentage of streambed dewatered under the Year-round 2 Inches-Per-Hour Ramping Rate was reduced to 3 percent or less in both reaches. The percentage of streambed dewatered under the year-round 6 inches-per-hour ramping rate was reduced to 7 percent above the Salmon River and 4 to 5 percent downstream of the Salmon River confluence. The percentage of streambed that was dewatered in the Flow Augmentation and Navigation scenarios was similar to Proposed Operations, except that the percentage of streambed that was dewatered in extremely high water years was somewhat increased in the upper reach and reduced in the lower reach.

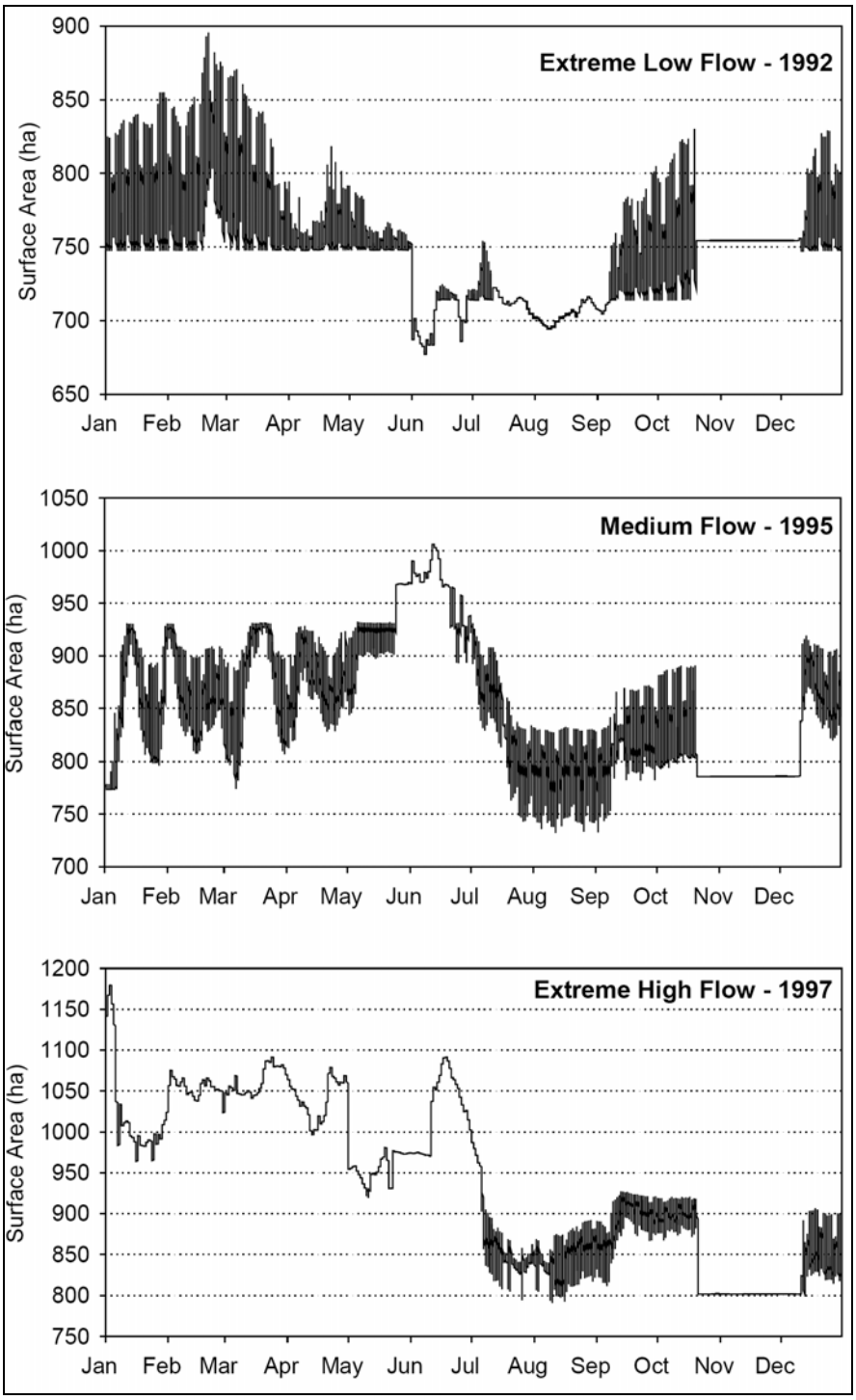


Figure 56. Hourly total wetted stream area predicted for the upper Hells Canyon reach (Hells Canyon dam to the Salmon River confluence) modeled under the Proposed Operations during the extremely low flow year of 1992 (top), the medium flow year (middle) and the extremely high flow year of 1997 (bottom). (Source: Brink and Chandler, 2005)

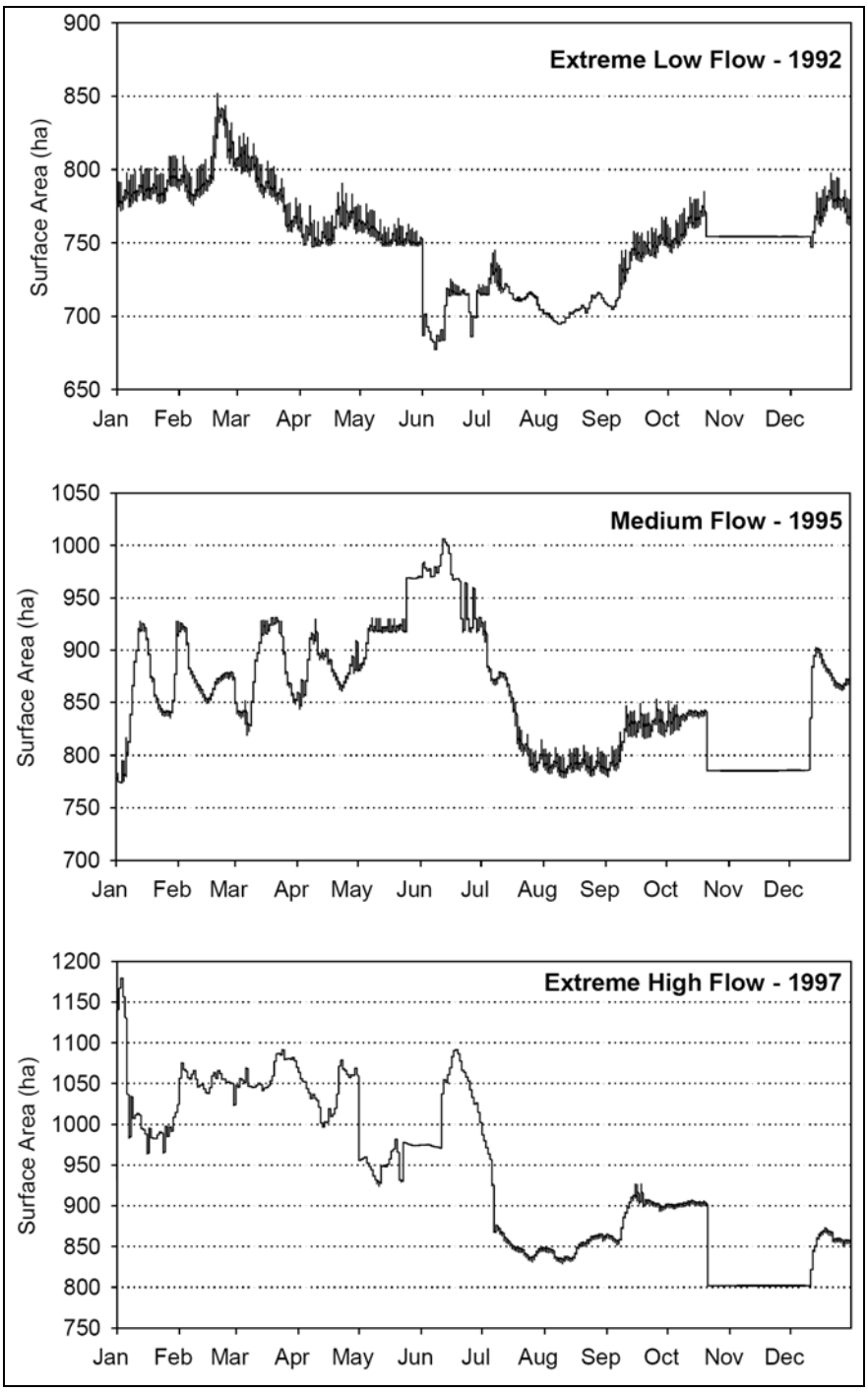


Figure 57. Hourly total wetted stream area predicted for the upper Hells Canyon reach (Hells Canyon dam to the Salmon River confluence) modeled under Scenario 1b, Year-round 2-Inches-Per-Hour Ramping Rate, during the extremely low flow year of 1992 (top), the medium flow year (middle) and the extremely high flow year of 1997 (bottom). (Source: Brink and Chandler, 2005)

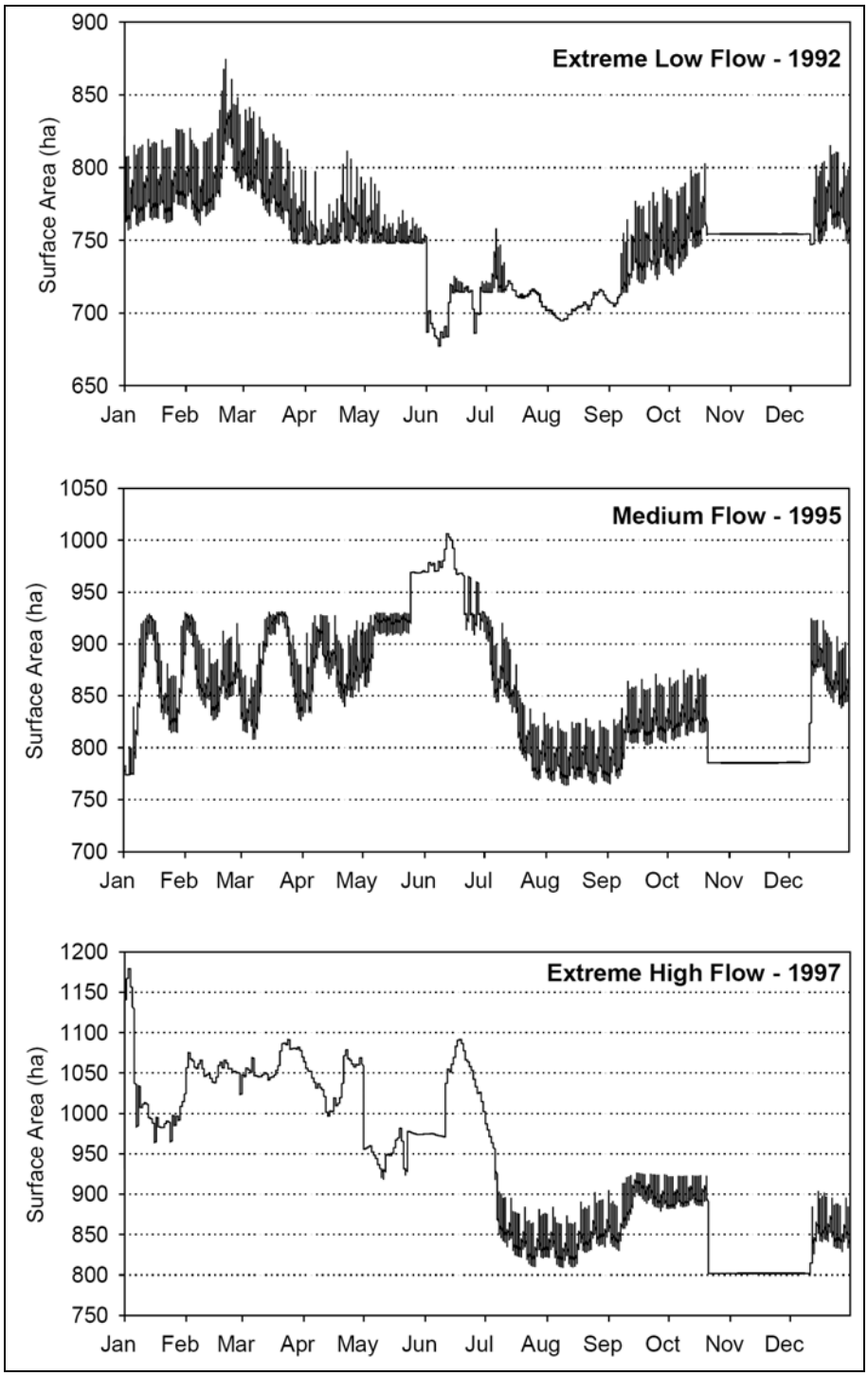


Figure 58. Hourly total wetted stream area predicted for the upper Hells Canyon reach (Hells Canyon dam to the Salmon River confluence) modeled under Scenario 1c, Year-round 6-Inches-Per-Hour Ramping Rate, during the extremely low flow year of 1992 (top), the medium flow year (middle) and the extremely high flow year of 1997 (bottom). (Source: Brink and Chandler, 2005)

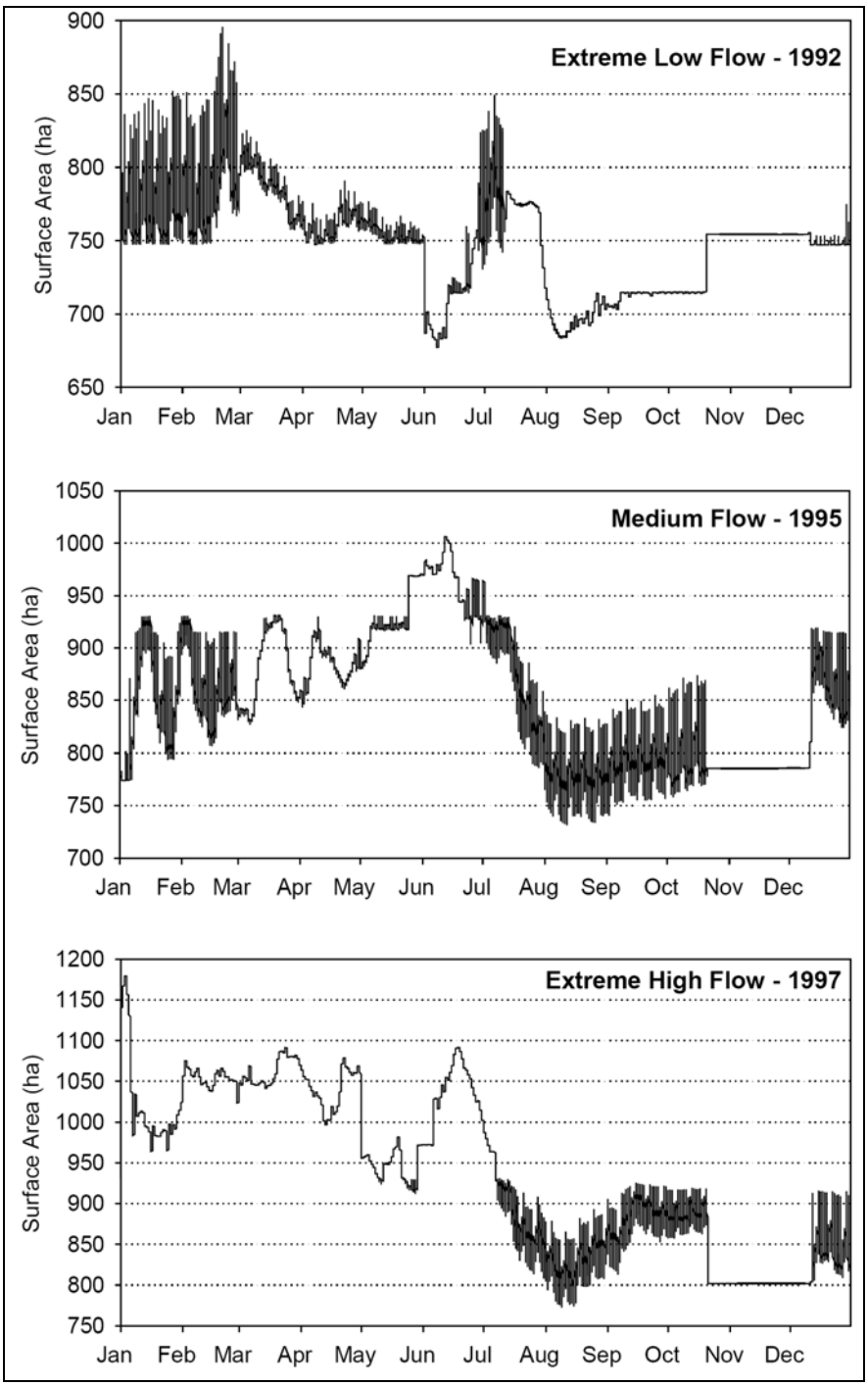


Figure 59. Hourly total wetted stream area predicted for the upper Hells Canyon reach (Hells Canyon dam to the Salmon River confluence) modeled under the Flow Augmentation Scenario during the extremely low flow year of 1992 (top), the medium flow year (middle) and the extremely high flow year of 1997 (bottom). (Source: Brink and Chandler, 2005)

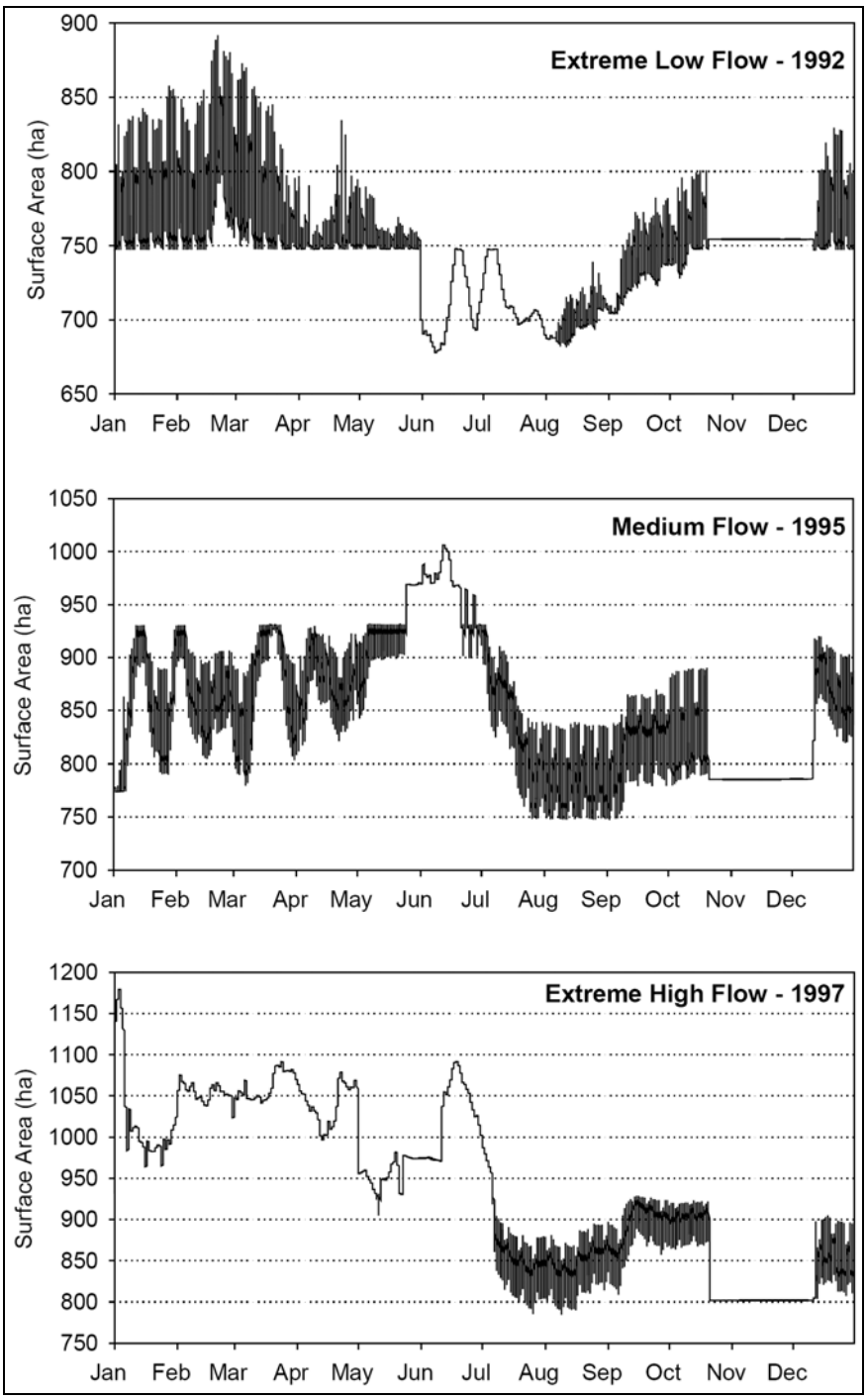


Figure 60. Hourly total wetted stream area predicted for the upper Hells Canyon reach (Hells Canyon dam to the Salmon River confluence) modeled under the Navigation Scenario during the extremely low flow year of 1992 (top), the medium flow year (middle) and the extremely high flow year of 1997 (bottom). (Source: Brink and Chandler, 2005)

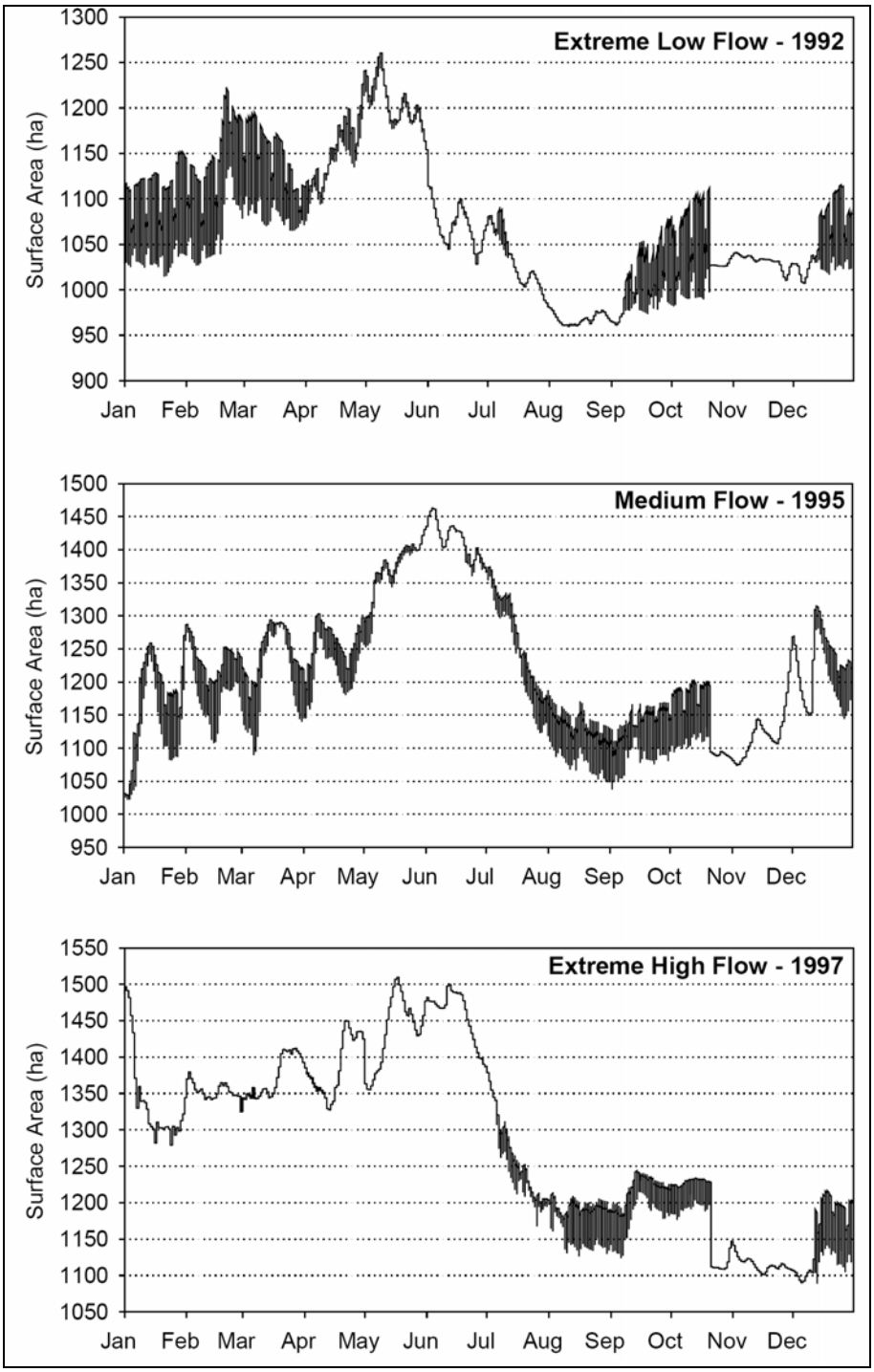


Figure 61. Hourly total wetted stream area predicted for the lower Hells Canyon reach (Salmon River confluence to Lower Granite reservoir) modeled under Proposed Operations during the extremely low flow year of 1992 (top), the medium flow year (middle) and the extremely high flow year of 1997 (bottom). (Source: Brink and Chandler, 2005)

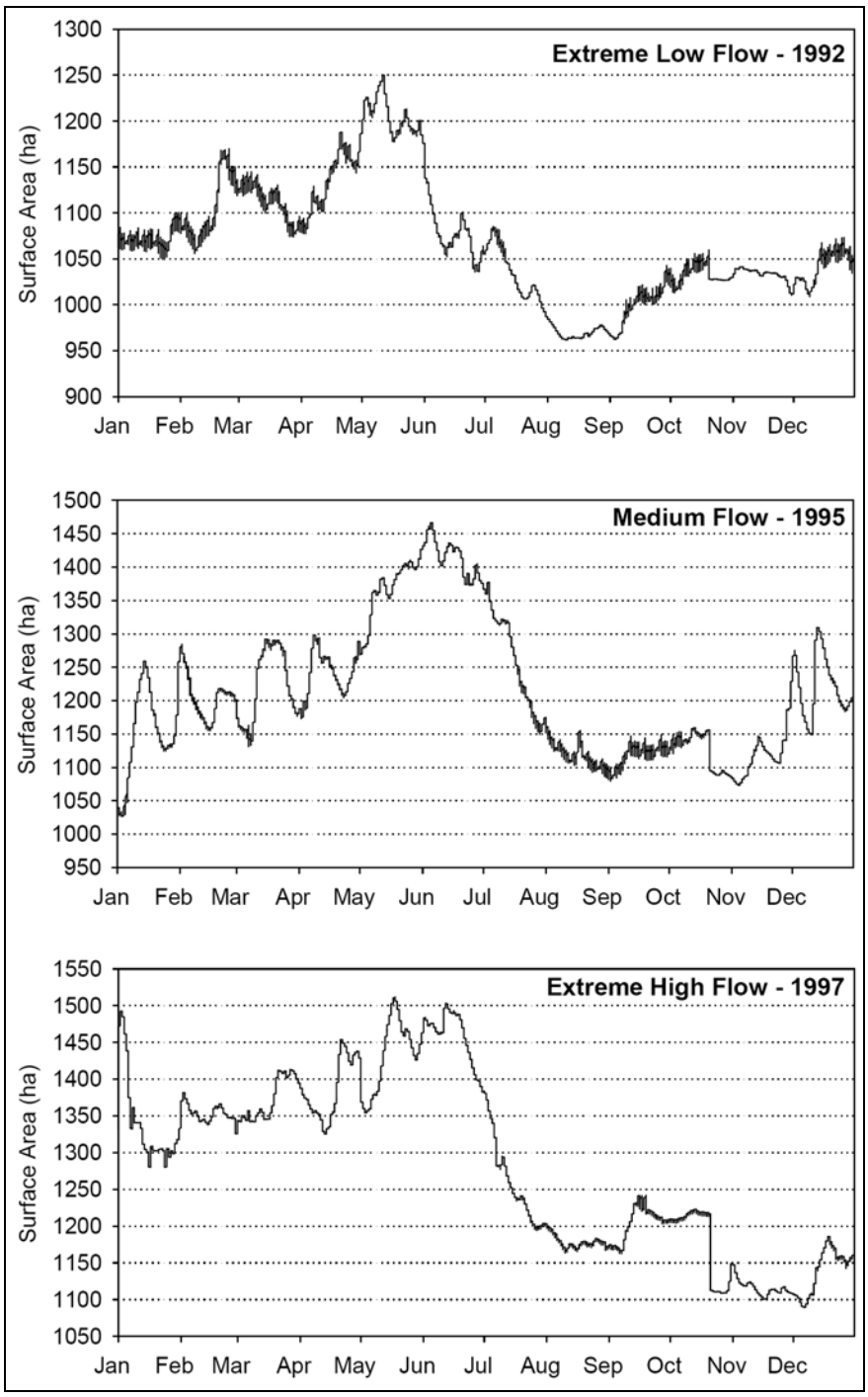


Figure 62. Hourly total wetted stream area predicted for the lower Hells Canyon reach (Salmon River confluence to Lower Granite reservoir) modeled under Scenario 1b, Year-round 2-Inches-Per-Hour Ramping Rate, during the extremely low flow year of 1992 (top), the medium flow year (middle) and the extremely high flow year of 1997 (bottom). (Source: Brink and Chandler, 2005)

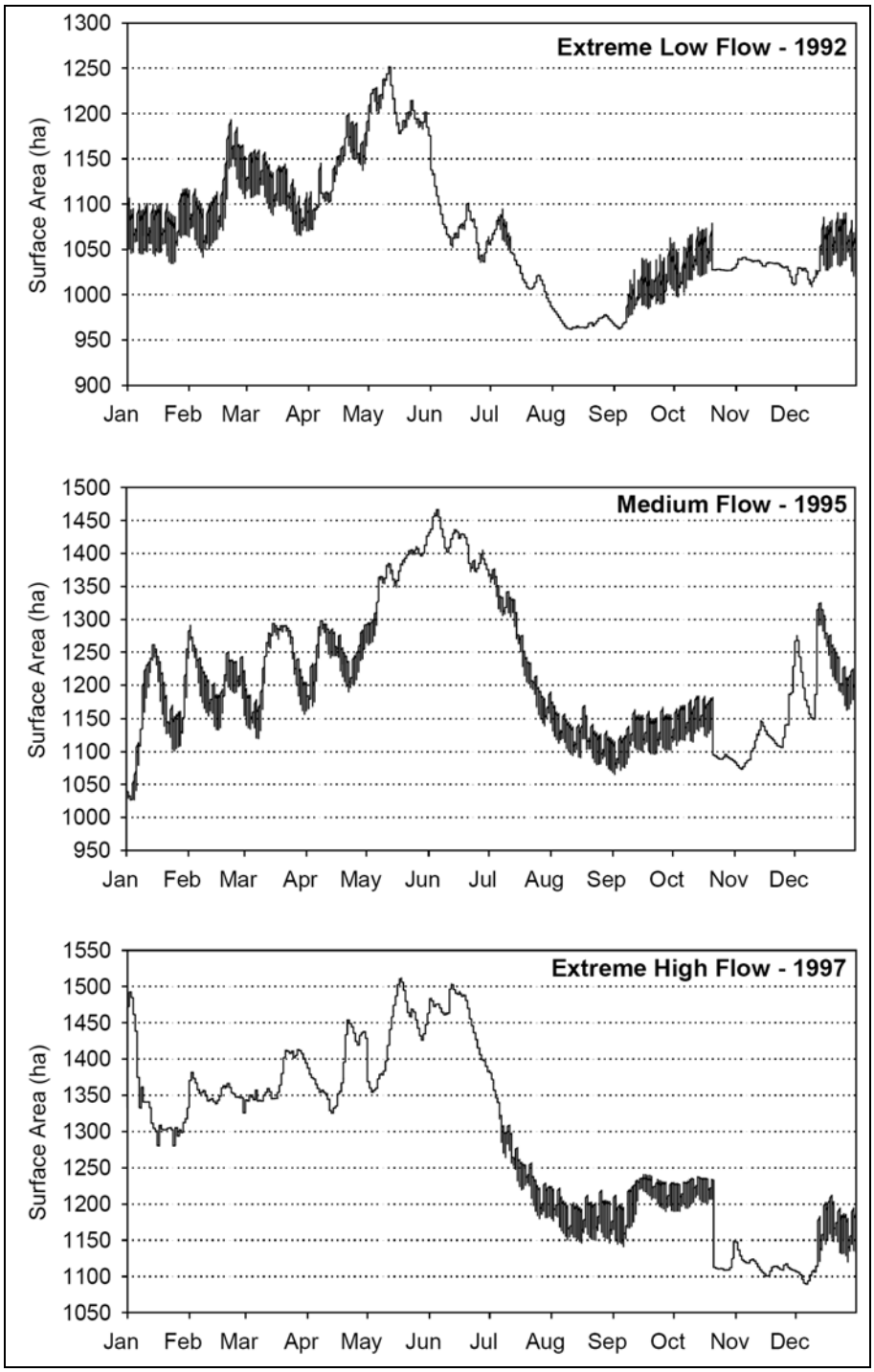


Figure 63. Hourly total wetted stream area predicted for the lower Hells Canyon reach (Salmon River confluence to Lower Granite reservoir) modeled under Scenario 1c, Year-round 6-Inches-Per-Hour Ramping Rate, during the extremely low flow year of 1992 (top), the medium flow year (middle) and the extremely high flow year of 1997 (bottom). (Source: Brink and Chandler, 2005)

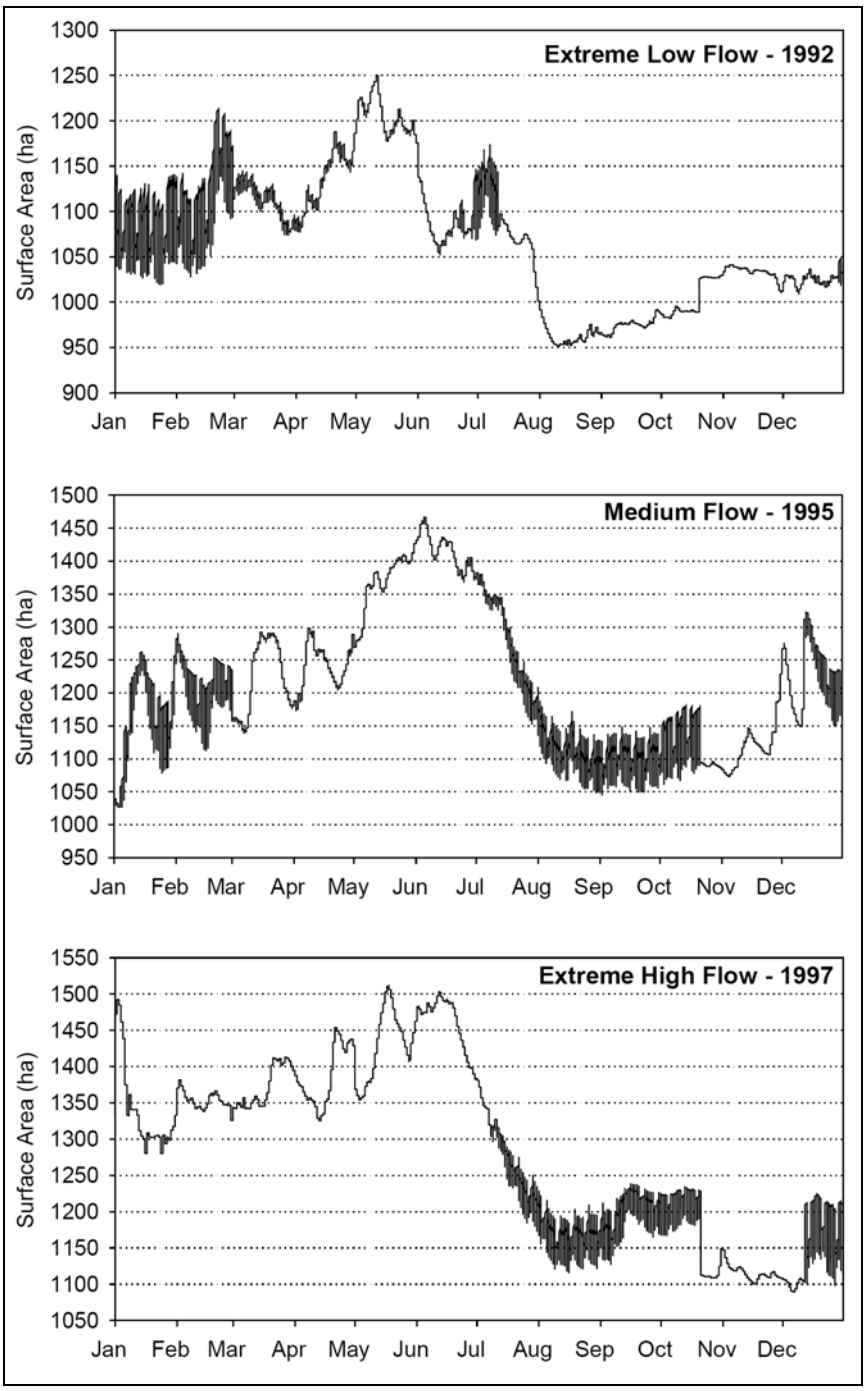


Figure 64. Hourly total wetted stream area predicted for the lower Hells Canyon reach (Salmon River confluence to Lower Granite reservoir) modeled under the Flow Augmentation Scenario during the extremely low flow year of 1992 (top), the medium flow year (middle) and the extremely high flow year of 1997 (bottom). (Source: Brink and Chandler, 2005)

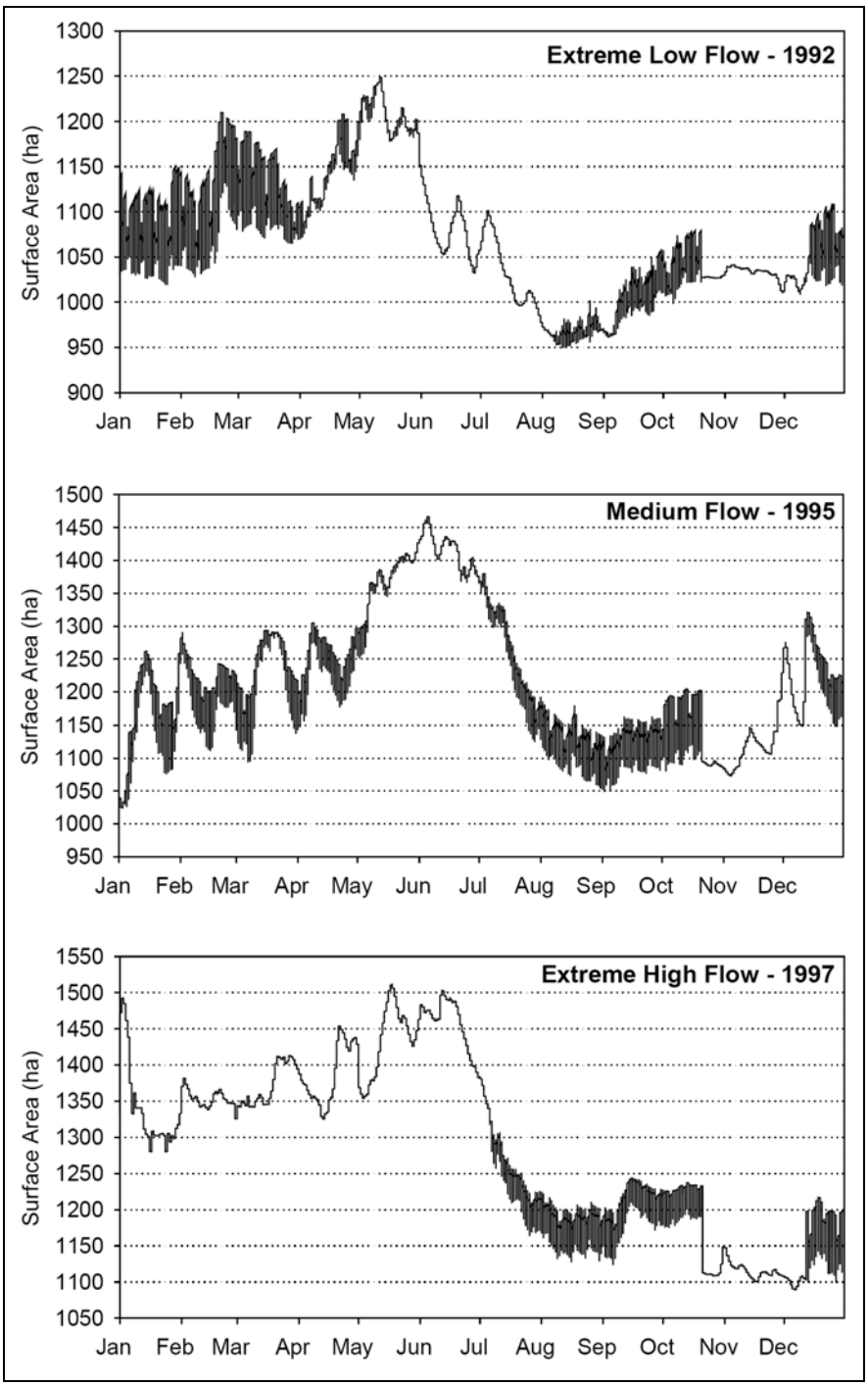


Figure 65. Hourly total wetted stream area predicted for the lower Hells Canyon reach (Salmon River confluence to Lower Granite reservoir) modeled under the Navigation Scenario during the extremely low flow year of 1992 (top), the medium flow year (middle) and the extremely high flow year of 1997 (bottom). (Source: Brink and Chandler, 2005)

Table 40. Estimated maximum seasonal percentage of streambed that would be subject to daily dewatering upstream and downstream of the Salmon River under Proposed Operations and four alternative scenarios. Maxima occur in different seasons depending on the scenario and water year type, see figures 56 through 65. (Source: Brink and Chandler, 2005, as modified by staff)

		Maximum Percent of Streambed Exposed Due to Load Following Operations	
Scenario	**Water Year Type**	**Above Salmon River**	**Below Salmon River**
Proposed Operations	Extremely low	10	10
	Medium	11	8
	Extremely high	7	7
Scenario 1b (Year-round 2-Inches-Per-Hour Ramping Rate)	Extremely low	3	2
	Medium	3	2
	Extremely high	<1	<1
Scenario 1c (Year-round 6 Inches-Per-Hour Ramping Rate)	Extremely low	7	5
	Medium	7	4
	Extremely high	7	4
Scenario 2 (Flow Augmentation)	Extremely low	10	9
	Medium	11	9
	Extremely high	7	6
Scenario 3 (Navigation)	Extremely low	11	10
	Medium	11	9
	Extremely high	11	5

We concluded in the draft EIS that the reduction in primary production and invertebrate biomass would be roughly proportional to the area of streambed that is subject to frequent dewatering. In its draft EIS comments, Interior states that this is a substantial underestimate because: (1) the shallow-water areas that are most subject to dewatering provide the most important forage area for macroinvertebrates; and (2) there would be a reduction in the standing crop due to stranding losses from repeated dewatering. We reviewed the references cited by Interior (Bailey [1974], Brusven et al. [1974], and R2 Resource Consultants [2005]), and conclude there is the potential that lost invertebrate production could exceed the proportion of the streambed subject to frequent dewatering. However, Brusven et al. (1974) stated that most insect life in the Hells Canyon reach "abounded" in regions not experiencing daily water fluctuations, including the deeper areas that they refer to as the *Cladophora* Zone (27 to 61 inches in depth). They also found that aquatic insects far exceed biomass values of smaller streams in northern Idaho containing less nutrients. Based on this information, we conclude that invertebrate standing crops are likely reduced primarily in areas that are subject to daily dewatering due to reduced periphyton production and from cumulative losses of invertebrates associated with repeated dewatering events.

Although there is some uncertainty regarding the extent of effects on invertebrate production, we conclude that this reduction is likely to be on the order of one to two times the proportion of the streambed that is subject to daily dewatering. Accordingly, we estimate that periphyton and invertebrate production may be reduced under Proposed Operations, in the Flow Augmentation Scenario, and in the Navigation Scenario by approximately 10 to 20 percent upstream of the Salmon River in medium to low flow years, with a lesser reduction downstream of the Salmon River. These effects would be reduced by about one-

third by implementing a 6 inches-per-hour ramping rate, and they would be reduced by about three-fourths by implementing a 2 inches-per-hour ramping rate. We discuss effects of lost invertebrate production on the growth rates of fall Chinook salmon, bull trout, and white sturgeon in subsequent sections.

Anadromous Fish Spawning

Flows released from Hells Canyon dam affect the quality and quantity of spawning habitat that is available to fall Chinook salmon in the Snake River between Hells Canyon dam and Lower Granite reservoir, a reach that contains most of the spawning habitat that is currently accessible to fall Chinook salmon in the Snake River basin. The reach is not known to be a major spawning area for any other anadromous fish species. In this section, we evaluate the effects that proposed and alternative operations would have on fall Chinook spawning and incubation until the time that fry emerge from the gravel. Effects on rearing fall Chinook salmon will be addressed in the next section.

Since 1991, Idaho Power has implemented a flow program to enhance spawning and incubation conditions for fall Chinook salmon in the Hells Canyon reach. To prevent redds from becoming dewatered during the spawning season, Idaho Power maintains steady flow conditions to keep spawning activity below a water level that can be maintained throughout the incubation and fry emergence stages. The spawning flow, which has typically been between 9,000 and 13,000 cfs, is determined each year before spawning begins based on forecasted inflows to Brownlee reservoir, predicted hydrologic-year type (low, medium, or high), and availability of habitat. After spawning has ended, Idaho Power maintains a minimum flow that protects the shallowest redd from being dewatered until fry have emerged from the gravel. Idaho Power proposes to continue the fall Chinook spawning flow program, although they indicate an interest in exploring whether some degree of flow fluctuation could be allowed during the spawning period without reducing the availability of spawning habitat or hindering spawning behavior.

Recommendations received from NMFS, the Nez Perce Tribe, ODFW, IDFG, and the Umatilla Tribes relating to the fall Chinook spawning flow program are summarized in table 41 and are discussed below.

Our Analysis

The fall Chinook spawning flow program benefits fall Chinook salmon by maintaining near-optimal flow levels during the spawning period and by preventing dewatering of redds during the incubation period. Since the flow program was first implemented in 1991, the number of adult fall Chinook salmon returning to the Snake River has increased substantially (refer to figure 100 in section 3.8.1.1, *Fall Chinook Salmon*). While other factors such as hatchery supplementation, improved migration survival, and favorable ocean conditions have contributed to this trend, there is little doubt that protecting redds from dewatering has improved incubation survival. NMFS, ODFW, IDFG, the Nez Perce Tribe and Umatilla Tribes all recommend that the fall Chinook flow program be continued.

In its description of this proposed measure, Idaho Power states that modifications of this flow program are currently being evaluated and explored in cooperation with interested agencies. In Groves and Chandler (2003), Idaho Power provides further discussion of the potential for allowing some flow variation during the spawning season. It notes that at flows between 8,000- and 15,000-cfs stage changes by about 0.9 meter. It also states that only 9 percent of measured redds have been observed at depths of less than 0.9 meters. We conclude that fish spawning at these shallower sites could be adversely affected by stage changes of this magnitude. We also note that any flow variation that occurs during the spawning period could result in redds being constructed at higher elevations, which would require higher flows to be maintained during the egg incubation season to avoid dewatering redds. Redds that are constructed at higher elevations would be more vulnerable to exposure (and exposure-related mortality of eggs and fry), especially when inflows to Brownlee reservoir are lower than was forecast at the start of the spawning season. We conclude that maintaining a stable flow during the spawning season is more protective than a variable flow regime would be.

Table 41. Fall Chinook spawning flow, incubation flow, and spawner survey recommendations. (Source: Staff)

Component	Idaho Power	NMFS	Nez Perce Tribe	ODFW	IDFG	Umatilla Tribes
General	Explore salmon flow program modifications in consultation with agencies; flows less than 8,000 cfs may be sufficient to support recovery and moderate flow fluctuations during the spawning period may be possible without reducing the availability of spawning habitat or hindering spawning behavior			ODFW-34. Supports the fall Chinook salmon flow program; consult with ODFW to refine specific details	IDFG-19. Supports the fall Chinook salmon flow program	
Spawning flow	To be determined each year based on forecasted inflows, hydrologic-year type, and availability of habitat, typically between 8,000 and 13,000 cfs	NMFS-1. Stable flow between 8,500 to 13,500, depending on runoff forecast, from when spawning starts between Hells Canyon dam and Lower Granite reservoir to when spawning is complete	NPT-1. Stable flow between 8,500 to 13,000 for the duration of the fall Chinook spawning period	ODFW-34. Stable flow of at least 8,000 cfs from October 1 through May		CTUIR-9. Minimum flow of 9,000 cfs
Incubation flow	Limited by the most critical shallow redd identified within the Hells Canyon reach	NMFS-1. Provide minimum flows equal to or greater than the spawning flow unless NMFS agrees that shallow water redds can be fully protected at a lower flow	NPT-1. Protect redds from becoming dewatered; spawning flow becomes the base flow			CTUIR-9. Minimum flow of 9,000 cfs

Component	Idaho Power	NMFS	Nez Perce Tribe	ODFW	IDFG	Umatilla Tribes
In-season flow modification	Flows may be decreased when inflow or seasonal precipitation decreases below forecasted levels	NMFS-2. Coordinate with NMFS and FWS to ensure operation remains effective for the duration of the license	NPT-1. Report to tribal, federal and state fishery managers any operational change necessary to protect redds			
Spawner surveys	Continue to support and participate in aerial and deep-water spawning surveys; continue temperature monitoring in the Snake River upstream of the Salmon River to estimate when emergence is complete. Note: measures related to monitoring the quantity and quality of spawning gravel are evaluated in section 3.4.2.2, *Sediment Augmentation and Monitoring*.	NMFS-3. Conduct both aerial and deep-water surveys weekly throughout the duration of the spawning period, to be coordinated with NMFS and FWS; each year provide draft reports to NMFS, FWS, ODFW, IDFG and Nez Perce Tribe for comment by July 1, final reports by December 1.	NPT-1. Monitor shallowest redds to ensure they do not become dewatered	ODFW-35. Continue shallow redd surveys; conduct deep water surveys every five years or when escapement increases to 10,000, 15,000 and 20,000 adults (whichever comes first); consult with ODFW and ODEQ to determine temperature monitoring sites	IDFG-2. Continue shallow redd surveys, consult with agencies to determine frequency of deep water redd monitoring, distribute temperature monitoring devices broadly so that effects of localized temperature differences on emergence timing can be determined.	

The spawning flow that is selected each year affects the quantity of habitat that would have suitable depths and velocities for spawning. As the number of spawners approaches the capacity of the habitat, the incidence of redd superimposition may increase, which can adversely affect incubation survival when eggs are disturbed or dislodged by later spawning fish. Idaho Power does not specify a range of spawning flows to be considered for future operations, and proposes that the spawning flow be determined each year based on forecasted inflows to Brownlee reservoir, predicted hydrologic-year type (low, medium, or high), and availability of habitat. NMFS (NMFS-1) recommends that the stable spawning flow be between 8,500 and 13,500 cfs, the Nez Perce Tribe (NPT-1) recommends that the flow be between 8,500 and 13,000 cfs, ODFW (ODFW-34) recommends that the spawning flow be at least 8,000 cfs, and the Umatilla Tribes recommend that the spawning flow be at least 9,000 cfs.

Idaho Power developed three alternative estimates of the number of redds that the habitat between Hells Canyon dam and Lower Granite reservoir could support. One estimate, which includes all areas within known spawning sites that have suitable spawning substrate, results in a capacity of 5,729 redds. A second method, which includes all areas containing suitable substrate regardless of proximity to known spawning areas, produces an estimated capacity of 10,730 redds. The third method, which is based on modeling habitat at 20 spawning sites expanded to include other known spawning sites based on geomorphic channel type, is summarized in table 42. This third method is the only one that provides an estimate of habitat capacity over a range of flows, and it indicates that habitat capacity varies by less than 10 percent at flows between 8,000 and 15,000 cfs.

We do not have a sufficient basis to judge which of the three methods for estimating habitat capacity is the most accurate. However, the relationship between habitat capacity and flow shown in table 42 indicates that steady flows within the 8,000 to 15,000 cfs range should provide near-optimal conditions for spawning fall Chinook salmon. Thus, providing stable flows in this range should minimize the potential for redd superimposition, especially in years when large numbers of fall Chinook salmon spawn in the Hells Canyon reach.

Table 42. Estimated redd capacity for the Snake River at selected discharge levels from Hells Canyon dam. (Source: Groves and Chandler, 2003, as modified by staff)

Hells Canyon Dam Discharge (cfs)	Estimated Snake River Redd Capacity
8,000	3,453
9,500	3,587
13,000	3,753
15,000	3,691
18,000	3,281

Other recommendations made by the agencies and tribes relate to: (1) consultation and monitoring requirements for establishing spawning flow levels; (2) in-season consultation on adjustments to flow levels due to changes in flow forecasts; (3) establishing the flow level that is required to protect redds until fry have emerged from the gravel; (4) determining the number and location of temperature monitors that are needed to track water temperatures and estimate the timing of fry emergence; (5) determining the frequency of both shallow and deep-water redd surveys; and (6) reporting requirements. Consultation with the resource agencies and tribes to determine appropriate monitoring efforts and to improve the efficiency of the flow management decision process would help to maximize resource benefits and avoid imposing any unnecessary constraints on project operations. This consultation could be accomplished through the development of an fall Chinook flow management plan.

Anadromous Fish Rearing

Flow fluctuations and changes in the seasonal flow regime caused by project operations can affect the quality and quantity of rearing habitat and the food supply that is available to rearing juvenile fall Chinook salmon and has the potential to cause juvenile fall Chinook salmon to become stranded on bars or trapped in pools that become isolated from the stream channel. Losses of fry that are trapped in pools may occur due to high water temperatures, increased vulnerability to predation, or stranding if the pools drain before they are reconnected to the river. The Hells Canyon reach is not known to provide important rearing habitat for other anadromous species, but it is the most important production area in the Snake River basin that is still accessible to fall Chinook salmon.

Idaho Power's fall Chinook flow program (which Idaho Power proposes to continue) provides stable flows during the fall Chinook spawning season and maintains flows sufficient to keep redds watered until emergence is complete, but their proposed operations would allow substantial flow fluctuations to occur during the fall Chinook rearing period (approximately March 15 through June 15). Idaho Power proposes to continue its current maximum up- and down-ramping rate of 12 inches per hour as measured at Johnson Bar. Under typical operating conditions,[67] Idaho Power would limit the maximum daily change in flow to 10,000 cfs from June 1 through September 30, and maintain a minimum flow of 6,500 cfs year-round.

Recommendations received from NMFS, Interior, the Forest Service, ODFW, IDFG, the Nez Perce Tribe, the Umatilla Tribes, and AR/IRU related to ramping rates and minimum flows outside of the fall Chinook spawning period are summarized in table 43, and are discussed below.

Our Analysis

Habitat Area

Idaho Power modeled juvenile fall Chinook rearing habitat using one-dimensional (1D) and two-dimensional (2D) modeling techniques. The 2D model was developed based on bathymetry, velocity and substrate data collected at seven sites in the upper Hells Canyon reach (Hells Canyon dam to the Salmon River) and four sites in the lower Hells Canyon reach (Salmon River to the Lower Granite reservoir). Idaho Power expanded the modeling results from these 11 sites to the entire reach based on the geomorphic features of the river channel. The 2D model used habitat suitability criteria for depth, velocity, and substrate to determine habitat suitability.

The 1D method used a one-dimensional hydrodynamic flow model and a detailed digital terrain model of the entire reach extending from Hells Canyon dam to the head of Lower Granite reservoir. The 1D model determined habitat suitability based on depth and shoreline gradient. Idaho Power developed the 1D modeling approach based on work conducted by Tiffan et al. (2002) on the Hanford reach of the Columbia River. Tiffan et al. (2002) found that shoreline gradient was the most important measured variable in determining the presence of subyearling fall Chinook salmon.

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[67] See table FW-4, footnote a, for a description of atypical operating conditions, under which a maximum daily flow change of 16,000 cfs and a minimum flow of 5,000 cfs would be allowed.

Table 43. Ramping rate and minimum flow recommendations outside of the fall Chinook spawning season. (Source: staff)

Component	Idaho Power	NMFS	Interior	Forest Service	ODFW
Year-round ramping rate or minimum flow	Twelve inches per hour measured at Johnson Bar, 6,500 cfs minimum except 5,000 cfs under atypical conditions,[a] maximum daily flow change of 10,000 cfs, except 16,000 cfs under atypical conditions[a]		Interior-66. Conduct a three-phased test program: (1) 12-inches-per-hour ramping rate measured within 1 mile of Hells Canyon dam; (2) same ramping rate with DO enhancement to achieve 6 mg/L or as high as possible; and (3) run-of-river operation at Hells Canyon dam, with continued DO enhancement.	FS-30. Same as Interior, but specifies a minimum flow of 8,500 cfs or inflow, a maximum daily flow change of 10,000 cfs from Memorial Day to Labor Day, and durations of 3, 3, and 5 years for the three test phases.	ODFW-33. Six inches per hour measured within 1 mile of Hells Canyon dam, except during fall Chinook spawning and rearing.
Restrictions specific to the fall Chinook rearing period		NMFS-4. Monitor stranding sites to determine flows to connect entrapment sites to the river; assess effects of load following on forage species, juvenile behavior, entrapment and mortality; release flows sufficient to reconnect the largest entrapment areas at least 2 hours per day; release stable flows of at least 11,500 cfs if daily average temperatures in any pool exceeds 16°C for more than three days or when peak temperatures exceed 19°C for more than 4 hours.		FS-30. Take measures to prevent fall Chinook juvenile entrapment from emergence through the outmigration period.	ODFW-33. Four inches per hour measured within 1 mile of Hells Canyon dam March 21 through June 21.
Consultation and reporting		NMFS-4. Based on study of entrapment areas, develop long-term operational protocols to protect, and minimize negative effects on, rearing juvenile fall Chinook.	Interior-66. Duration and timing of each test to be determined in consultation with FWS; each test would likely require several years to assess effects.		

Component	IDFG	Nez Perce Tribe	Umatilla Tribes	AR/IRU
Year-round ramping rate or minimum flow				AR/IRU-23a. Two inches per hour to be measured at Hells Canyon dam, consult with the Technical Advisory Committee to determine a maximum daily change in discharge to protect biological and other resource values
Restrictions specific to the fall Chinook rearing period	IDFG-1b. Fall Chinook flow program should be revised to include measures to prevent stranding of fall Chinook fry and other species.	NPT-3 and NPT-4. Two-inches-per-hour ramping rate during the fall Chinook rearing period; if stranding is found based on monitoring, release sufficient flows to reconnect entrapment sites twice in a 24-hour period.	CTUIR-10. Two inches per hour during fall Chinook spawning, emergence and early rearing; consult to establish critical flow levels to protect juvenile fall Chinook from stranding and entrapment.	AR/IRU-23b. Identify and monitor potential stranding sites upstream of the Salmon River; take measures needed to minimize potential stranding of fall Chinook, implement a minimum flow that maintains connection to important entrapment pools.
Consultation and reporting				AR/IRU-23d. Develop and implement a monitoring and reporting plan for load following operations

[a] As defined by Idaho Power, atypical conditions would be conditions when Idaho Power determines that operation of the project is needed to: (1) protect the performance, integrity, reliability, or stability of Idaho Power's electrical system or any electrical system with which it is interconnected; (2) compensate for any unscheduled loss of generation; (3) provide generation during severe weather or extreme market conditions; (4) inspect, maintain, repair, replace, or improve Idaho Power's electrical systems or facilities related to the project; (5) prevent injury to people or damage to property; or (6) assist in search-and-rescue activities

Idaho Power used both the 1D and 2D models to develop weighted useable area (WUA) habitat versus discharge relationships for the reaches upstream and downstream of the Salmon River confluence. As shown in WUA versus discharge plots on figures 66 and 67, both models indicate that the Snake River downstream of the Salmon River provides approximately 4 to 5 times as much rearing habitat for fall Chinook salmon as the upstream section from Hells Canyon dam to the Salmon River. The results from both models also indicate that fall Chinook rearing habitat declines with increasing discharge in both sections of the river. Declines in habitat in the upper reach are relatively gradual, while habitat in the lower reach declines rapidly as flows increase to about 25,000 cfs, after which the amount of habitat declines more gradually.

In Brink and Chandler (2005), staff requested that Idaho Power use both the 2D and 1D habitat models to evaluate the effects of different operating scenarios on fall Chinook habitat in the upper and lower Hells Canyon reaches. Idaho Power generated plots of hourly WUA using flow data from 3 water years representing extremely low flow, medium flow, and extremely high flow conditions. Representative plots showing predicted hourly WUA for fall Chinook juveniles in the upper Hells Canyon reach under proposed operations are shown in figure 68 (2D model) and figure 69 (1D model). The period in which juvenile fall Chinook salmon are present in the reach (March 15 to June 15) is indicated by the hatch marks shown on each figure.

To compare the amount of habitat that is predicted to occur in each reach, year, and operating scenario, we used these plots to estimate the maximum and minimum WUA and the normal maximum daily percent fluctuation[68] of WUA that occurred within the fall Chinook rearing period, and we summarized these values in table 44 for the 2D model and in table 45 for the 1D model. For example, from figure 68, we estimated that under proposed operations in the upper Hells Canyon reach in the extremely low flow year, the minimum WUA was 107,000 square meters, the maximum WUA was 125,000 square meters, and the maximum daily fluctuation in WUA was about 5 percent. For the medium flow year, under proposed operations, we estimated that the minimum WUA was 69,000 square meters, the maximum WUA was 122,000 square meters, and the maximum daily fluctuation in WUA was about 8 percent. For the extremely high flow year, under proposed operations, we estimated that the minimum WUA was 38,000 square meters, the maximum WUA was 117,000 square meters, and the maximum daily fluctuation in WUA was less than 1 percent.

Results tabulated from the 2D model plots indicated that the maximum WUA above the Salmon River was similar for all water years and scenarios, ranging between 110,000 and 125,000 square meters (table 44). Maximum WUA downstream of the Salmon River was consistent between scenarios, but more habitat was available in low water years. The 1D model showed the same general relationships (table 45), except that the reduction in WUA values in higher water years was more pronounced than it was in the 2D model.

The minimum WUA values showed a similar consistency between scenarios, and showed consistently lower WUA values in higher water years. Results tabulated from the 2D model plots for the six scenarios showed minimum WUA above the Salmon River did not vary between scenarios but did vary by water year, ranging from 38,000 square meters in the extremely high water year to 107,000 square meters in the extremely low water. Similarly consistent patterns were found in the 2D data from downstream of the Salmon River and in the 1D data for both reaches.

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[68] To illustrate the maximum effect of load following operations while excluding larger changes in flow that do not occur on a regular basis, we based this estimate on the largest percentage change in WUA that occurred in at least 3 consecutive days.

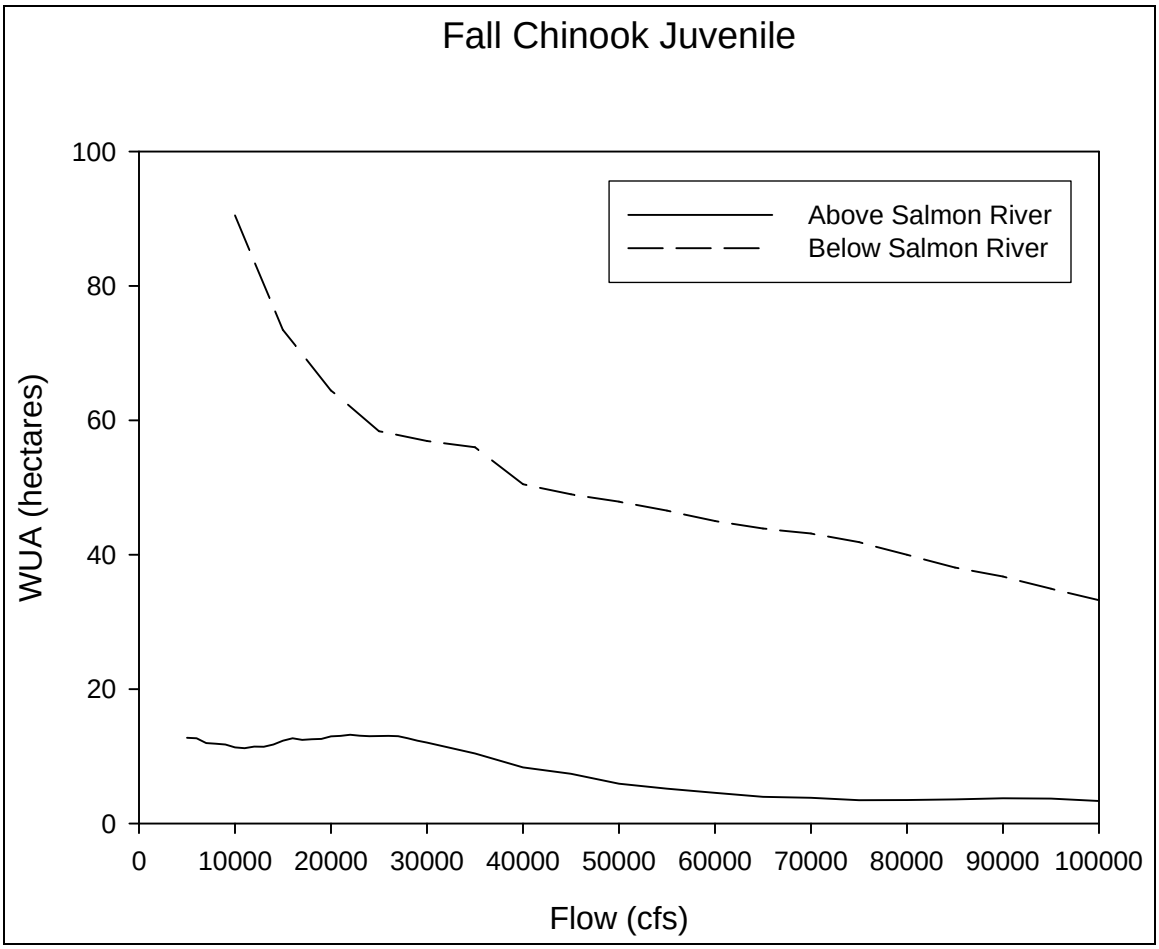

Figure 66. Weighted useable area versus discharge for fall Chinook juvenile habitat above the Salmon River (Hells Canyon dam to the Salmon River confluence) and below the Salmon River (Salmon River confluence to Lower Granite reservoir) predicted using the 2D habitat model. (Source: Chandler et al., 2003c, as modified by staff)

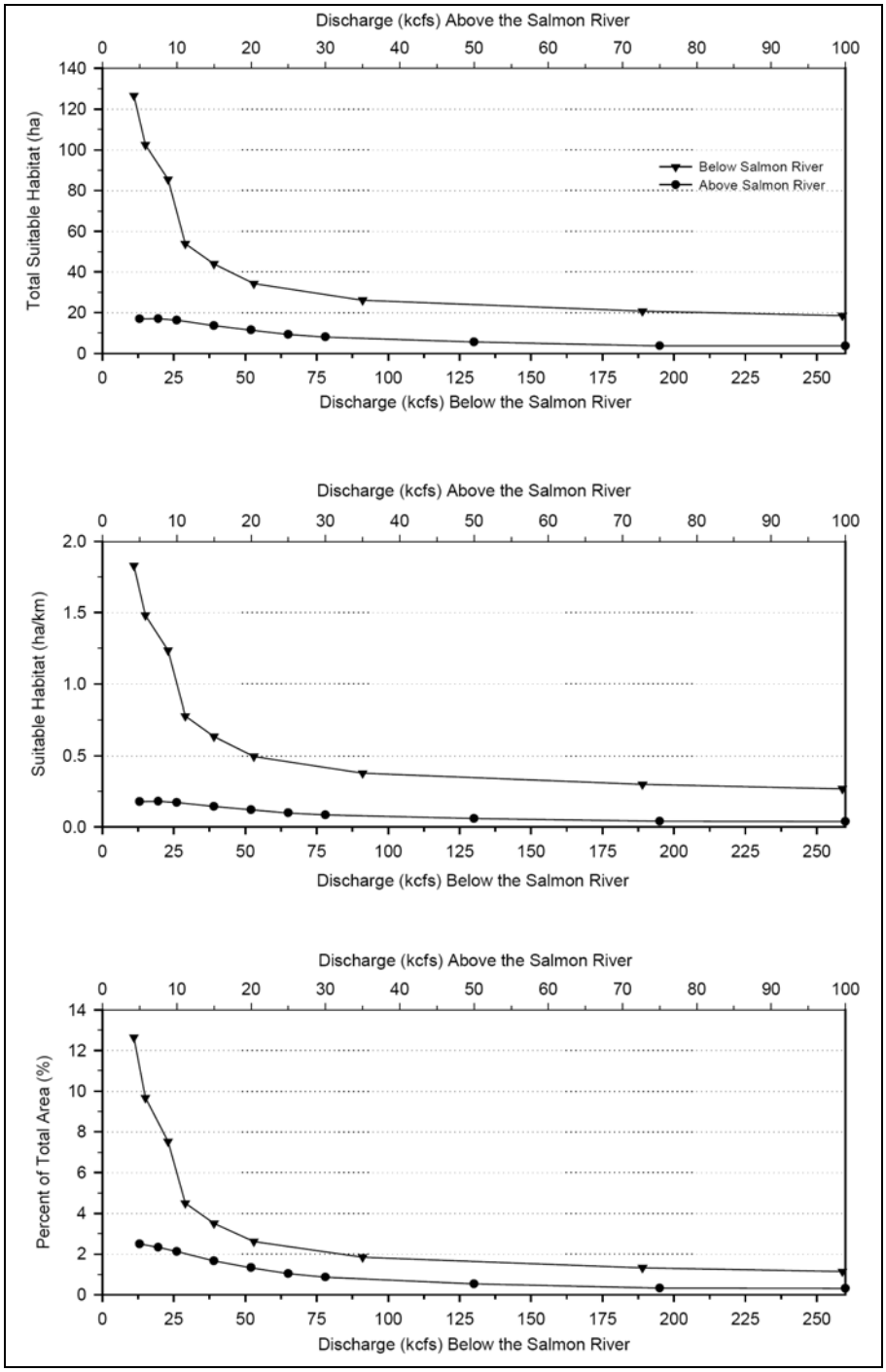

Figure 67. Weighted useable area versus discharge for fall Chinook juvenile habitat upstream of the Salmon River (Hells Canyon dam to the Salmon River confluence) and downstream of the Salmon River (Salmon River confluence to Lower Granite reservoir) predicted using the 1D habitat model. (Source: Chandler et al., 2003c)

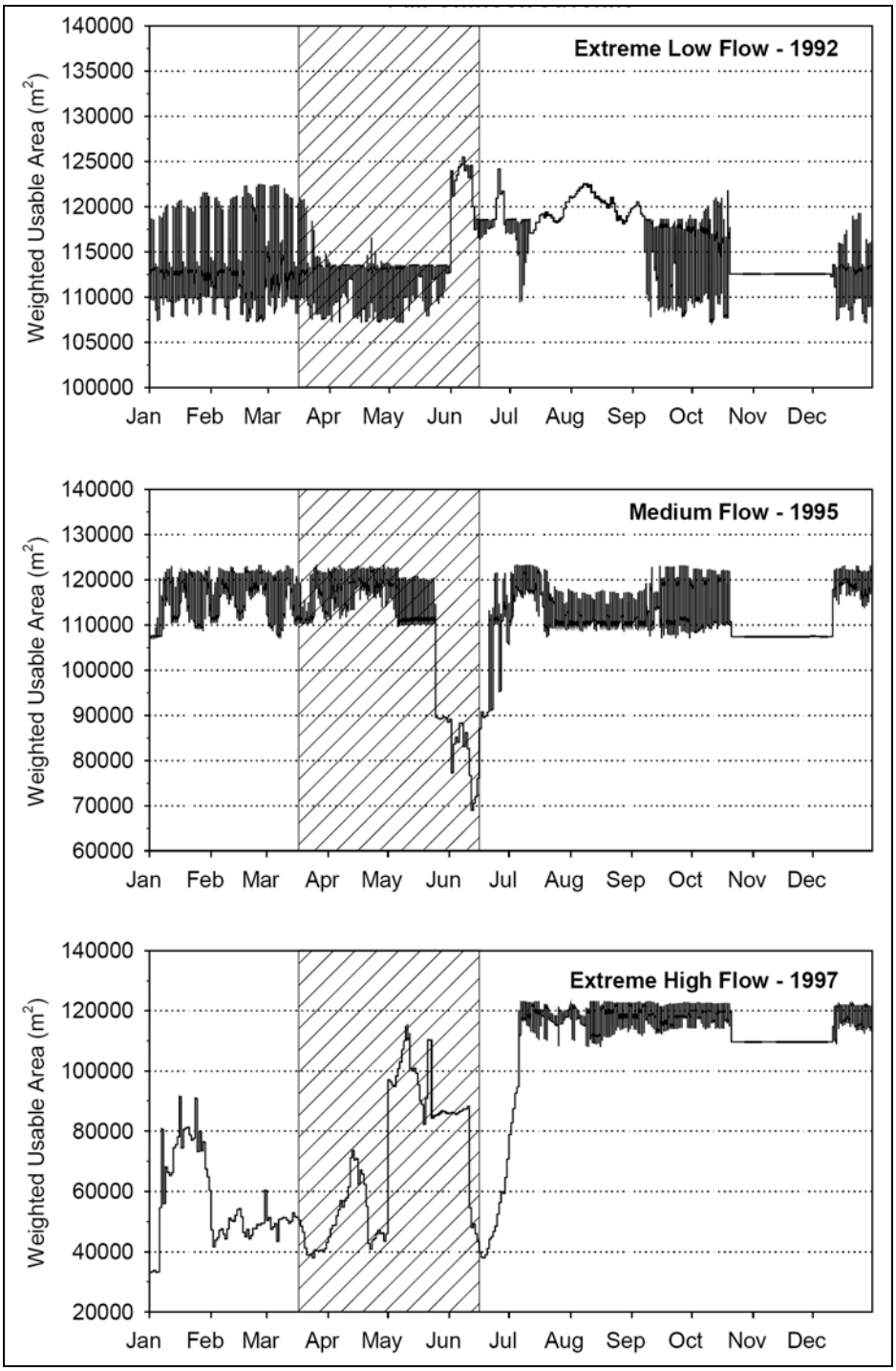

Figure 68. Hourly weighted useable area for fall Chinook juveniles upstream of the Salmon River simulated for proposed operations using the 2D model for three water year types. (Source: Brink and Chandler, 2005)

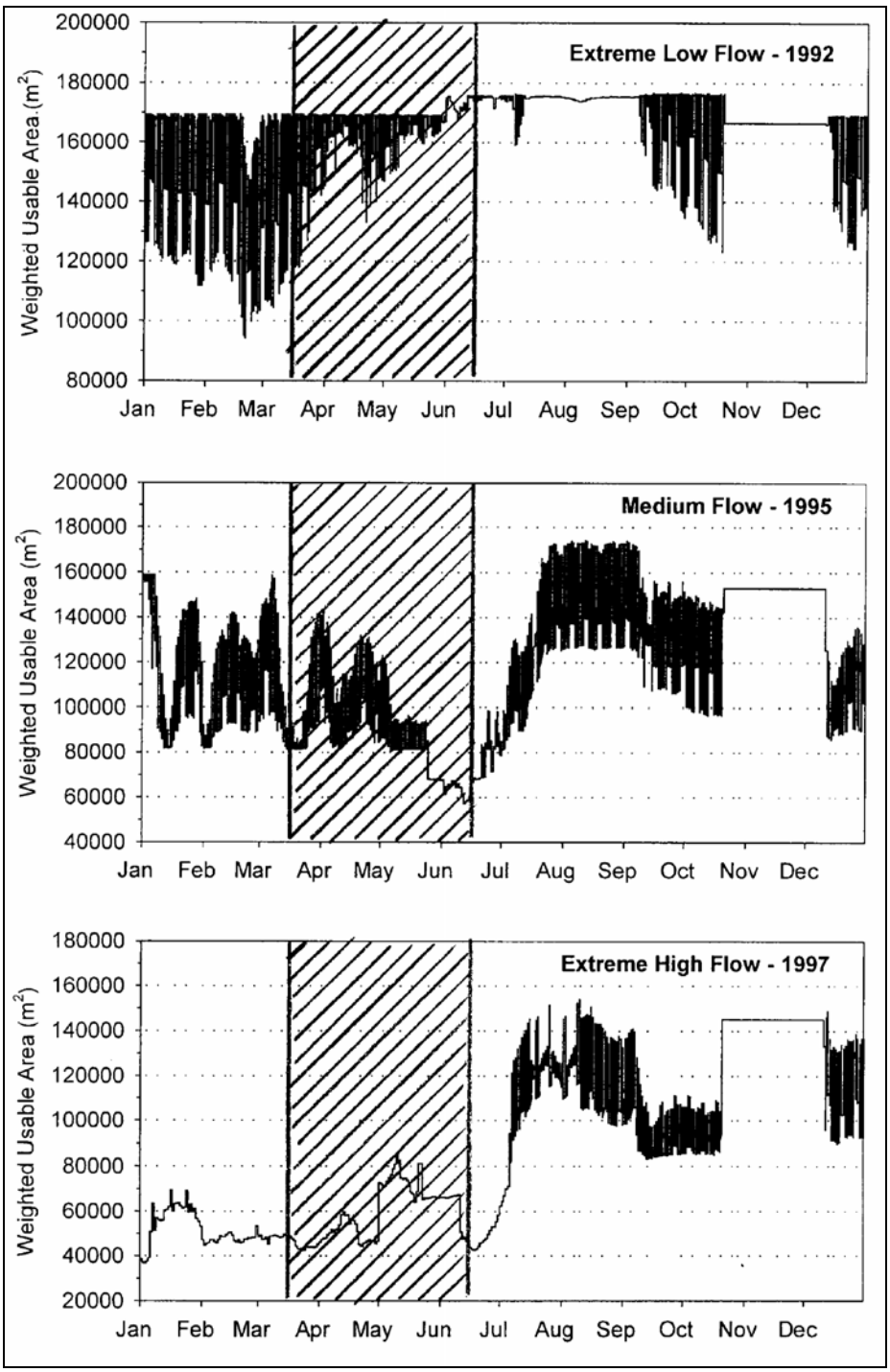

Figure 69. Hourly weighted useable area for fall Chinook juveniles upstream of the Salmon River simulated for proposed operations using the 1D model for three water year types. (Source: Brink and Chandler, 2005)

Table 44. Estimated minimum, maximum, and maximum percent daily fluctuation in WUA during the fall Chinook rearing period (March 15 to June 15), based on 2D modeling of fall Chinook rearing habitat in the Hells Canyon reach upstream and downstream of the Salmon River. (Source: Brink and Chandler, 2005, as modified by staff)

		Above Salmon River			Below Salmon River		
Scenario	**Year**	**Min WUA[a]**	**Max WUA[a]**	**% Fluct.**	**Min WUA[a]**	**Max WUA[a]**	**% Fluct.**
Proposed	Extremely low	107	125	5	550	710	9
	Medium	69	122	8	300	630	9
	Extremely high	38	117	<1	250	490	<1
Scenario 1a (Reregulating)	Extremely low	107	125	<1	560	700	<1
	Medium	69	123	<1	295	605	<1
	Extremely high	38	116	<1	250	490	<1
Scenario 1b (Year-round 2-Inches-Per-Hour Ramping Rate)	Extremely low	107	125	5	560	700	2
	Medium	69	123	5	295	605	<1
	Extremely high	38	111	<1	250	490	<1
Scenario 1c (Year-round 6-Inches-Per-Hour Ramping Rate)	Extremely low	107	125	5	560	685	5
	Medium	69	124	11	295	605	5
	Extremely high	38	117	<1	250	490	<1
Scenario 2 (Flow Augmentation)	Extremely low	107	125	5	560	700	2
	Medium	69	124	4	295	610	<1
	Extremely high	38	118	<1	250	490	<1
Scenario 3 (Navigation)	Extremely low	107	125	5	560	700	9
	Medium	69	124	8	295	630	6
	Extremely high	38	120	<1	250	490	<1

[a] WUA values are shown in 1,000 square meters.

Table 45. Estimated minimum, maximum, and maximum percent daily fluctuation in WUA during the fall Chinook rearing period (March 15 to June 15) based on 1D modeling of fall Chinook rearing habitat in the Hells Canyon reach upstream and downstream of the Salmon River. (Source: Brink and Chandler, 2005, as modified by staff)

		Above Salmon River			Below Salmon River		
Scenario	**Year**	**Min WUA[a]**	**Max WUA[a]**	**% Fluct.**	**Min WUA[a]**	**Max WUA[a]**	**% Fluct.**
Proposed	Extremely low	120	177	17	410	1,050	18
	Medium	60	142	29	280	510	15
	Extremely high	40	82	<1	250	310	<1

Scenario	Year	Above Salmon River			Below Salmon River		
		Min WUA[a]	Max WUA[a]	% Fluct.	Min WUA[a]	Max WUA[a]	% Fluct.
Scenario 1a (Reregulating)	Extremely low	152	177	<1	450	910	<1
	Medium	60	120	<1	370	610	<1
	Extremely high	40	82	<1	250	310	<1
Scenario 1b (Year-round 2-Inches-Per-Hour Ramping Rate)	Extremely low	143	177	5	450	1,020	6
	Medium	60	120	6	275	625	<1
	Extremely high	40	82	<1	250	310	<1
Scenario 1c (Year-round 6-Inches-Per-Hour Ramping Rate)	Extremely low	133	177	19	420	980	18
	Medium	60	120	24	280	680	22
	Extremely high	40	82	<1	250	310	<1
Scenario 2 (Flow Augmentation)	Extremely low	146	177	8	420	1,020	4
	Medium	60	120	4	280	620	<1
	Extremely high	40	90	8	250	310	<1
Scenario 3 (Navigation)	Extremely low	117	177	32	420	1,020	30
	Medium	60	150	32	280	720	21
	Extremely high	40	93	<1	250	310	<1

[a] WUA values are shown in 1,000s of hectares.

Maximum daily fluctuation of WUA showed substantial differences between scenarios and water year types. Results from the 2D model (table 44) indicate that the maximum daily fluctuation in the upper reach was typically in the 5 to 8 percent range for the extremely low and medium water years for all but the run-of-river scenario, where fluctuations were less than one percent. Fluctuations downstream of the Salmon River were more variable, but showed similar trends. The results from the 1D model (table 45) indicate substantially larger daily fluctuations in WUA for Proposed Operations; Scenario 1c, (Year-round 6-Inches-Per-Hour Ramping Rate); and the Navigation Scenario in the extremely low and medium water years. Upstream of the Salmon River, the maximum fluctuation shown by the 1D model exceeded 20 percent in 1 or more water years under Proposed Operations; Scenario 1c (Year-round 6-Inches-Per-Hour Ramping Rate); and the Navigation Scenario. Downstream of the Salmon River, the maximum fluctuation in WUA was slightly reduced but followed very similar trends between scenarios.

Increasing habitat stability would benefit rearing fall Chinook salmon by allowing fish to locate and remain in areas of optimal habitat, and by avoiding energy expenditures associated with moving between or residing in less favorable habitats. Based on our evaluation of the WUA patterns modeled by Idaho Power, we conclude that Scenario 1a, Reregulating, would provide the highest level of habitat stability for rearing fall Chinook salmon. Proposed Operations, the Navigation Scenario, and Scenario 1c (Year-round 6-Inches-Per-Hour Ramping Rate) would provide the least stable habitat conditions. Scenario 1b (Year-round 2-inches-Per-Hour Ramping Rate) and the Flow Augmentation Scenario, which included a 2-inches-per-hour ramping rate restriction during the fall Chinook rearing period, would provide an intermediate level of habitat stability.

The Forest Service filed a review (Hardy, 2006) of Idaho Power's instream flow study with its draft EIS comments. Dr. Hardy raised four primary concerns regarding Idaho Power's approach to

modeling effects on juvenile fall Chinook salmon. These were: (1) the basis for using of the 1-D model without including simulated velocities was not adequately verified; (2) modeling rearing habitat without considering proximity to cover may produce unrealistic results; (3) Idaho Power's analysis did not follow standard approaches for determining effective habitat (habitat that remains suitable over the diurnal range of flows); and (4) the analysis did not consider the effects of reduced invertebrate production and reduced drift associated with lost production along stream margins. Although each of these points has some merit, the Forest Service does not refute our conclusion that favorable growth rates of juvenile fall Chinook salmon indicate that any adverse effects of load following on the habitat conditions and food supply for this species have been limited in scope, at least up until the last several years, when growth rates have started to decline (see section 3.6.1.2, *Primary Production and Aquatic Macroinvertebrates*). As we discuss in the following sections, we conclude that reduced ramping during the fall Chinook rearing period would likely benefit juvenile fall Chinook salmon by increasing the food supply and by reducing the potential for mortality from stranding and entrapment.

Food Supply

Flow fluctuations may also affect rearing fall Chinook salmon by affecting the available food supply. Although juvenile Chinook salmon feed on a variety of aquatic and terrestrial insects as well as larval fish (Moyle, 2002), Rondorf et al. (1990) found that aquatic macroinvertebrates predominated in the diet of subyearling Chinook salmon in riverine (unimpounded) habitat in the Columbia River. Although Connor and Burge (2003) report that juvenile fall Chinook salmon downstream of Hells Canyon dam exhibit rapid growth compared to other populations, we note that their study was based on juvenile sampling conducted between 1995 and 2000. Because the number of fall Chinook spawning in this reach has increased approximately four-fold since the 1999 brood year (which produced the juveniles that would have been sampled in 2000), it is likely that competition for available food resources has increased substantially in the Hells Canyon reach.

In subsection *Primary Production and Aquatic Invertebrates* in section 3.6.2.1, we concluded that invertebrate production is likely to be substantially reduced in shallow areas that are regularly dewatered. The maximum percentage of streambed that would be dewatered due to daily flow fluctuations during the fall Chinook rearing period (March 15 to June 15) under Proposed Operations and four alternative scenarios are summarized in table 46. The percentage of the streambed that would be exposed from daily flow fluctuation under proposed operations was less than 1 percent in both the upper and lower reaches in an extremely high flow year and ranged between 5 and 8 percent in both reaches in extremely low and medium water years. The exposed area would be slightly decreased with a 6-inches-per-hour ramping rate and would be reduced to 1 to 2 percent under a 2-inches-per-hour ramping rate.

Table 46. Estimated maximum seasonal percentage of streambed that would be subject to daily dewatering during the fall Chinook rearing period (March 15 to June 15) upstream and downstream of the Salmon River under Proposed Operations and four alternative scenarios. (Source: Brink and Chandler, 2005, as modified by staff)

		Maximum Percent of Streambed Exposed Due to Load Following 0perations Between March 15 and June 15	
Scenario	**Water Year Type**	**Above Salmon River**	**Below Salmon River**
Proposed Operations	Extremely low	5	8
	Medium	7	5
	Extremely high	< 1	< 1

Scenario	Water Year Type	Maximum Percent of Streambed Exposed Due to Load Following 0perations Between March 15 and June 15	
		Above Salmon River	Below Salmon River
Scenario 1b (Year-round 2-Inches-Per-Hour Ramping Rate)	Extremely low	2	1
	Medium	2	< 1
	Extremely high	< 1	< 1
Scenario 1c (Year-round 6-Inches-Per-Hour Ramping Rate)	Extremely low	3	3
	Medium	6	3
	Extremely high	< 1	< 1
Scenario 2 (Flow Augmentation)	Extremely low	1	2
	Medium	2	< 1
	Extremely high	< 1	< 1
Scenario 3 (Navigation)	Extremely low	4	7
	Medium	6	6
	Extremely high	< 1	< 1

Another way to examine potential effects on food supply in fall Chinook rearing habitat is based on stage change. If flows are ramped down at the proposed maximum ramping rate of 12 inches per hour for 5 consecutive hours, this would result in a 60-inch change in stage at Johnson Bar, effectively dewatering all of the stream margins that had suitable depths for rearing fall Chinook salmon (< 1.5 meters [59 inches] deep) during the daytime peaking hours. The corresponding stage change that would occur under a 6-, 4- or 2-inches-per-hour ramping rate would be 30, 20 and 10 inches, respectively, indicating that more restrictive ramping rates would protect a substantial portion of the suitable fall Chinook habitat from daily dewatering. Because invertebrate production can be greatly reduced in areas that are frequently dewatered, implementing run-of-river operations or a 2-inches-per-hour or 4-inches-per-hour ramping rate would provide a substantial increase in the food that is available in habitat areas that are used by juvenile fall Chinook salmon.

If invertebrate production is reduced in areas that are frequently exposed during load following operations, this would affect the food supply for rearing fall Chinook salmon and other fish species including redband and bull trout. The reduction in growth rates of fall Chinook salmon observed in the last several years indicates that any reduction in the available food supply is likely to affect growth rates and survival of fall Chinook salmon. In addition, flow fluctuations could cause mortality of several sensitive species of mollusks, or adversely affect the quality of their habitat.

Entrapment and Stranding

In its response to AIR OP-1(f), Idaho Power conducted a study to evaluate the effects of alternative operating scenarios on fish stranding. Idaho Power used helicopter video footage of the Snake River downstream of Hells Canyon dam at a flow of 5,600 to 5,800 cfs to identify areas that formed stranded pools of water where fish could become entrapped as flows recede. From this review, Idaho Power identified 12 entrapment pools to determine the elevations and discharges at which the pools become disconnected from the river. Two of the sites were found to form entrapment pools at flows lower than the 6,500 cfs normal minimum flow proposed by Idaho Power, 3 sites formed entrapment

pools at flows between 8,000 and 16,000 cfs, and 7 sites formed entrapment pools at flows greater than 20,000 cfs (Brink and Chandler, 2005).

Idaho Power performed additional survey work in the spring of 2005 to obtain more definitive information on the flows at which potential entrapment pools become disconnected from the river, quantify the number of fish entrapped, and monitor potential losses due to stranding and entrapment (Brink, 2006). Idaho Power reported that it did not attempt to conduct surveys of stranding on cobble bars because it is difficult to detect any small fish that become stranded on coarse substrates. Pressure transducers were installed in pools to determine the flow at which pools became isolated from the river, and water temperatures were continuously monitored in most pools. Fish surveys were conducted on a weekly basis starting on March 15 and ending on June 15.

A total of 22 entrapment pools located between RM 190.5 and RM 234.1 were identified and surveyed during the spring 2005 monitoring studies. Table 47 shows the location and entrapment flow that was determined for each pool, the number of times that each pool was isolated from the river during the survey period, and the estimated number of juvenile fall Chinook salmon that died or became entrapped in each pool. In its analysis, Idaho Power assumed that no fish survived in a pool where the water temperature increased as high as 23°C. Table 48 shows the total number of fish other than wild age-0 fall Chinook salmon that were observed during the entrapment pool surveys.

Idaho Power used the survey data in combination with its 1D hydraulic model of the upper Hells Canyon reach to estimate the percentage reduction in age-0 fall Chinook mortality that would have occurred in 2005 under alternative minimum flows and ramping rates. The results of its analysis indicate that higher minimum flows up to 12,000 cfs would have prevented less than 20 percent of the estimated mortalities (table 49), while ramping rates of 4 inches per hour and 2 inches per hour were predicted to have prevented 93 and 95 percent of the mortalities, respectively (table 50). Idaho Power reported that the effectiveness of these operational constraints would vary between years depending on flow conditions in that year. We also note that reducing the ramping rate would be very likely to reduce stranding losses that may occur in cobble bars, which Idaho Power did not attempt to quantify due to the difficulty of finding stranded fish in dewatered areas with large substrate.

Reducing ramping rates during the fall Chinook rearing season would provide several benefits to juvenile fall Chinook salmon. Based on our analysis of Idaho Power's habitat modeling studies, restricting ramping rates would increase habitat stability, which would reduce energy expenditures from fish having to repeatedly move to find optimal rearing habitats or reduce food intake from residing in sub-optimal habitat. Based on our analysis of effects on invertebrate production, Idaho Power's proposed ramping rate could result in complete dewatering of favored rearing habitats (<1.5 meters deep), which would substantially reduce macroinvertebrate abundance and the food base that is available to fall Chinook salmon in their preferred rearing habitat. Furthermore, from our analysis of Idaho Power's entrapment monitoring work, we conclude that implementing more restrictive ramping rates could substantially reduce mortalities due to stranding and from entrapment.

Idaho Power identifies the primary fall Chinook rearing season to be from March 15 to June 15, while ramping rate restrictions recommended by other stakeholders to protect rearing fall Chinook salmon include March 1 to May 31 (AR/IRU), April and May (Nez Perce Tribe), and March 21 to June 21 (ODFW). Observations on emergence timing reported in Connor et al. (2002) indicate that fall Chinook salmon typically start to emerge in early April in both the upper and lower Hells Canyon reaches. Also, Idaho Power reports that juvenile fall Chinook salmon have completely emigrated from both reaches by the third week in June. Implementing restrictive ramping rates as early as March 15 would benefit rearing fall Chinook salmon by allowing macroinvertebrates time to start colonizing shoreline rearing habitats before fall Chinook fry emerge from the gravel and take up residence in these areas. In addition, maintaining a ramping rate restriction until June 15 would protect the great majority of fall Chinook salmon from the risk of entrapment and stranding losses associated with load following operations.

Table 47. Entrapment site locations, flows at which sites disconnect from the river (entrapment flow), number of entrapment events, and numbers of age-0 fall Chinook salmon estimated to be entrapped and killed between March 15 and June 15, 2005 in the upper Hells Canyon reach of the Snake River. (Source: Brink, 2006)

Site Name	River Mile	Entrapment Flow	No. of events	Entrapments		Mortalities		Temp (23°C)	Total
				Observed	Estimated	Observed	Estimated		
Knight Creek	190.5	17,314	48	406	2,692	3	16	0	16
Trail Gulch	199.3	16,923	52	158	1,105	0	0	0	0
Middle Pine Bar	227.3	15,735	60	2,203	15,842	2	14	2,000	2,014
Lower Turtle Cove	223.5	14,664	60	138	999	0	0	0	0
Saddle Creek	236	14,467	59	1,528	10,390	2	14	0	14
Lower Bernard	235	13,386	56	7	42	3	24	0	24
Lower Pleasant Valley (upper)	213.8	12,619	55	13	74	7	43	7	50
Imnaha	191.7	12,589	54	1,967	12,913	0	0	0	0
Dug Bar	196.1	11,560	48	3	18	2	14	2	16
Russell Bar	219.7	11,309	46	1,443	8,853	4	24	0	24
Durham Bar (pools nos. 2 to 5)	217.5	11,154	46	10,362	55,527	2	17	0	17
Big Sulfur	200	11,007	46	1,681	10,579	1	14	0	14
Dry Creek	200.9	10,756	46	1	7	2	14	0	14
Durham Bar (pool no. 1)	217.5	10,668	45	242	1,400	0	0	0	0
Upper Kirby (downstream)	219.5	10,467	45	1	7	2	14	0	14
Lower Pine Bar	227.1	10,301	43	2,087	13,054	0	0	0	0
Upper Kirby (upstream)	219.5	9,931	43	4	23	1	7	1	8
Hat Creek	235.6	9,919	43	160	391	1	2	0	2
Little Bar	224.9	9,879	43	3,606	22,149	43	196	0	196
Lower Pleasant Valley (lower)	213.8	9,347	39	262	1,364	1	1	140	141
Lower Campbell	205.1	9,195	38	61	275	0	0	77	77
Dry Basin	234.1	8,960	32	36	142	1	2	0	2
		Totals	1,047	26,369	157,846	77	416	2,227	2,643

Table 48. Total number of fish other than wild age-0 fall Chinook salmon encountered during entrapment pool surveys conducted in the upper Hells Canyon reach of the Snake River in 2005. (Source: Brink, 2006, as modified by staff)

	Sampling Method				
Species	**Snorkel Counts**	**Visual Observations**	**Beach Seine**	**Hand Dip Net**	**Electro-fishing**
Hatchery fall Chinook	0	1	0	0	0
Wild spring Chinook	0	2	0	1	0
Hatchery spring Chinook	0	1	0	0	0
Wild steelhead	1	38	0	0	0
Hatchery steelhead	0	25	0	0	0
Smallmouth bass	13	260	3	0	6
Crappie spp.	0	0	2	0	0
Carp	62	142	0	0	30
Largescale sucker	1	2	0	0	0
Bluegill	0	0	0	0	10
Northern pikeminnow	0	0	0	0	1
Sculpin spp.	0	2	0	1	0
Cyprinid spp.	100	175	0	0	0
Yellow perch	0	1	0	0	0

Table 49. Estimated age-0 fall Chinook salmon entrapment losses under the 2005 minimum flow (8,700 cfs) and three alternative modeled flows released from Hells Canyon dam. (Source: Brink, 2006)

Minimum Flow (cfs)	**Events**	**Estimated Number Entrapped**	**Estimated Total Mortalities**	**Mortality Rate (%)**	**Reduction in Entrapment (%)**	**Reduction in Mortality (%)**
8,700	1,047	157,846	2,643	1.67	--	--
10,000	809	133,502	2,217	1.66	15.42	16.12
11,000	630	119,034	2,189	1.84	24.59	17.18
12,000	444	44,057	2,118	4.81	72.09	19.86

Table 50. Estimated age-0 fall Chinook salmon entrapment losses under the 2005 ramping rate (12-inches-per-hour) and three alternative ramping rates applied to Hells Canyon dam operations at an inflow of 11,340 cfs (observed April 26, 2005). (Source: Brink, 2006)

Ramping Rate (per hour)	Events	Estimated Number Entrapped	Estimated Total Mortalities	Mortality Rate (%)	Reduction in Entrapment (%)	Reduction in Mortality (%)
12 inches	1,047	157,846	2,643	1.67	--	--
6 inches	838	152,268	2,407	1.58	3.53	8.93
4 inches	589	112,864	187	0.17	28.50	92.92
2 inches	295	87,964	121	0.14	44.27	95.42

Most of the agencies, tribes, and NGOs recommend ongoing monitoring and adaptive flow management to protect juvenile fall Chinook salmon from stranding and entrapment losses during the rearing and outmigration period. NMFS also recommends that sufficient flow be released each day during the fall Chinook rearing season to reconnect the largest entrapment areas for at least 2 hours each day and increase minimum flows to 11,500 cfs if water temperatures in entrapment pools exceed 16°C for more than 3 days or when peak water temperatures in any pool exceed 18°C for more than 4 hours.

The level of protection that is provided by a specific ramping rate or minimum flow would vary between years, depending on overall flow levels. In addition, the monitoring conducted to date has focused exclusively on juvenile fall Chinook salmon, and has not included monitoring of stranding and entrapment of bull trout. Therefore, monitoring of fall Chinook salmon and bull trout entrapment and stranding would help to identify whether any changes in project operation or other protective measures would be beneficial. For example, fish salvage operations would be beneficial when water temperatures increase to high levels in entrapment pools that are occupied by juvenile fall Chinook salmon, or when occupied pools become disconnected from the river as seasonal flows recede. It would also be beneficial to extend monitoring studies to include habitat downstream of the Salmon River, which does not appear to have been included in Idaho Power's 2005 surveys. Elements that should be considered as part of a monitoring plan include monitoring stranding on cobble bars and entrapment of fish in key pools, determining flows needed to reconnect those pools on a daily basis, mark/recapture surveys to monitor fish distribution, survival assessments, and conducting salvage operations as necessary.

The benefits of NMFS's recommendation that a minimum flow of 11,500 cfs be provided when water temperatures rise to high levels in entrapment pools are uncertain, since most of the 2005 mortalities occurred at the middle Pine Bar pool, which Brink (2006) reports became disconnected from the river at a flow of 15,735 cfs (table 47). However, the benefits of this type of operational measure could be evaluated, refined, and implemented through an adaptive management process.

Finally, we are not convinced that the multi-year ramping rate study recommended by FWS and the Forest Service (table 43) is feasible or warranted. This measure would involve monitoring operational effects on periphyton and aquatic invertebrate productivity during a three-phased operational test period extending over several years, including: (1) 12-inches-per-hour ramping rate measured within 1 mile of Hells Canyon dam; (2) the same ramping rate with DO enhancement to achieve a DO level of 6 mg/L or as high as possible; and (3) run-of-river operation at Hells Canyon dam, with continued DO enhancement. We question two aspects of the proposed ramping rate study recommended by FWS and the Forest Service. First, the schedule for implementing DO measures is likely to be established in the water quality certificate for the project, and it is likely that the certificate will require DO measures to be implemented as soon as practical after license issuance. Second, the program recommended by FWS and the Forest Service would not be likely to allow a sufficient amount of time to monitor the effect of implementing a

12-inch-per-hour ramping rate measured within 1 mile downstream of Hells Canyon dam, which would be more restrictive than Idaho Power's current and proposed ramping rates that would be measured at Johnson Bar. Instead, implementing a comprehensive periphyton and invertebrate monitoring program under the existing and proposed ramping rate would supplement information already collected by Idaho Power at this ramping rate, and would provide a more robust data set to determine the effects of any DO measures that are implemented under a new license. As we discuss in section 3.6.2.15, *Benthic Community Monitoring*, a well-designed monitoring program could assess the effects of load following operations on periphyton and invertebrate production by comparing and evaluating species composition and abundance in areas that have been dewatered at different frequencies over a range of hydrologic year-types. Therefore, we conclude that a comprehensive periphyton and invertebrate monitoring program conducted under the existing and proposed ramping rate, in conjunction with monitoring fish stranding and entrapment, would provide sufficient information to determine whether any further restrictions on ramping rates would be warranted to improve invertebrate production or to reduce fish stranding and entrapment.

Anadromous Fish Juvenile Migration

Project operations could potentially affect downstream migration conditions for anadromous fish produced in the mainstem of the Snake River and its tributaries and, to a lesser extent, fish that emigrate through the Lower Columbia River. Juvenile fall Chinook salmon emigrating from the Hells Canyon reach have the greatest potential to be affected, especially in the reach upstream of the Salmon River where flow and water temperatures are most strongly affected by project operations.

Juvenile fall Chinook salmon historically migrated from the Snake River in May and June, but impoundment of the river and blocked access to historical habitats has led to delayed migration in late June, July, and early August (NMFS, 1999). The thermal regime in the historical production area upstream of the project, which was primarily between Auger Falls (RM 607) and Huntington (RM 328), was influenced by substantial spring inflows and promoted early emergence, rapid growth and early emigration. Current spawning locations are generally cooler compared to the historical production area because they are farther removed from the Thousand Springs reach near Upper Salmon Falls, where spring-inflows provided a warmer incubation and early rearing environment. Loss of access to these spring-influenced production areas resulted resulting in reduced growth potential and delayed emigration of juvenile fall Chinook salmon, which is associated with reduced survival (Connor et al., 1998; Smith et al., 2003). These adverse effects have been compounded by the construction of additional dams on the lower Snake and Columbia rivers, through increased water temperatures, increased predation, and slower migration. According to data from PIT-tag detections,[69] during the past decade the timing of outmigration past Lower Granite dam has advanced by several weeks and the average size of fall Chinook migrants has decreased, apparently due to increased competition for food and space as the number of adult returns has increased approximately 20-fold.

From 1989 to 2000, as part of a comprehensive Snake River flow augmentation effort, Idaho Power released an average of 224 kaf of water from Brownlee reservoir to enhance migration of juvenile fall Chinook salmon. From 1996 through 2000, the augmentation flows were made as part of an energy exchange agreement between Idaho Power and BPA. That agreement expired in April 2001 and was not renewed by BPA. However, from 2002 through 2004, at the request of the Governor of Idaho, Idaho Power cooperated with a rental program initiated by BOR to assist with meeting its commitment to provide 427 kaf of flow augmentation water from the upper Snake River basin. Idaho Power leased the natural flow water rights that were acquired by the BOR from the state water bank for power purposes to

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[69] Summarized by NMFS in its letter filed January 26, 2006, stating recommended terms and conditions.

ensure that the BOR rentals complied with state law and passed that water through the project. BOR and BPA were responsible for these costs. Additional augmentation flows were resumed in 2005 as part of an interim agreement to protect federally listed fall Chinook salmon (see figure 70). During the period 1991 through 2000, annual flow augmentation from the upper Snake River basin ranged from 90,000 to 437,281 acre-feet and averaged 371,188 acre-feet. Under the recent Nez Perce settlement, BOR has committed to provide 427 kaf from the upper basin each year for the next 30 years.

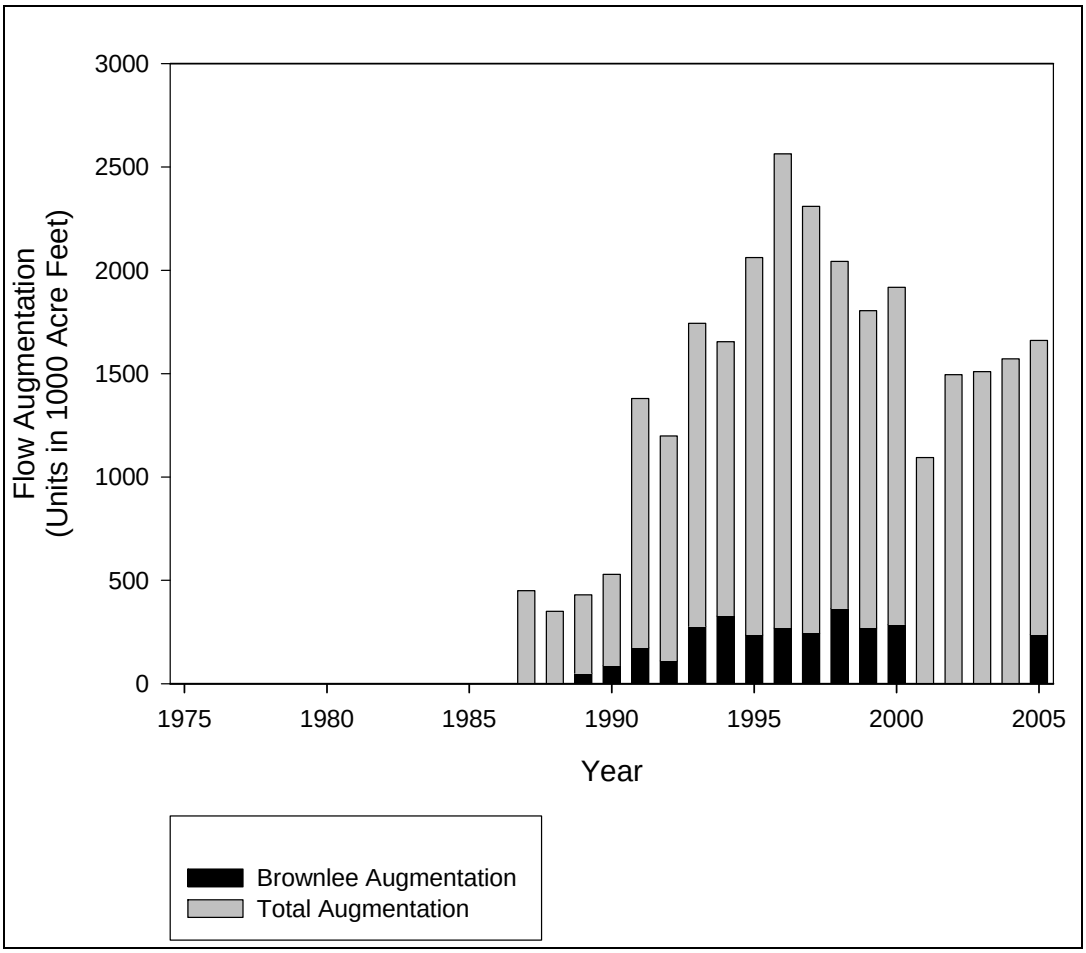

Figure 70. Flow augmentation water provided from Brownlee reservoir and total flow augmentation water provided from the Snake River basin. (Source: Staff)

Idaho Power does not propose any measures to enhance migration conditions for juvenile fall Chinook salmon. However, flow augmentation was recommended by several resource agencies, tribes, and other interested parties as a method to enhance migration by increasing flow through the lower Snake and Columbia River projects (see table 9). Specific recommendations fall into six general categories: (1) providing 237 kaf of flow augmentation water from Brownlee reservoir during the summer subyearling fall Chinook outmigration season; (2) requiring Idaho Power to provide timely passage of flows released from upstream BOR storage facilities; (3) requiring Idaho Power to "shape" or pre-release water to be made up by later deliveries from BOR storage reservoirs; (4) requiring that Idaho Power refill Brownlee reservoir as early as possible to avoid reducing outflows during the spring outmigration season of yearling Chinook salmon and steelhead smolts; (5) managing Brownlee reservoir to maximize flow augmentation during the spring and summer smolt migration seasons using real-time management based on January-July runoff forecasts; and (6) shifting flood control responsibilities to Lake Roosevelt (Grand

Coulee reservoir) on the upper Columbia River to increase flows through the Snake River during the smolt migration season.

Our Analysis

Several studies provide evidence that increasing flows during the fall Chinook subyearling smolt outmigration may increase migration speed and improve survival. Smith et al. (2003) analyzed data from 1995 through 2000 on the survival of PIT-tagged subyearling fall Chinook salmon released into free-flowing sections of the Snake River from mid-June through July. The estimated survival from the point of release to the tailrace of Lower Granite dam decreased for fish released later in the season (figure 71). Estimated survival for the early release groups ranged from 45 to 76 percent, but was 20 percent or less for the later release groups. This decrease in survival was correlated with decreased discharge, increased water transparency, and increased water temperature (figure 72).

Similarly, Connor et al. (2003a) modeled the effect of flow, temperature, and three other factors (initial tagging date, fork length on tagging date, and riverine distance traveled before reaching Lower Granite dam) on the rate of seaward migration of subyearling fall Chinook salmon. Flow and temperature influenced migration rate in the free-flowing sections of the river upstream of the fish's first encounter with a dam, but not in the period between passage at the first dam and the next dam downstream. Connor et al. (2003a) concluded that flow augmentation increases the rate of seaward movement in free-flowing sections of the river.

Connor et al. (1998) analyzed the survival rate of wild subyearling fall Chinook salmon released upstream of Lower Granite dam between 1992 and 1995. They found that detection of fish at the dam was positively related to mean summer flow and negatively related to maximum water temperature (figure 73). Connor et al. (1998) concluded that summer flow augmentation would be a beneficial interim recovery measure because it would increase flow and decrease water temperatures.

In some cases, flow and temperature can account for more than 90 percent of the variability in salmon survival. Connor et al. (2003b) released four cohorts (marked release groups) of wild subyearling fall Chinook salmon in free-flowing sections of the Snake River each year from 1998 to 2000 and compared the probability of survival for the groups. In general, survival increased with increasing flow and decreased with increasing temperature. Connor et al. (2003b) developed a predictive model of survival that included the following variables: (1) tagging date, (2) mean fork length, (3) flow exposure index (mean flow during the period when the majority of smolts within a cohort passed Lower Granite dam), and (4) water temperature exposure index (mean temperature during the period when the majority of smolts within a cohort passed Lower Granite dam). Ninety-two percent of the observed variability in survival between the four groups was attributed to flow and temperature. Using this model, Connor et al. (2003b) estimated the survival that would have occurred in the absence of flow augmentation. In all cases, the model predicted greater survival of subyearling Chinook salmon with flow augmentation than without (figure 74).

Flow augmentation from the Snake River basin may also provide benefits to smolts migrating through the Lower Columbia River migratory corridor. Williams et al. (2006) found that the survival rates of subyearling fall Chinook salmon traveling from the McNary dam tailrace to the John Day dam tailrace was positively correlated with flow, temperature, percent spill and water clarity. However, after the data were adjusted for annual means to remove generalized year effects, only flow was significantly correlated with survival (figure 75). In the multiyear analysis, the regression line slopes for adjusted and unadjusted flow were nearly the same and showed that, on average, each 10,000 cfs increase in the flow index was associated with a 1.3 to 1.5 percent increase in survival.

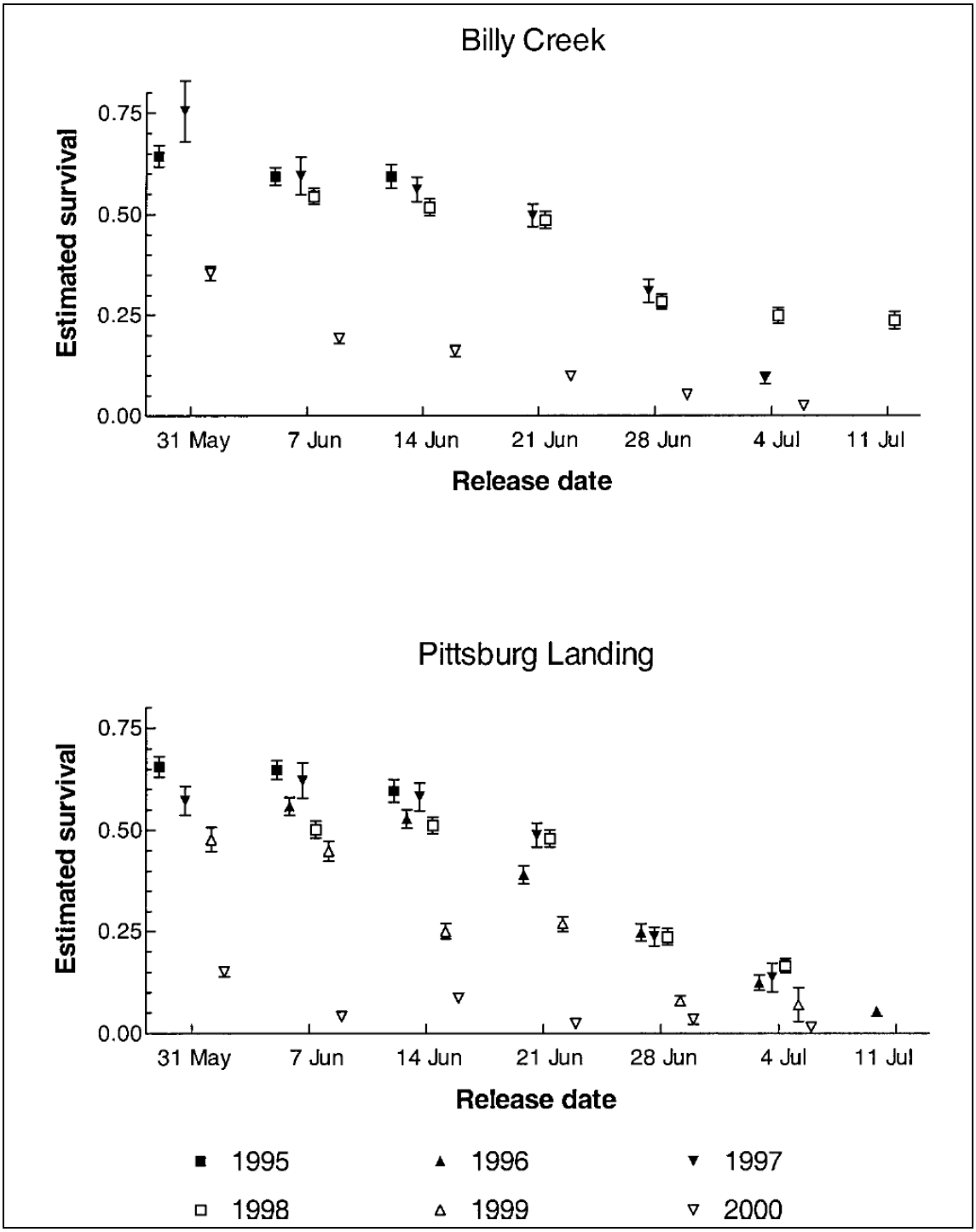

Figure 71. Estimated survival probabilities (with standard errors) from the point of release in the Snake River (Billy Creek [RM 164.7] or Pittsburg Landing [RM 215]) to the tailrace of Lower Granite dam for PIT-tagged hatchery fall Chinook salmon, 1995–2000. (Source: Smith et al., 2003)

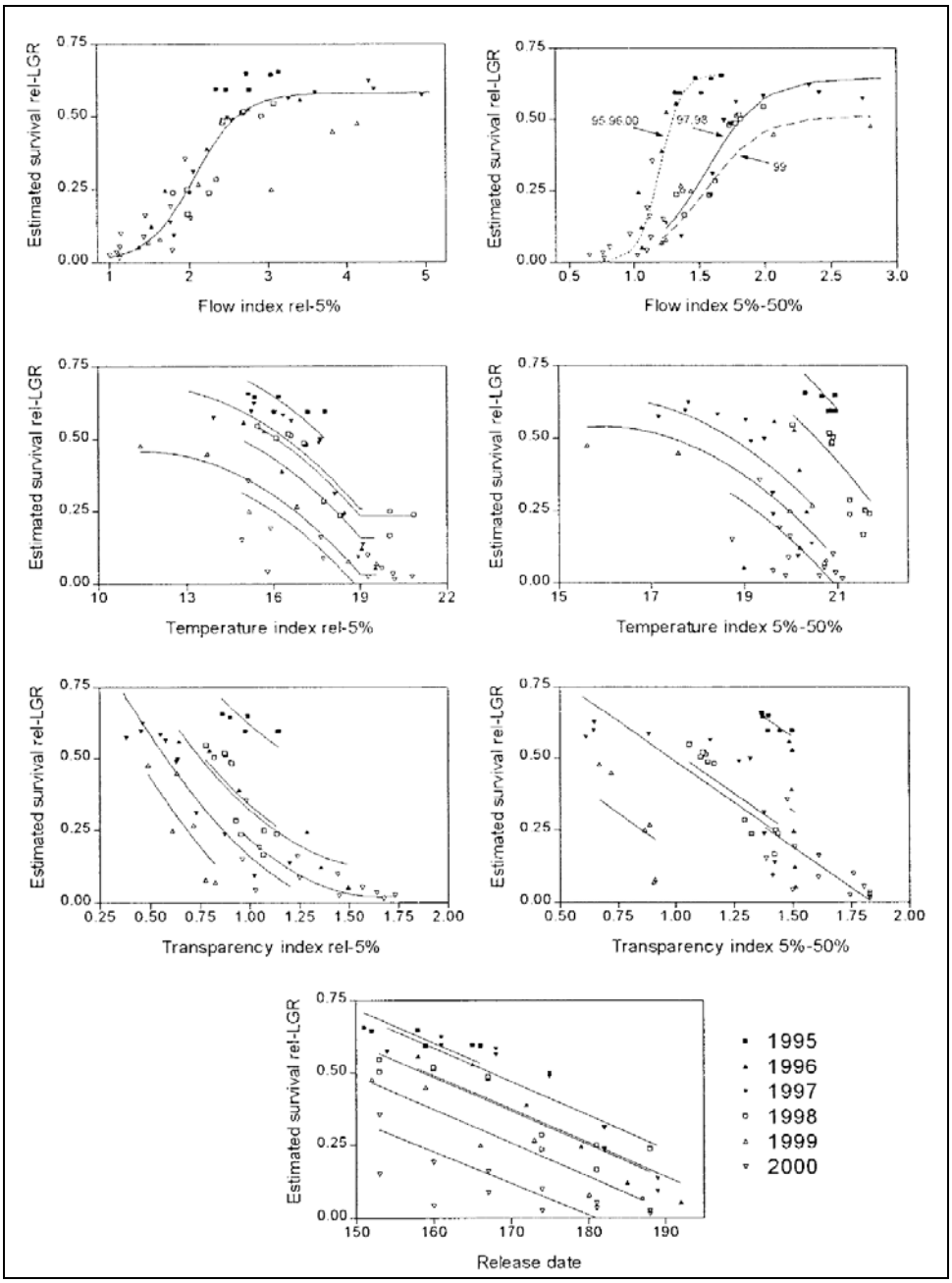

Figure72. Relations between the estimated probability of survival to Lower Granite dam and indices of discharge, temperature, and transparency and release date for groups of PIT-tagged hatchery fall Chinook salmon released at Pittsburg Landing and Billy Creek on the free-flowing Snake River, 1995–2000. Lines illustrate descriptive models selected from generalized additive and linear regression analyses. Indices of exposure for each group were defined as the averages of the daily values of the three river condition variables (flow, temperature, and transparency) during each index period. (Source: Smith et al., 2003)

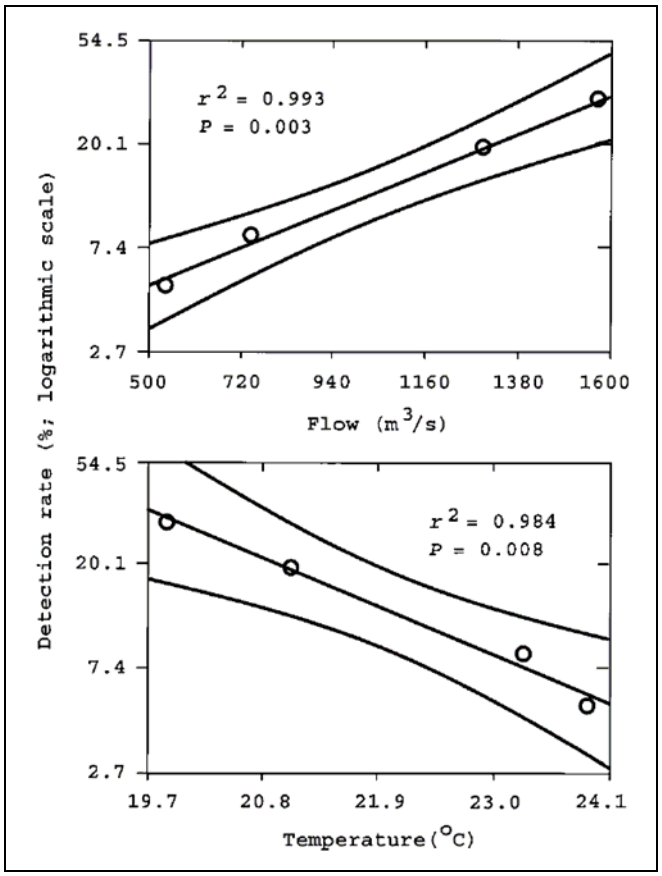

Figure 73. Detection rate of PIT-tagged Snake River subyearling Chinook salmon at Lower Granite dam, 1992–1995 and its relation to mean summer flow (top) and maximum summer water temperature (bottom) in Lower Granite reservoir. Ninety-five percent simultaneous confidence intervals are shown on either side of the regression lines. (Source: Connor et al., 1998)

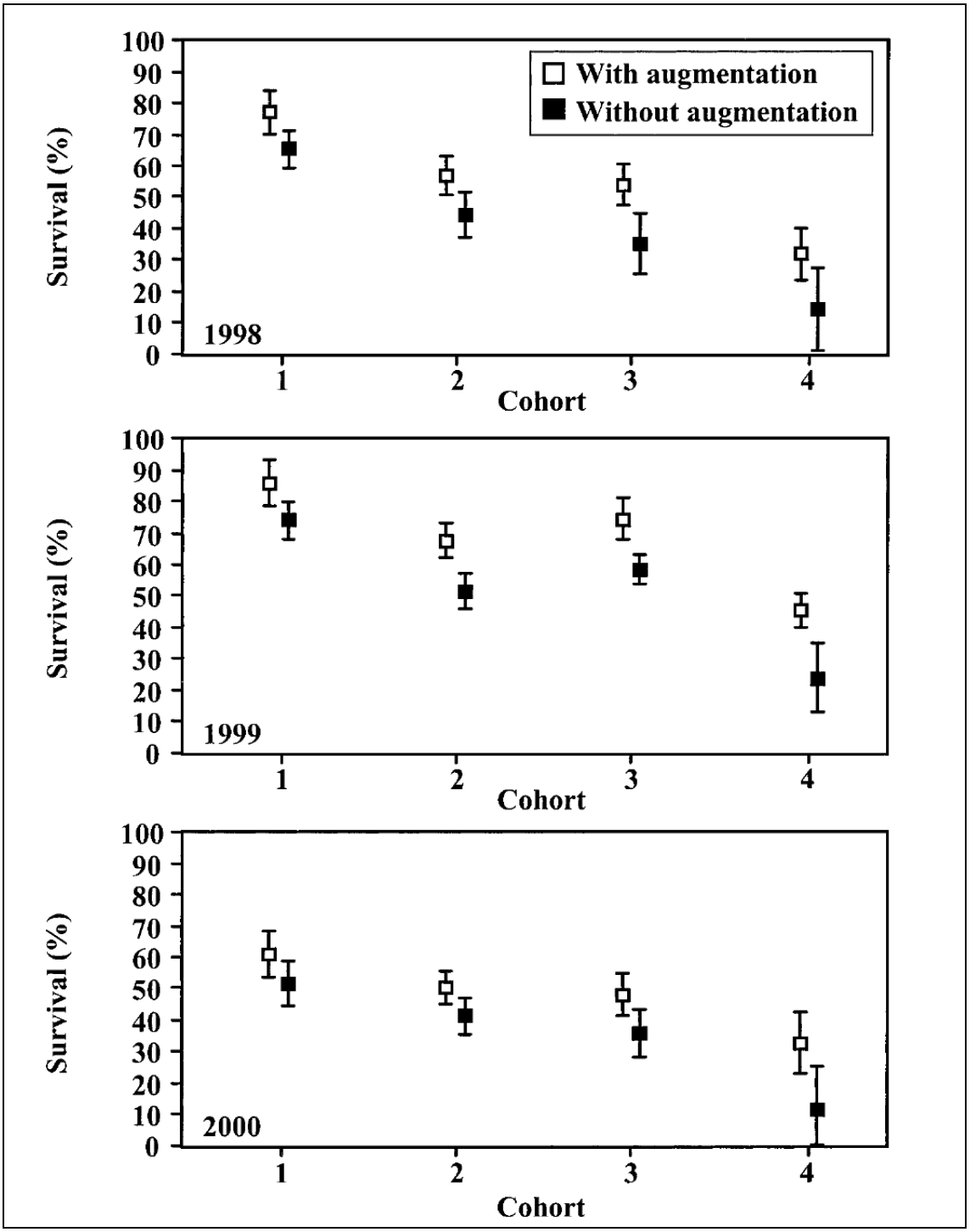

Figure 74. Survival (with 95 percent confidence intervals) to the tailrace of Lower Granite dam for PIT-tagged wild subyearling fall Chinook salmon in 1998 (top), 1999 (center), and 2000 (bottom), predicted from mean flows and water temperatures with and without summer flow augmentation. (Source: Connor et al., 2003b)

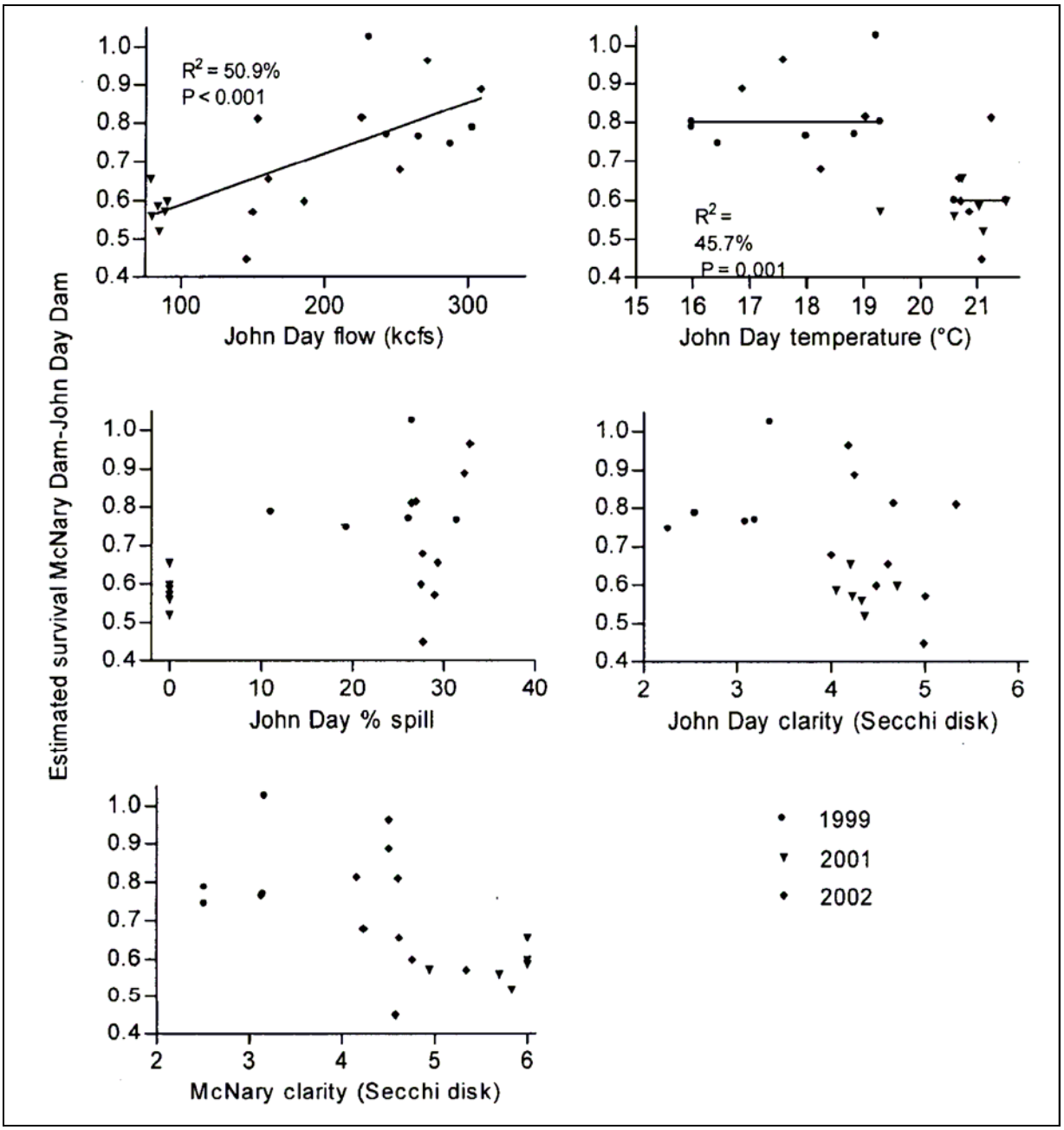

Figure 75. Estimated survival between McNary dam tailrace and John Day dam tailrace plotted against various river condition indices for run-of-river subyearling Chinook salmon released in tailrace of McNary dam, 1999, 2001, and 2002. Flow index panel illustrates simple linear regression line without year effects. Temperature index panel illustrates constant mean survival above and below 20°C. (Source: Williams et al., 2005)

Although the studies summarized above indicate that summer flow augmentation downstream of the project benefits outmigrating subyearling fall Chinook salmon by increasing flow volume and reducing travel time, releasing large volumes of summer flow augmentation water from Brownlee reservoir has the potential to adversely affect subyearling fall Chinook migrants by increasing water temperatures downstream of Hells Canyon dam. In its response to AIR OP-1(e), Idaho Power used a 2-dimensional laterally averaged model (CE-QUAL-W2) to simulate the temperature effects of augmenting river flows by releasing 350,000 acre-feet of storage from Brownlee reservoir during the month of July in 5 representative water years (Scenario 2, Flow Augmentation) (Idaho Power, 2005b). In most cases, there was little temperature effect downstream of the project. However, in an extremely low flow year (1992), simulated water temperatures downstream of Hells Canyon dam increased by up to 2°C under the Flow Augmentation Scenario (figure 76). This temperature increase is likely offset by increased resistance to warming as the higher flow volume passes through the Hells Canyon reach. In addition, downstream of the confluence with the Clearwater River, the effect of warm water released from Brownlee reservoir is compensated for by managed releases of cooler augmentation water from Dworshak dam. Because the majority of fall Chinook salmon that rear in the Hells Canyon reach have begun their seaward migration by early July, most smolts are in and below Lower Granite reservoir by the time flow augmentation water is released from Brownlee reservoir (starting in late June) and few smolts are likely to be affected by any increase in water temperature that occurs in the Hells Canyon reach. In higher water years when the simulated temperature of outflows from Hells Canyon dam was similar to those simulated under Proposed Operations, downstream temperatures in the lower part of the Hells Canyon reach would probably be slightly reduced under the Flow Augmentation Scenario due to reduced warming.

In its April 11, 2006, reply comments on recommended terms and conditions, Idaho Power cites recent testimony from NMFS and other scientists indicating that there is considerable disagreement on the benefits of flow augmentation for Snake River fall Chinook salmon. Part of this uncertainty relates to a recent analysis of scales taken from adult fall Chinook salmon in 2004, which indicated that fall Chinook juveniles that overwinter in the river/reservoir environment before completing their migration the following spring may contribute more than half of the adult returns. In its comments on the draft EIS, NMFS states that its recommendation to maintain Brownlee elevations to within 1 foot of the April 15 and April 30 minimum flood control requirements should benefit these spring migrating fish by minimizing the amount of reservoir space that needs to be refilled to meet summer flow augmentation requirements and minimizing any reduction in flows during the spring migration season. NMFS also states that the proportion of fish from each spawning area that overwinters in the river/reservoir environment is unknown, but fish that adopt this life-history strategy appear to be predominantly from the cooler water spawning and rearing areas and not from the mainstem Snake River that is the most directly affected by project operations.

In 2003, the Independent Scientific Advisory Board (ISAB) completed a review of flow augmentation at the request of the Northwest Power Planning Council. ISAB (2003) concluded that "*there is a range of flow over which survival of PIT-tagged smolts increase with increasing flow and a range of higher flows in which fish survival appears to be independent of incremental changes in flow*." ISAB identified this "break point" to be around 50,000 cfs for the summer-migrating subyearling fall Chinook salmon and 100,000 cfs for spring-migrating yearling Chinook salmon. ISAB further concluded that several parameters that may affect survival are correlated with flow, that there is uncertainty regarding their effects, and that deliberately designed experiments may be needed to determine the effects of these variables. Variables identified by the ISAB include water temperature, water clarity, fluctuations in dam discharges, gas supersaturation, the timing of entry to the estuary and the ocean, and ocean conditions.

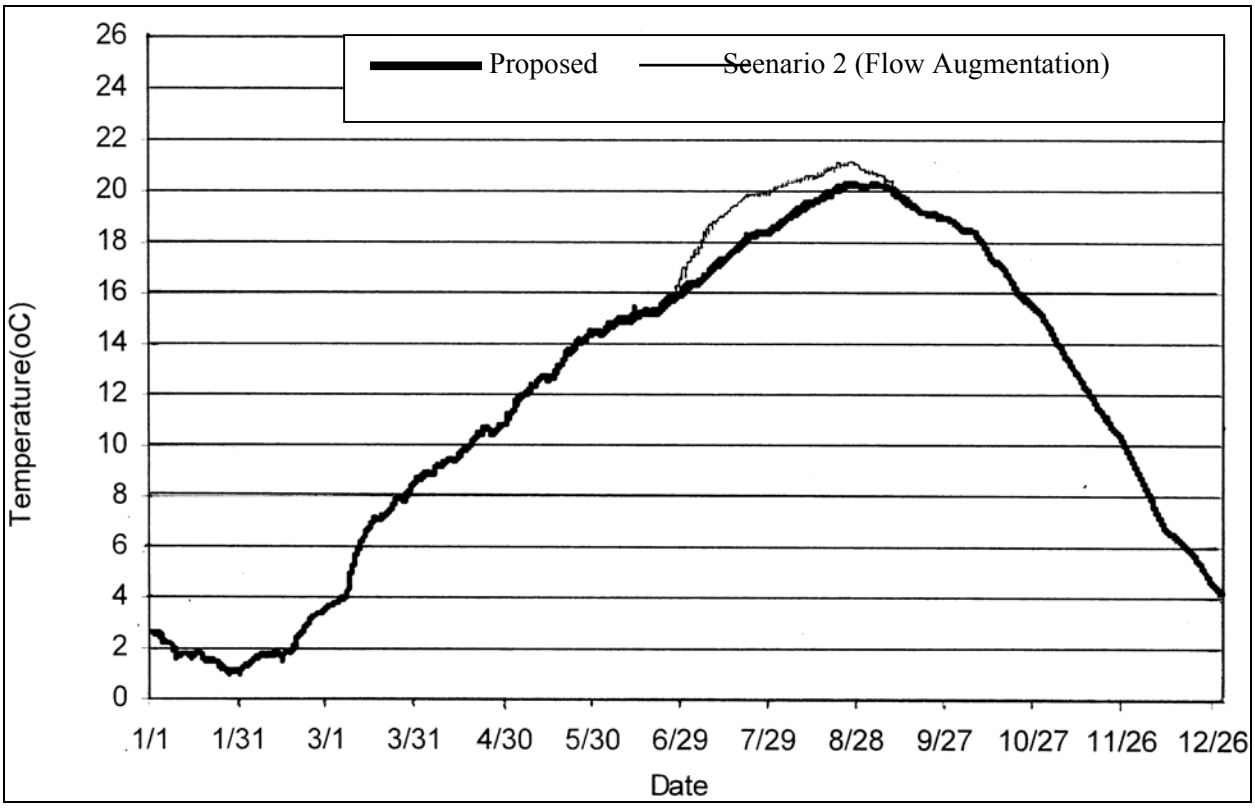

Figure 76. 1992 simulated hourly Hells Canyon outflow temperatures for the Flow Augmentation Scenario and Proposed Operations. (Source: Idaho Power, 2005b

A review of trends in adult fall Chinook returns lends further support to the ISAB conclusion that there is a generally positive relationship between flow and survival for outmigrating fall Chinook salmon. There has been a substantial increase in adult fall Chinook returns past lower Granite dam, closely tracking with both the total flow augmentation provided from the Snake River basin (figure 77) and flow augmentation provided from Brownlee reservoir (figure 78) during the year of outmigration. However, we note that this increase also corresponds with a substantial increase in the number of yearling and subyearling fall Chinook salmon that have been released from acclimation sites upstream of lower Granite dam (table 51). Other factors that may have contributed to increasing returns include ocean conditions favorable to survival and improvements in the passage survival of juvenile salmonids migrating through the Lower Columbia River migratory corridor.

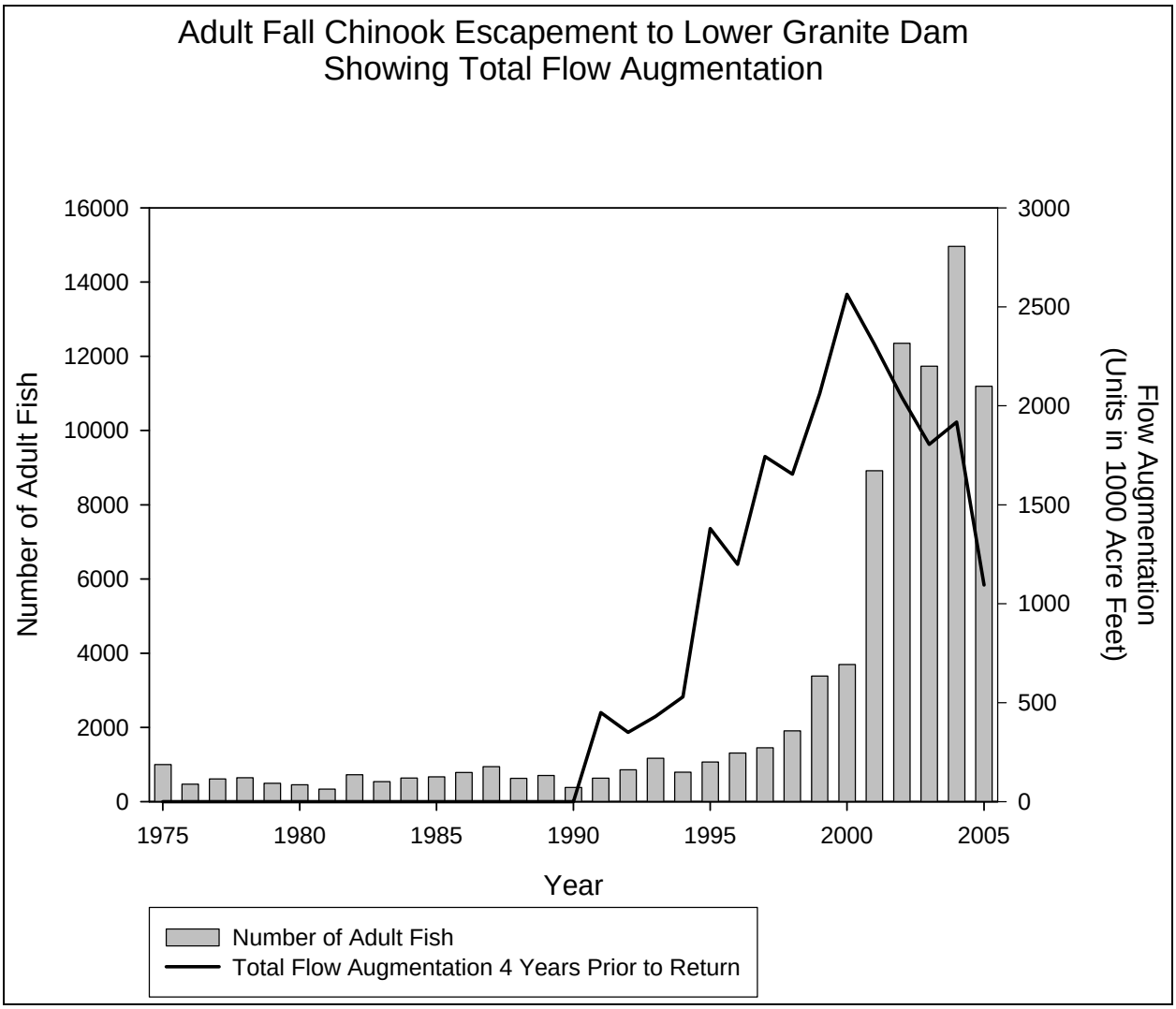

Figure 77. Total adult fall Chinook salmon passing Lower Granite dam and total flow augmentation volume provided from the Snake River basin during the primary year of outmigration (4 years prior to adult return data). (Source: Staff, based on FPC, 2006)

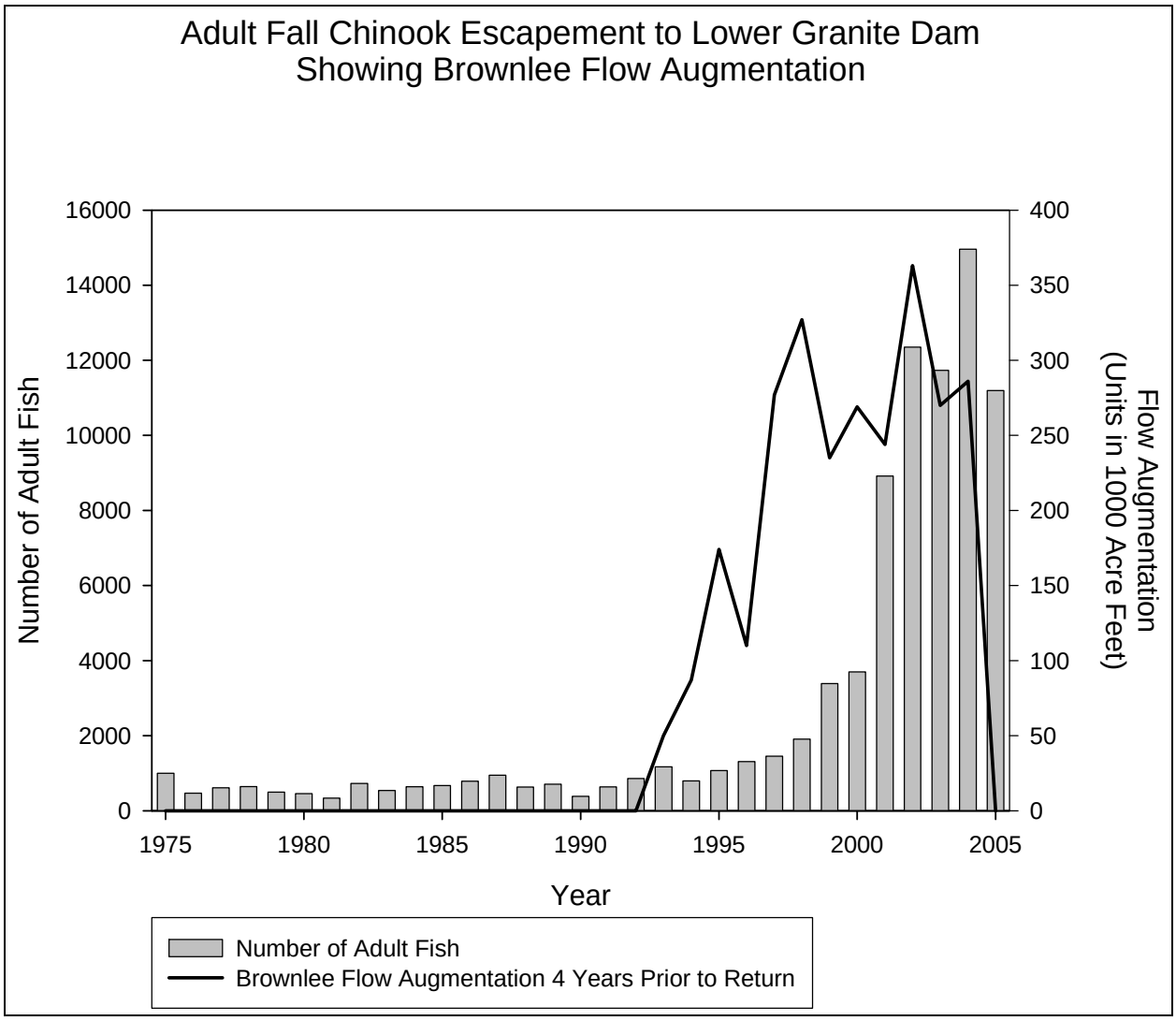

Figure 78. Total adult fall Chinook salmon passing Lower Granite dam and total flow augmentation volume provided from Brownlee reservoir during the primary year of outmigration (4 years prior to adult return data). (Source: Staff, based on FPC, 2006)

Table 51. Total number of yearling and subyearling fall Chinook salmon released from acclimation sites in the Hells Canyon reach (Pittsburg Landing and Captain John Rapids) and in the Clearwater River (Big Canyon), fall Chinook returns over Lower Granite dam, and redd counts in the Clearwater and Snake rivers. (Source: McLeod, 2006).

Year	Total Number of Yearlings Released	Total Number of Sub-yearlings Released	Number of Adult Fall Chinook Salmon Passed over Lower Granite Dam	Number of Fall Chinook Salmon Redds in the Clearwater River	Number of Fall Chinook Salmon Redds in the Snake River
1995	0	0	1,067	20	65
1996	114,299	0	1,308	69	104
1997	345,769	252,705	1,451	72	58
1998	336,191	0	1,909	78	185
1999	529,503	670,033	3,384	184	373
2000	397,339	2,183,447	3,602	180	346
2001	318,932	1,732,167	8,915	336	770
2002	479,358	2,398,079	12,347	527	1,113
2003	437,633	1,700,758	11,724	571	1,524
2004	414,452	1,337,420	14,960	630	1,718

We anticipate that new information will continue to be developed, which we expect to improve our understanding of the physical and biological effects of providing flow augmentation water from Brownlee reservoir. For example, in its draft EIS comments, IDFG cited a recent study funded by BPA (Cook et al., 2006) that modeled the effects of flow releases from Dworshak dam and from Brownlee reservoir on stratification and water temperatures in the four lower Snake River reservoirs. The results suggest that releasing too large a volume of water from the upper Snake River may increase mixing and, therefore, increase summer temperatures in an otherwise cooler hypolimnion, which may also affect the temperature of outflows from Lower Granite reservoir. Based on this work and the likelihood that more information will become available in the future, we conclude that reviewing this information would likely be beneficial to determine whether the information warrants any adjustments to the timing or volume of flow augmentation water that is delivered from Brownlee reservoir.

In the draft EIS, we stated that the discontinuation of flow augmentation from Brownlee reservoir from 2001 through 2004, as shown on figure 70, provided an opportunity to assess the effects of this change on adult fall Chinook salmon returns. We noted that fish that emigrated during this period will return predominantly as 4-year-old fish between 2005 and 2008, and concluded that evaluating adult return trends through 2008 could improve our understanding of the effects of providing flow augmentation water from Brownlee reservoir. In their comments on the draft EIS, multiple parties indicated that they considered this expectation to be unrealistic, given that many factors influence the

number of adult fall Chinook salmon that return to the Snake River. Also, NMFS commented that re-evaluating the benefits of flow augmentation in 2009, as detailed in the Staff Alternative in the draft EIS, introduced uncertainty that would impede efforts to complete ESA section 7 consultation for listed salmon and steelhead ESUs. We recognize these concerns, and have developed an alternative approach that would defer the re-evaluation until 6 years after license issuance, remove the focus of the evaluation on adult returns, and include consultation with NMFS to determine whether formal consultation should be reinitiated before any change in Idaho Power's participation in the flow augmentation program is adopted. We conclude that these revisions should effectively address the concerns raised by NMFS and other stakeholders regarding the proposed flow augmentation evaluation report.

The Nez Perce Tribe's recommendation (NPT-7) to manage Brownlee reservoir to maximize flow augmentation during the spring and summer smolt migration seasons includes three components: (1) drafting Brownlee Reservoir by May 15 to augment flows during the spring outmigration period; (2) refilling Brownlee Reservoir by June 15 while passing some portion of inflows during this period; and (3) drafting Brownlee for summer flow augmentation by August 1 and then refill to a level necessary to provide minimum flow of 9,000 cfs for fall Chinook spawning and incubation below the Project. Drawing Brownlee reservoir down to augment river flows during the spring would likely provide some benefits to yearling smolts that outmigrate during the spring, but the findings of the ISAB that we summarized above suggest that augmentation of river flows during this period may provide little or no benefit when flows passing Lower Granite dam are in excess of about 100,000 cfs. In addition, reducing outflows from the project when Brownlee reservoir would be refilled (between May 15 and June 15) could adversely affect juvenile fall Chinook salmon that are rearing or outmigrating through the Hells Canyon reach during this time period.

As noted previously and shown in figure 38, PIT-tag detections at Lower Granite dam indicate that there has been a distinct trend toward earlier emigration of subyearling fall Chinook smolts between 1993 and 2005, with data from 2003 through 2005 indicating that the peak migration occurred between June 1 and July 15. Because most fall Chinook subyearlings typically spend between 20 and 40 days within Lower Granite reservoir before passing Lower Granite dam (Connor et al., 2003), this means that peak emigration from the Hells Canyon reach into Lower Granite reservoir likely occurs from early May into mid-June, coinciding with the period in which Brownlee reservoir would be refilled under the Nez Perce Tribe's recommendation, which could adversely affect the survival of subyearling smolts migrating from the Hells Canyon reach. Finally, although we recognize that maximizing the volume of flow augmentation water provided from Brownlee reservoir during medium and high water years could provide survival benefits to subyearling migrants, we note that the ISAB concluded that the survival rate of subyearling fall Chinook salmon appeared to be independent of flow at river flows exceeding about 35,000 cfs at Lower Granite dam. However, we recognize that the relationship between survival rates and flow may have changed with the implementation of increased summer spills at the downstream Federal Columbia River Power System projects, and that additional evaluation of the potential benefits of increasing flow augmentation volumes in medium and high flow years is probably warranted.

The recommendations to provide timely pass-through of augmentation water released from BOR's storage reservoirs in the upper Snake River basin relate to a concern that Idaho Power could delay passage of this water through Brownlee reservoir to benefit power production at the project. Delaying passage of water could reduce the level of benefit that is provided to outmigrating juvenile anadromous fish. Because Brownlee reservoir provides more than 96 percent of the active storage at the project, we conclude that adoption of measures NMFS-8 (maintain Brownlee reservoir levels within 1 foot of the April 15 and April 30 minimum flood control requirements) and NMFS-9 (draw Brownlee down to 2,066 by July 15 and 2059 by July 31) would ensure that flow augmentation water is passed through the project in a timely manner during the juvenile salmonid migration period, as intended.

The recommendations pertaining to the pre-release (also referred to as "shaping") of augmentation water released from BOR's storage reservoirs could help to ensure that augmentation water

is delivered to the Snake River below Hells Canyon dam in a period that would provide maximum benefits to outmigrating juvenile anadromous fish. In its justification for flow shaping (measure Interior-22), BOR indicated that in past years, operational considerations at BOR and at other Idaho Power developments have made it hard to deliver all of its augmentation water by August 31. During the section 10(j) meeting, Idaho Power reported that BOR has developed approaches for managing its storage facilities that have allowed its augmentation water to be delivered to the lower Snake River in a timely fashion.

The recommendations pertaining to refilling Brownlee reservoir as early as possible while meeting flood control obligations are directed toward avoiding excessive reductions in outflows from the project during the spring migration season for yearling steelhead and Chinook salmon smolts. Preventing such flow reductions would help to maintain suitable migration flows for spring-migrating yearling Chinook salmon and steelhead produced in the Salmon River, other Snake River tributaries, and to a lesser extent, spring migrants passing through the Lower Columbia River. These flows would also benefit yearling fall Chinook salmon that are produced in the Clearwater River and the portion of the fall Chinook salmon migrants that overwinter in the Snake River before migrating as yearlings.

Based on runoff forecasts, the Corps establishes flood control curves that specify maximum Brownlee reservoir elevations for February 28, March 31, April 15, and April 30. NMFS (NMFS-8) recommends that Brownlee reservoir be refilled to within 1 foot of the April 15 and April 30 minimum elevations necessary to meet the Corps flood control requirements and to coordinate refill after April 30 with NMFS. This measure would limit the volume of water that must be refilled during the spring outmigration to that required by the Corps for flood control, and would minimize the project's impacts on the spring hydrograph. The Umatilla (CTUIR-7) and Nez Perce (NPT-5) tribes recommend that Idaho Power maintain Brownlee reservoir at its upper flood control rule elevation from February 28 to April 15 of each year. We see little biological benefit, however, in requiring Brownlee reservoir to be maintained at the maximum levels specified for the February 28 and March 31 flood control targets, because these dates precede the spring outmigration (flow objectives identified for the spring outmigration extend from April 10 to June 20). In their draft EIS comments, the Nez Perce and Umatilla tribes also recommend that Brownlee not be refilled during the spring target flow period unless target flows are being met at Lower Granite dam. This recommendation, however, would conflict with NMFS's recommendation that Brownlee be refilled by June 20 to provide storage for flow augmentation during the June 21 through July 31 period to benefit outmigrating subyearling fall Chinook salmon.

Shifting flood control space from Brownlee reservoir to Lake Roosevelt would facilitate meeting flow objectives in the Snake River, but may have adverse effects on flows during the smolt migration season in the upper and mid-Columbia River. In *Comprehensive Development* section 5.2.2, *Flood Storage*, we discuss the issue of agency jurisdiction over flood storage decisions.

Native Resident Salmonids

Flow fluctuations and changes in the seasonal flow regime caused by project operations can affect the quality and quantity of rearing habitat and the food supply that is available to rearing bull trout and redband trout, and have the potential to cause fish to become stranded on bars or trapped in pools that become isolated from the stream channel. Any bull trout or redband trout that become trapped in pools may be subject to mortality from high water temperatures, from increased vulnerability to predation, or from stranding if the pools drain before they are reconnected to the river.

Our Analysis

Habitat Area

Idaho Power modeled adult bull trout and redband trout habitat using two-dimensional modeling techniques. The model was developed based on bathymetry, velocity and substrate data collected at seven sites in the upper Hells Canyon reach (Hells Canyon dam to the Salmon River) and four sites in the lower Hells Canyon reach (Salmon River to the Lower Granite reservoir). Idaho Power expanded the modeling results from these eleven sites to the entire reach based on the geomorphic features of the river channel. The model used habitat suitability criteria for depth, velocity and substrate to determine habitat suitability expressed in Weighted Useable Area (WUA).

Idaho Power's modeling results indicate that habitat available to bull trout and rainbow trout adults declines with increasing discharge over the range of modeled flows, which extended from 5,000 to 100,000 cfs in the upper reach, and from 10,000 to 260,000 cfs in the lower reach (figure 79). Idaho Power used these relationships to evaluate habitat conditions for proposed and alternative operations for three water years representing extremely low flow, medium flow, and extremely high flow conditions (table 52). Representative plots showing predicted hourly WUA for bull trout under Proposed Operations and under the Flow Augmentation Scenario are shown in figures 80 and 81, and the same plots for redband trout are shown in figures 82 and 83.

The potential for adverse effects to bull trout and redband trout is somewhat reduced by the movement of a portion of the population into tributaries as water temperatures increase in the summer. For example, bull trout telemetry studies conducted by Chandler et al. (2003a) indicated that 8 out of 15 bull trout that were tagged and released downstream of Hells Canyon dam moved into the Imnaha River by the end of May.

Food Supply

Flow fluctuations may also affect the food supply available to native resident salmonids. Stream-rearing species (rainbow trout) feed mostly on drifting aquatic organisms and terrestrial insects, but they will also take active bottom invertebrates (Moyle, 2002). Bull trout are opportunistic feeders, with food habits being primarily a function of size and life-history strategy. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macro-zooplankton, and small fish, while adult migratory (fluvial, adfluvial and anadromous) bull trout feed on various fish species (FWS, 2002a). Although many native resident salmonids may move into tributary streams during the summer months, others do not and are dependent year-round on the food supply that is available in the mainstem Snake River.

In the *Primary Production and Aquatic Invertebrates* subsection of section 3.6.2.1, we concluded that invertebrate production is likely to be substantially reduced in shallow areas that are regularly dewatered. In that section, we estimate that production of aquatic invertebrates under the proposed action may be reduced by approximately 10 to 20 percent, compared to what would be available without load following operations. The availability of small forage fish may also be reduced due to stranding or a reduction in primary or secondary production associated with load following operations. We estimate that the food supply available to subadult and adult bull trout would be reduced by a comparable amount of about 10 to 20 percent.

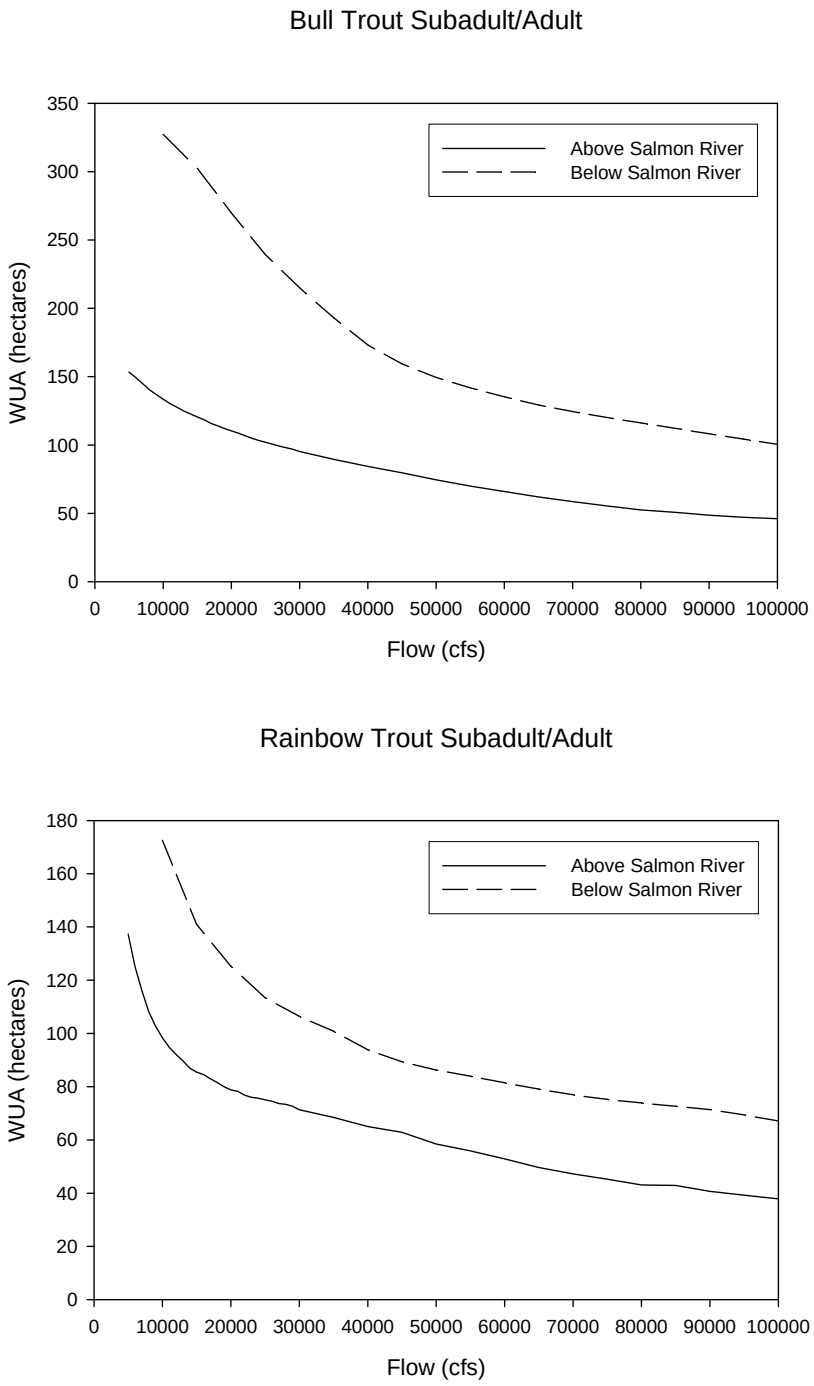

Figure 79. Weighted useable area versus discharge relationships for bull trout (upper plot) and redband trout (lower plot) in the upper and lower Hells Canyon reaches. (Source: Chandler et al., 2003c, as modified by staff)

Table 52. Estimated minimum, maximum, and maximum percent daily fluctuation in WUA for bull trout and redband trout adults in the upper Hells Canyon reach (Hells Canyon dam to the Salmon River). (Source: Brink and Chandler, 2005, as modified by staff)

		Bull Trout Adults			Redband Trout Adults		
Scenario	**Year**	**Min WUA[a]**	**Max WUA[a]**	**% Fluct.**	**Min WUA[a]**	**Max WUA[a]**	**% Fluct.**
Proposed Operations	Extremely low	1,020	1,540	20	740	1,375	27
	Medium	800	1,400	16	600	1,125	21
	Extremely high	475	1,275	17	390	925	15
Scenario 1a (Reregulating)	Extremely low	1,150	1,540	< 1.0	820	1,370	< 1.0
	Medium	800	1,330	< 1.0	620	975	< 1.0
	Extremely high	475	1,250	< 1.0	400	900	< 1.0
Scenario 1b (Year-round 2-Inches-Per-Hour Ramping Rate)	Extremely low	1,130	1,540	5	810	1,375	6
	Medium	800	1,330	6	620	975	5
	Extremely high	475	1,250	< 1.0	400	900	< 1.0
Scenario 1c (Year-round 6-Inches-Per-Hour Ramping Rate)	Extremely low	1,070	1,540	10	760	1,375	17
	Medium	800	1,350	11	620	1,020	15
	Extremely high	475	1,250	9	400	900	14
Scenario 2 (Flow Augmentation)	Extremely low	1,020	1,540	16	750	1,375	22
	Medium	800	1,430	15	620	1,125	22
	Extremely high	475	1,320	19	400	975	18
Scenario 3 (Navigation)	Extremely low	1,020	1,540	19	750	1,375	25
	Medium	800	1,390	17	620	1,060	20
	Extremely high	475	1,300	17	400	950	16

[a] WUA values are shown in 1,000 square meters.

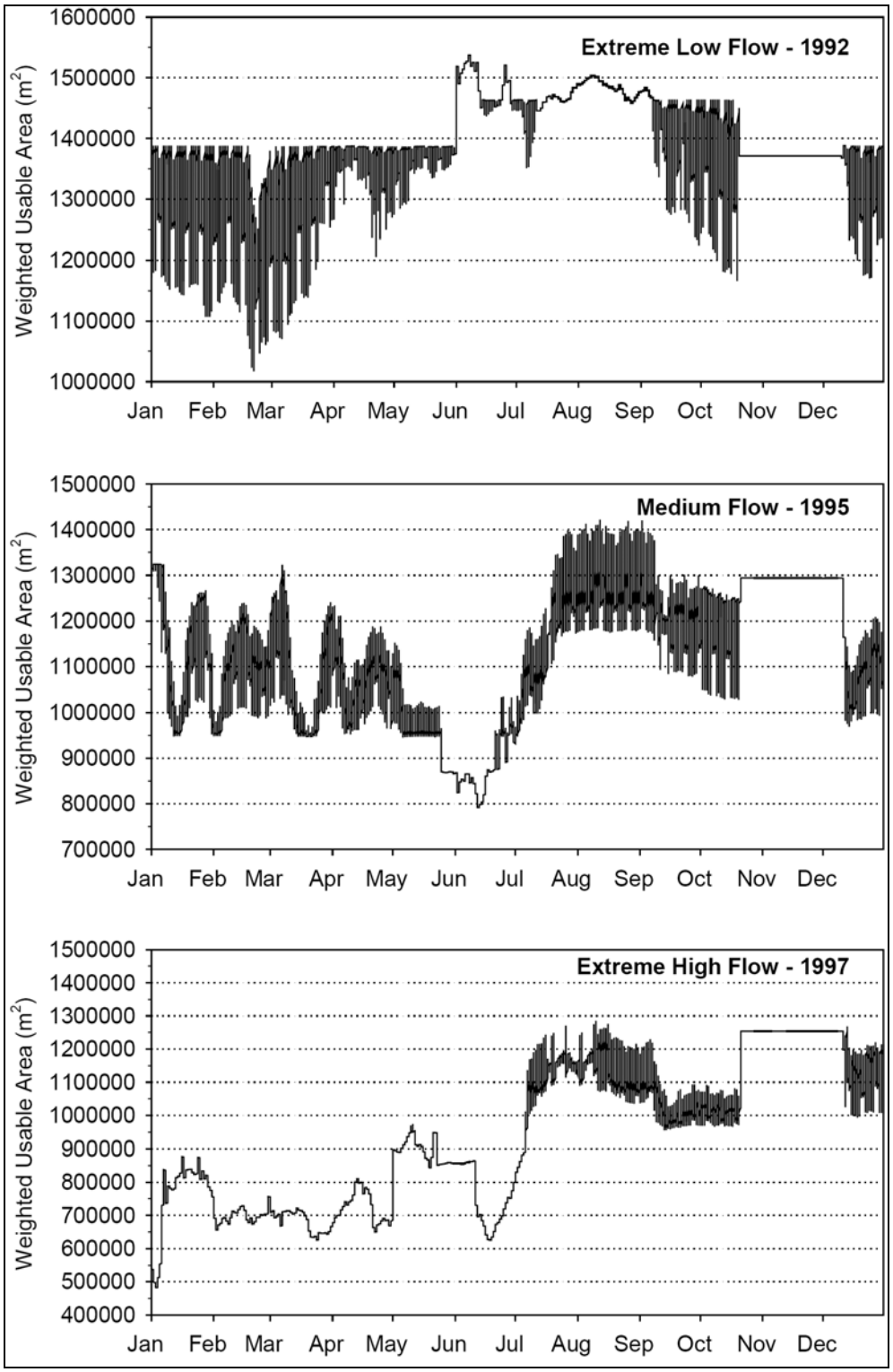

Figure 80. Hourly weighted useable area for bull trout adults in the upper Hells Canyon reach (Hells Canyon dam to the Salmon River confluence) simulated for Proposed Operations for three water year types. (Source: Brink and Chandler, 2005)

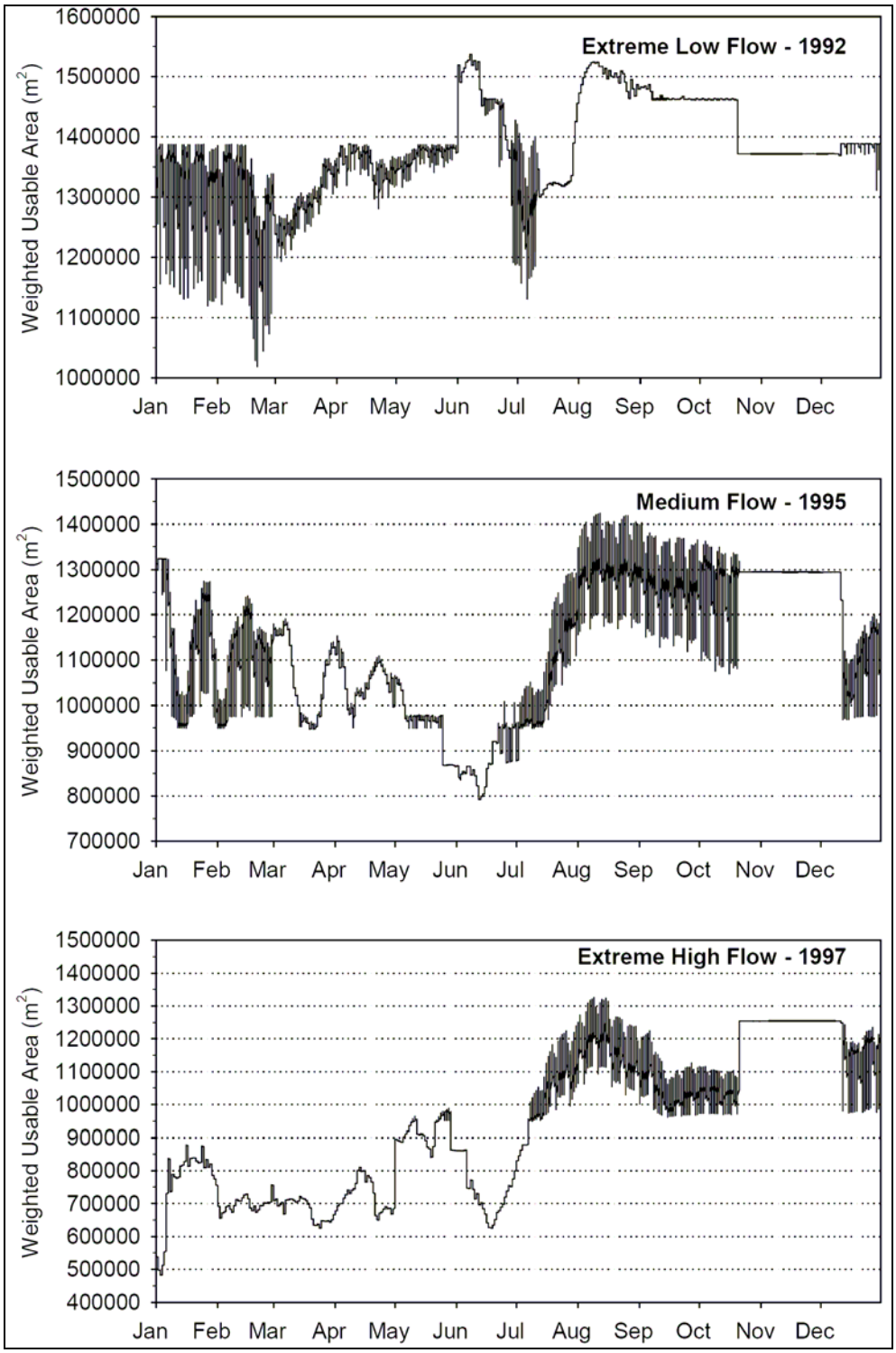

Figure 81. Hourly weighted useable area for bull trout adults in the upper Hells Canyon reach (Hells Canyon dam to the Salmon River confluence) simulated for the Flow Augmentation Scenario for three water year types. (Source: Brink and Chandler, 2005)

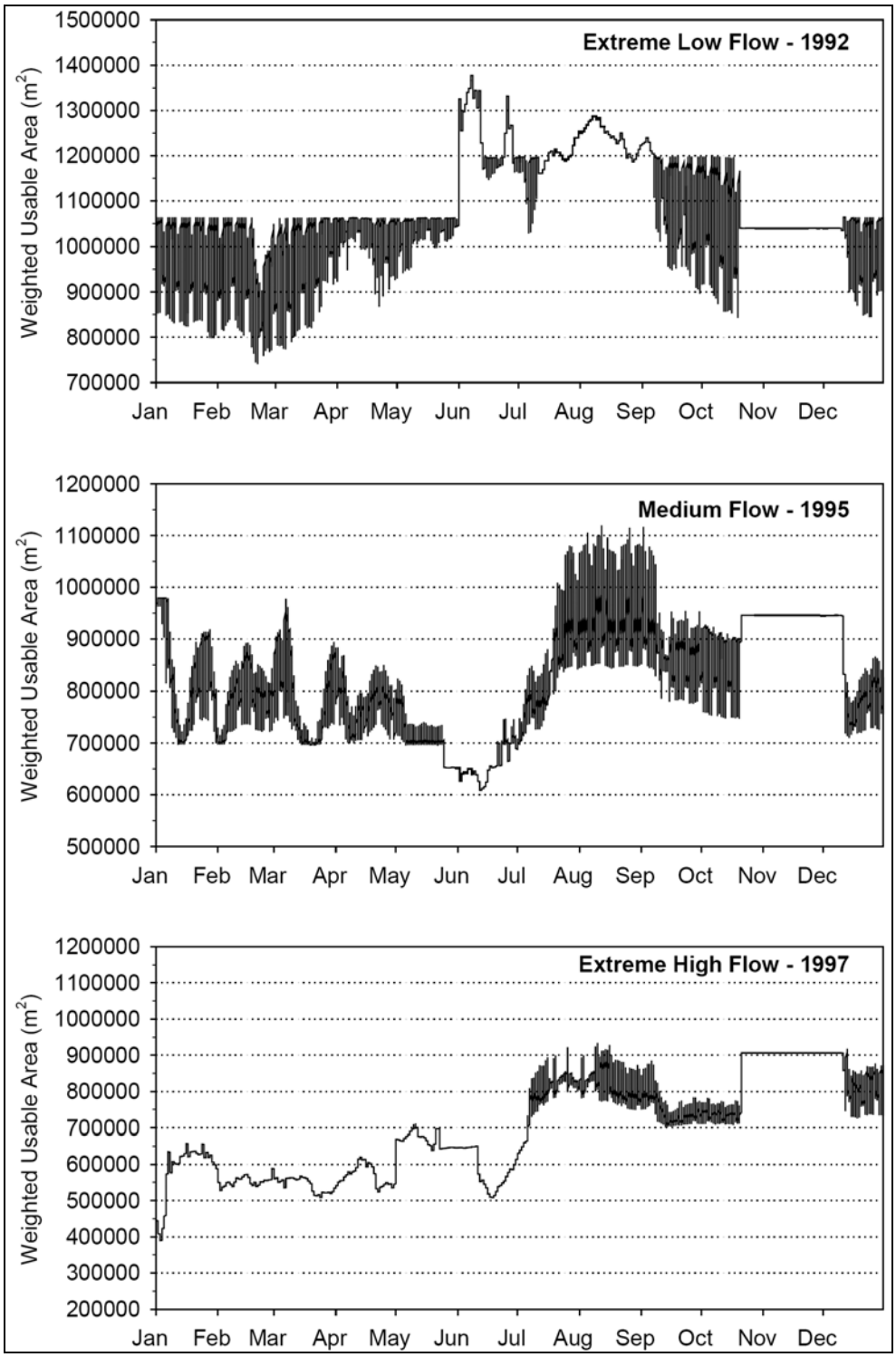

Figure 82. Hourly weighted useable area for redband trout adults in the upper Hells Canyon reach (Hells Canyon dam to the Salmon River confluence) simulated for Proposed Operations for three water year types. (Source: Brink and Chandler, 2005)

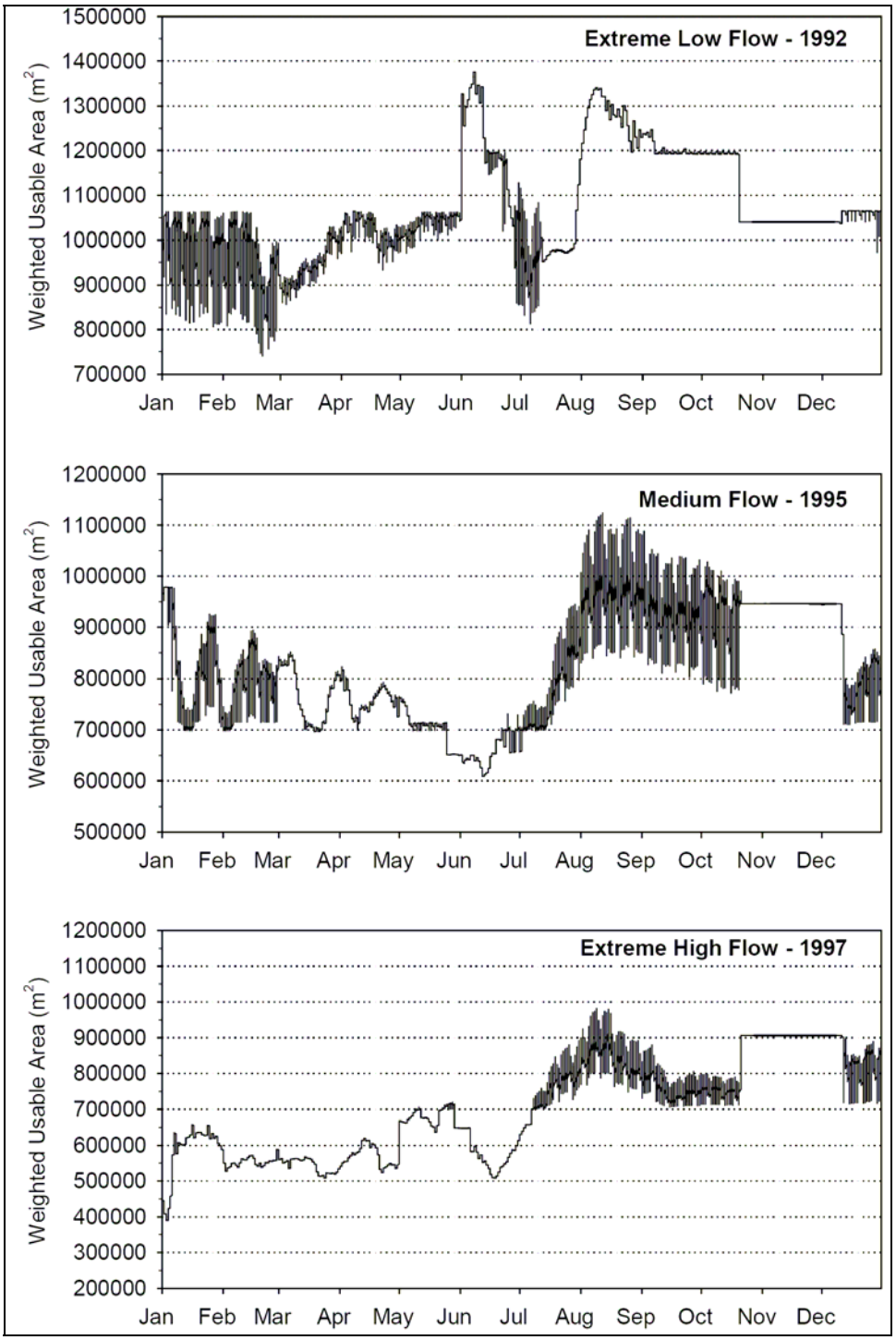

Figure 83. Hourly weighted useable area for redband trout adults in the upper Hells Canyon reach (Hells Canyon dam to the Salmon River confluence) simulated for the Flow Augmentation Scenario for three water year types. (Source: Brink and Chandler, 2005)

Chandler et al. (2006) reports that the size and condition factor of fluvial bull trout collected in the Snake River are comparable to those found in the unregulated Salmon River and its tributaries. In addition, Schill et al. (1994) collected downstream migrating bull trout in the Rapid River, a tributary to the Little Salmon River. Many of these fish were observed to overwinter in the main Salmon River in the vicinity of the confluence with the Little Salmon River. The size of fluvial migrants in the Salmon River ranged between 180 mm to 600 mm, with an average of 406 mm. Chandler et al. (2006) reports that bull trout captured by Idaho Power in the Snake River below Hells Canyon dam have ranged from 290 mm to 641 mm, with an average of 395 mm. In addition to the size distribution of fluvial bull trout, Chandler et al. (2006) reported that relative weight[70] and weight at length comparisons of bull trout in the Salmon River basin to those captured by Idaho Power below Hells Canyon dam also suggest that the two populations are very similar, relative to their condition. The mean relative weight of bull trout collected in the Salmon River was 86.51 and the mean relative weight of bull trout collected below Hells Canyon dam was 85.99. The similarity in size and condition of these two populations, located in similar stream systems within the same geographic region, suggest that fluctuations associated with load following operations (which occur in the Snake River but not in the unregulated Salmon River) do not have a pronounced adverse effect on growth rates of bull trout in the Hells Canyon reach.

Entrapment and Stranding

As we discussed in the *Anadromous Fish Rearing* subsection of section 3.6.2.1, flow fluctuations may cause fish mortality from fish becoming stranded or entrapped in pools where they may be subject to elevated water temperatures and increased predation potential. However, in Idaho Power's entrapment studies (discussed previously in *Anadromous Fish Rearing*), Idaho Power did not observe any stranded or entrapped bull trout or redband trout, although some fish species other than fall Chinook salmon, including juvenile steelhead, were observed in entrapment pools. Because of the bull trout's relative scarcity compared to fall Chinook salmon, additional monitoring would need to be conducted before conclusions could be drawn on the risk of stranding. The daytime habitat use observations of radio-tagged bull trout in the Hells Canyon reach reported by Chandler et al. (2003d) indicate that habitat less than one meter deep was rarely used by bull trout or by redband trout. Studies of diel habitat use in the Flathead River by Muhlfeld et al. (2003) indicate that subadult bull trout may move into shallow, channel margin habitats at night to feed on small fishes. This behavioral attribute may increase the trout's vulnerability to stranding and entrapment. However, Chandler et al. (2003a) state that in contrast to the unconfined, braided nature of the Flathead River, the Snake River in Hells Canyon is highly confined and characterized by short, deep pools and numerous rapids with large boulder and cobble substrates intermixed with areas of gravel and sand. These differences in channel character suggest that there is less shallow habitat available for feeding forays in the Hells Canyon reach, and less risk of stranding or entrapment. Regardless, the potential for bull trout to become stranded or entrapped due to peaking operations in the Hells Canyon reach is unknown. Additional monitoring to assess this risk would provide useful information.

White Sturgeon

Flow fluctuations and changes in the seasonal flow regime caused by project operations can affect the quality and quantity of habitat that is available to all lifestages of white sturgeon. Because sturgeon tend to reside in deeper areas of the river, there is very little potential for adverse effects from stranding or from dewatering-related reduction of the food supply that is available within their preferred habitats.

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[70] Relative weight is the ratio of a fish's weight to a standard weight for the same species multiplied by 100, with values exceeding 100 representing above average and less than 100 being below average.

Our Analysis

Idaho Power modeled white sturgeon habitat using two-dimensional modeling techniques in the same manner as we described for native resident salmonids. The relationship between habitat (represented by WUA) and flow was determined for six life stages of sturgeon: spawning, incubation, larvae, young-of-year, juvenile, and adult. Representative plots showing predicted hourly WUA for each lifestage under Proposed Operations and under the Flow Augmentation Scenario are shown in figures 84 through 95. For lifestages that do not occur year-round (spawning, incubation, larvae and young-of-year), the season in which they are present is indicated by hatchmarks.

To compare the amount of habitat that is predicted to occur in each year and operating scenario, we used these plots to estimate the minimum and maximum WUA, and the normal maximum daily percent fluctuation[71] of WUA that occurred within the time period that each lifestage is present. We summarize these values for each lifestage in table 53. We base our analysis on habitat modeling results from the upper Hells Canyon reach (upstream of the Salmon River), where the flow regime and habitat conditions are the most strongly tied to flow releases from Hells Canyon dam.

For white sturgeon spawning under proposed operations, substantial variation in WUA is evident during extremely low and medium water years (table 53 and figure 84). As indicated in figure 85, less WUA variation would occur during the spawning season under the Flow Augmentation Scenario. This is a result of the 2-inches-per-hour ramping rate that this scenario includes during the fall Chinook rearing period. As shown in table 53, implementing a 6-inches-per-hour ramping rate would reduce WUA variations by half in the extremely low water year and by two-thirds in a medium water year, and variation would be further reduced by imposing a 2-inches-per-hour ramping rate.

The white sturgeon incubation and larval lifestages show very similar trends between water years and scenarios (table 53 and figures 86 through 89), as we described for the spawning lifestage. Because the fall Chinook rearing period overlaps with most of the season in which the incubation and larval lifestages occur, implementing ramping rate restrictions during the fall Chinook rearing period would substantially reduce variations in WUA for the incubation and larval lifestages. For white sturgeon larvae in the extremely low flow year, overall WUA values and the variation in WUA increased during July under the Flow Augmentation Scenario (figure 89). This is a result of more water being released during July and the use of this water to support load following operations.

For the young-of-year lifestage, restricting ramping rates during the fall Chinook rearing period provides little benefit, as the transition from the larval to young-of-year lifestage occurs around the same time that fall Chinook salmon emigrate from the Hells Canyon reach. Ramping rate restrictions imposed from mid-June through December would reduce WUA variability for this lifestage, although no load following would occur during the fall Chinook spawning period under Proposed Operations. In the extremely low flow year, WUA fluctuations are eliminated during October under the Flow Augmentation Scenario, since less water is available for load following when Brownlee reservoir is being refilled.

As shown in table 53 and figures 92 through 95, the level of variation in WUA for juvenile and adult lifestages is relatively small, less than 7 percent for all year types and scenarios. This lack of variation results from fish at these lifestages preferring deep, low velocity pool habitats that are relatively unaffected by changes in river flows. The deepwater habitats favored by sturgeon are not subject to dewatering during load following operations, which would reduce the risk of stranding or a reduction in food supply that would affect growth rates of sturgeon. Habitat use information presented in Lepla and Chandler (2003) indicates that all lifestages of sturgeon rarely occur in areas that are less than 4 meters deep.

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[71] To illustrate the maximum effect of load following operations while excluding larger changes in flow that do not occur on a regular basis, we base our estimate on the largest percentage change in WUA that occurs in at least 3 consecutive days.

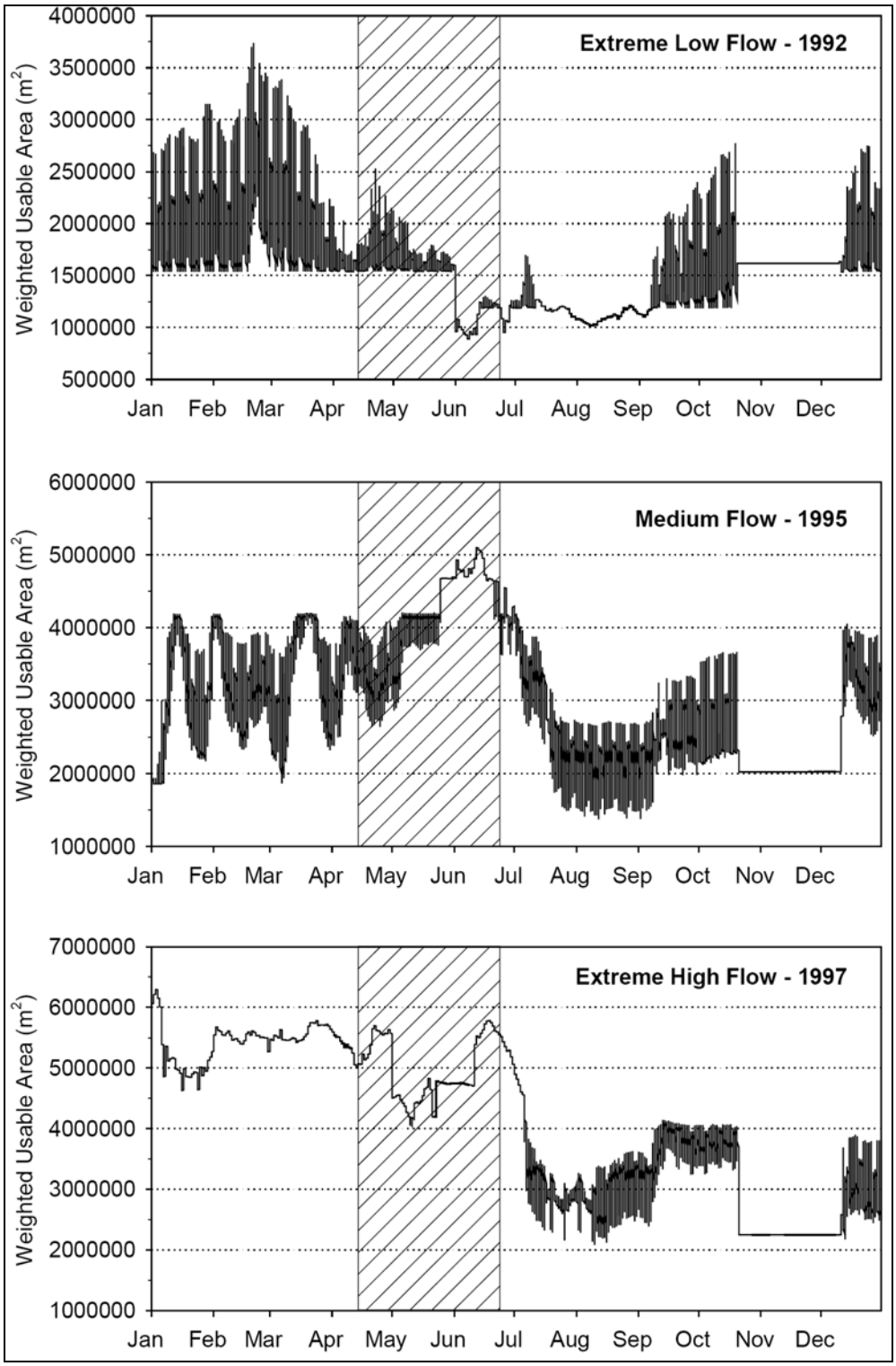

Figure 84. Hourly weighted useable area for white sturgeon spawning in the upper Hells Canyon reach (Hells Canyon dam to the Salmon River confluence) simulated for Proposed Operations for three water year types. (Source: Brink and Chandler, 2005)

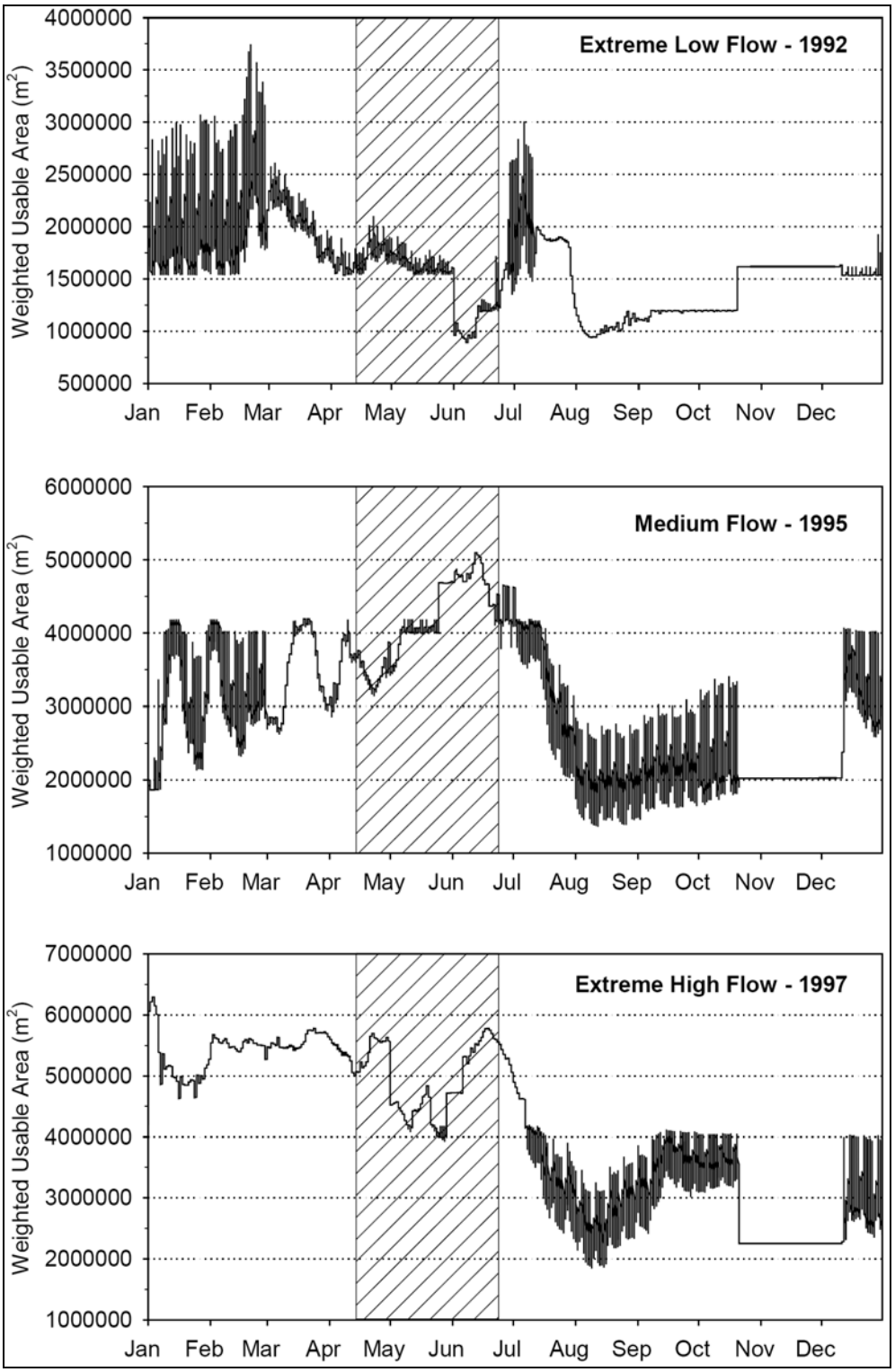

Figure 85. Hourly weighted useable area for white sturgeon spawning in the upper Hells Canyon reach (Hells Canyon dam to the Salmon River confluence) simulated for the Flow Augmentation Scenario for three water year types. (Source: Brink and Chandler, 2005)

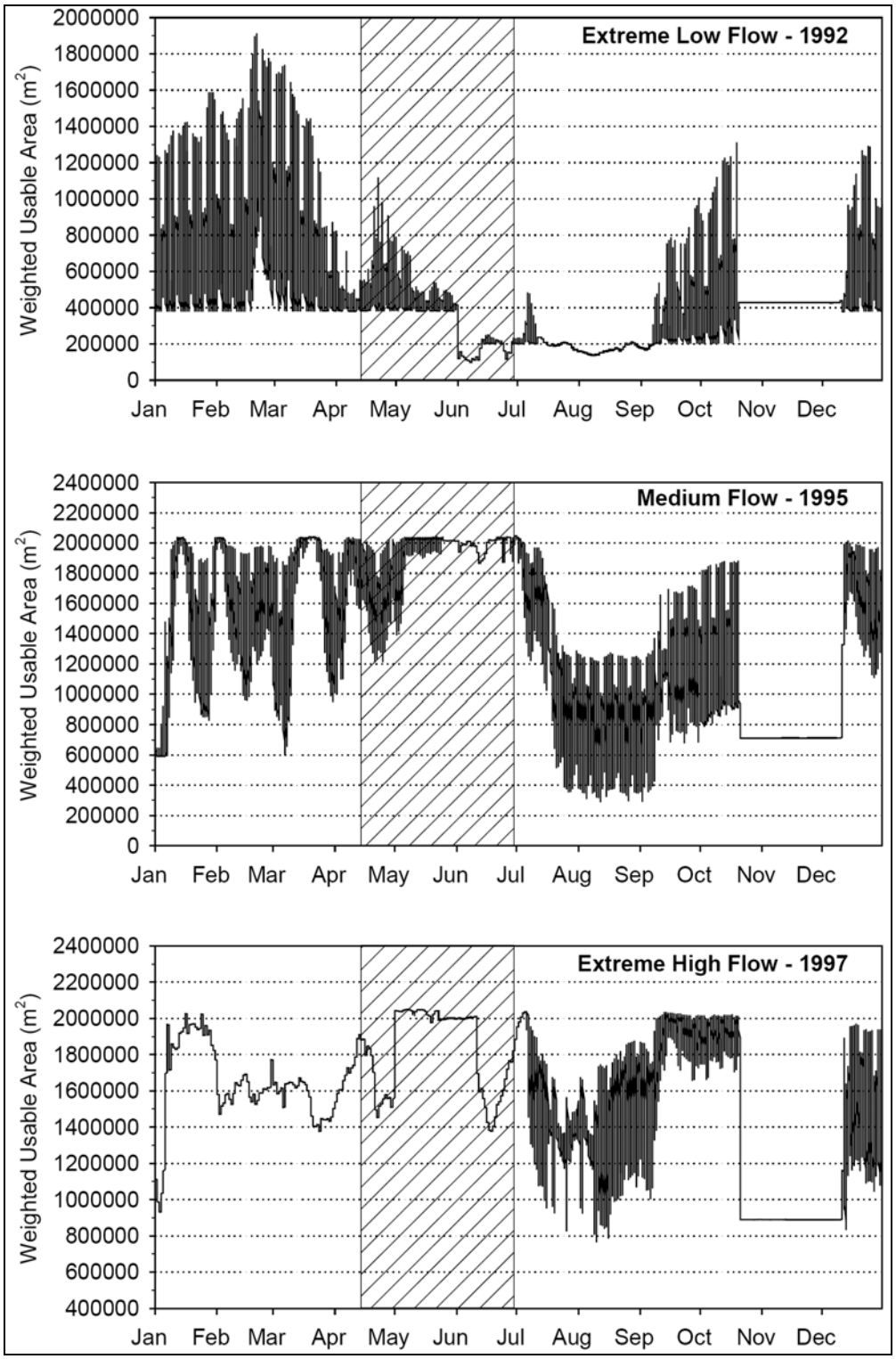

Figure 86. Hourly weighted useable area for white sturgeon incubation in the upper Hells Canyon reach (Hells Canyon dam to the Salmon River confluence) simulated for Proposed Operations for three water year types. (Source: Brink and Chandler, 2005)

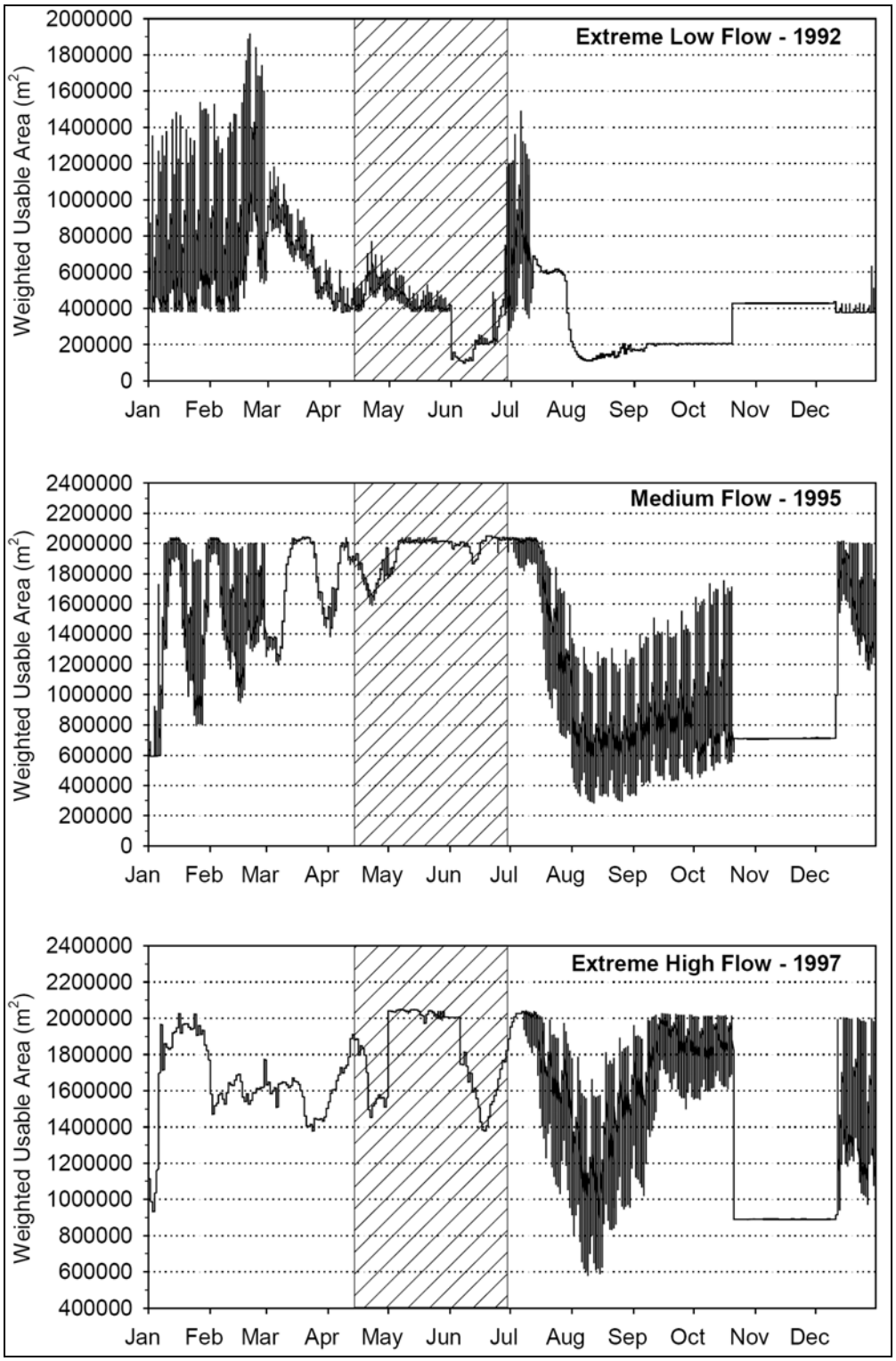

Figure 87. Hourly weighted useable area for white sturgeon incubation in the upper Hells Canyon reach (Hells Canyon dam to the Salmon River confluence) simulated for the Flow Augmentation Scenario for three water year types. (Source: Brink and Chandler, 2005)

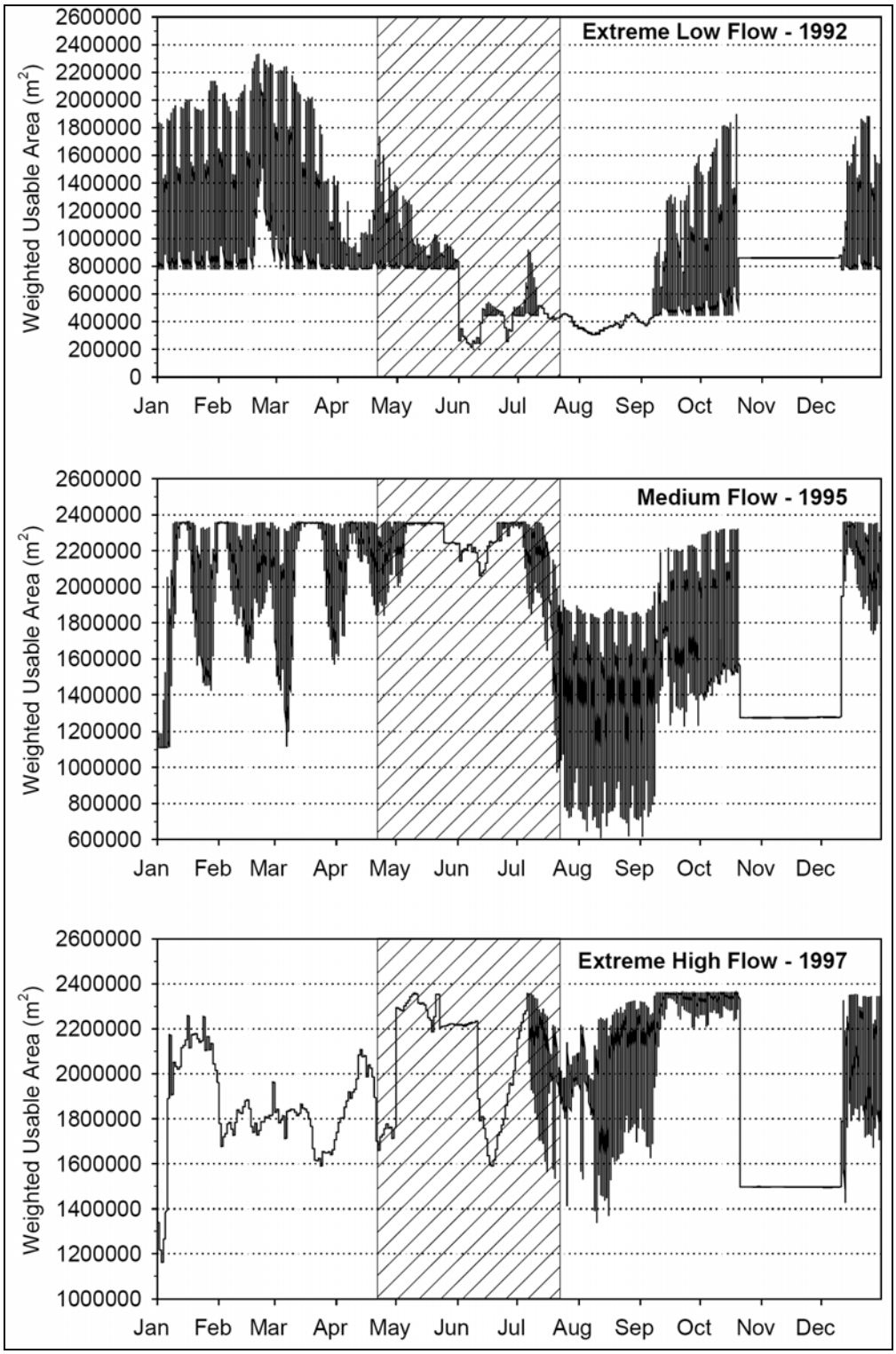

Figure 88. Hourly weighted useable area for white sturgeon larvae in the upper Hells Canyon reach (Hells Canyon dam to the Salmon River confluence) simulated for Proposed Operations for three water year types. (Source: Brink and Chandler, 2005).

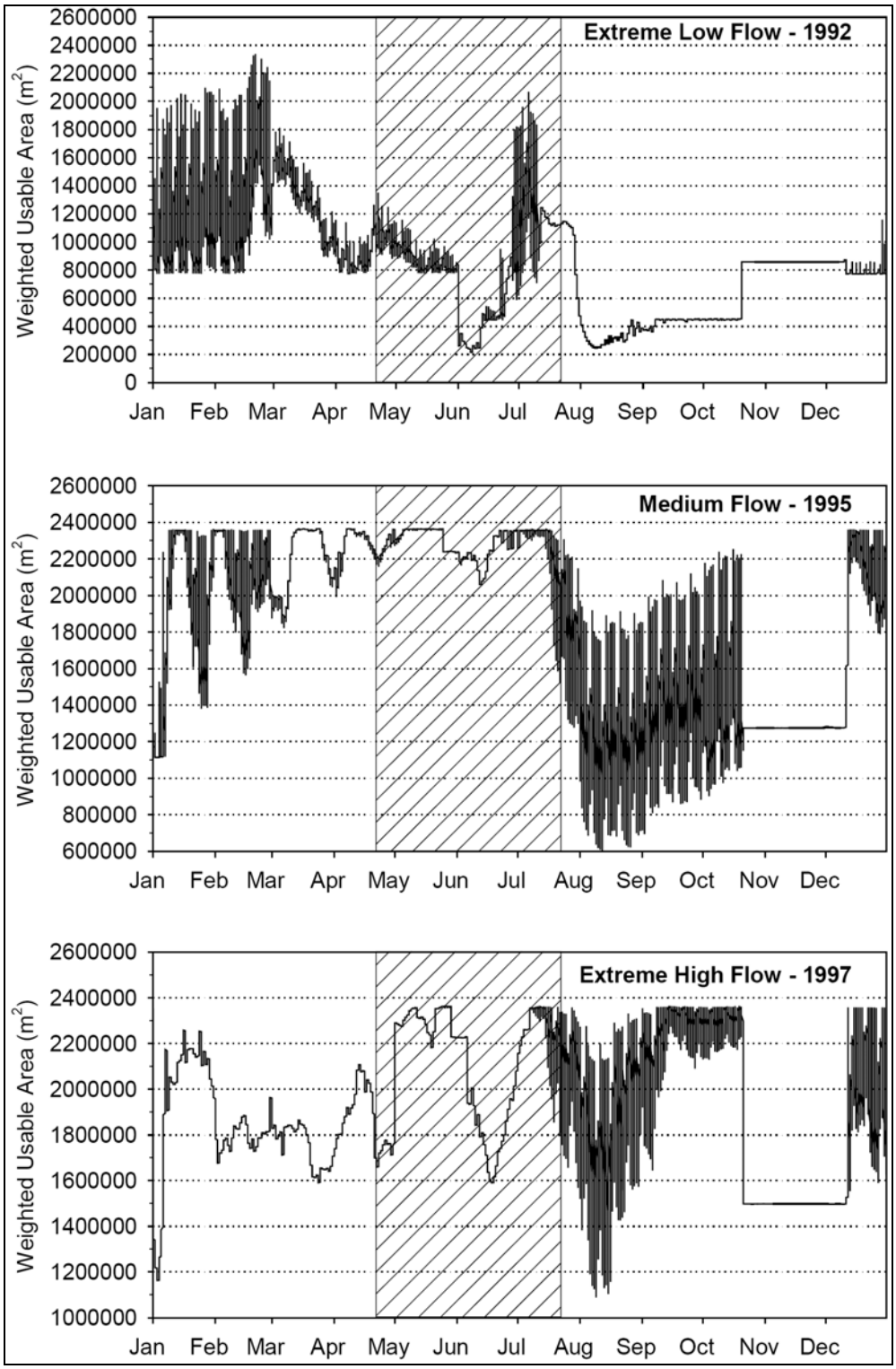

Figure 89. Hourly weighted useable area for white sturgeon larvae in the upper Hells Canyon reach (Hells Canyon dam to the Salmon River confluence) simulated for the Flow Augmentation Scenario for three water year types. (Source: Brink and Chandler, 2005)

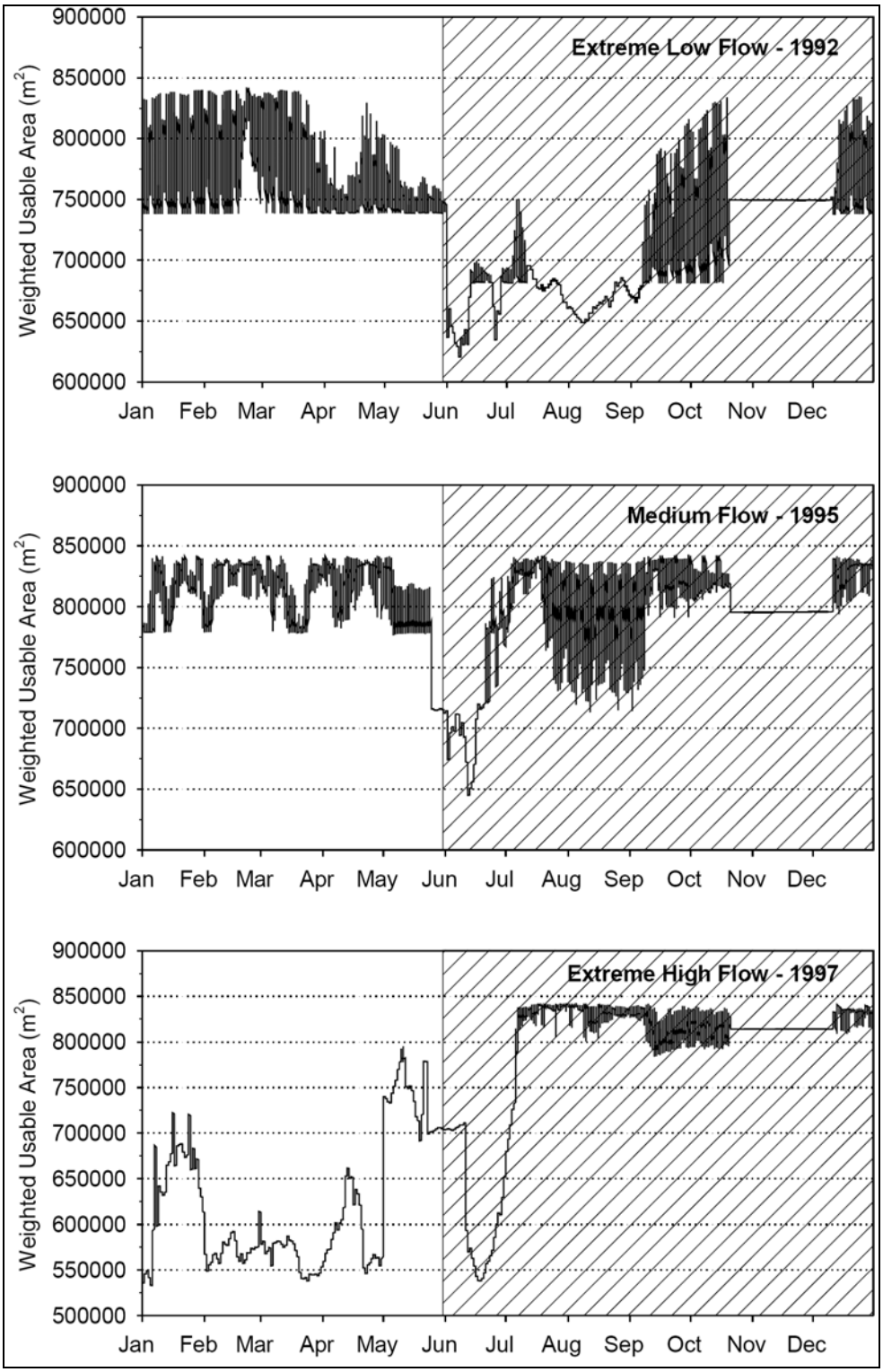

Figure 90. Hourly weighted useable area for white sturgeon young-of-year in the upper Hells Canyon reach (Hells Canyon dam to the Salmon River confluence) simulated for Proposed Operations for three water year types. (Source: Brink and Chandler, 2005)

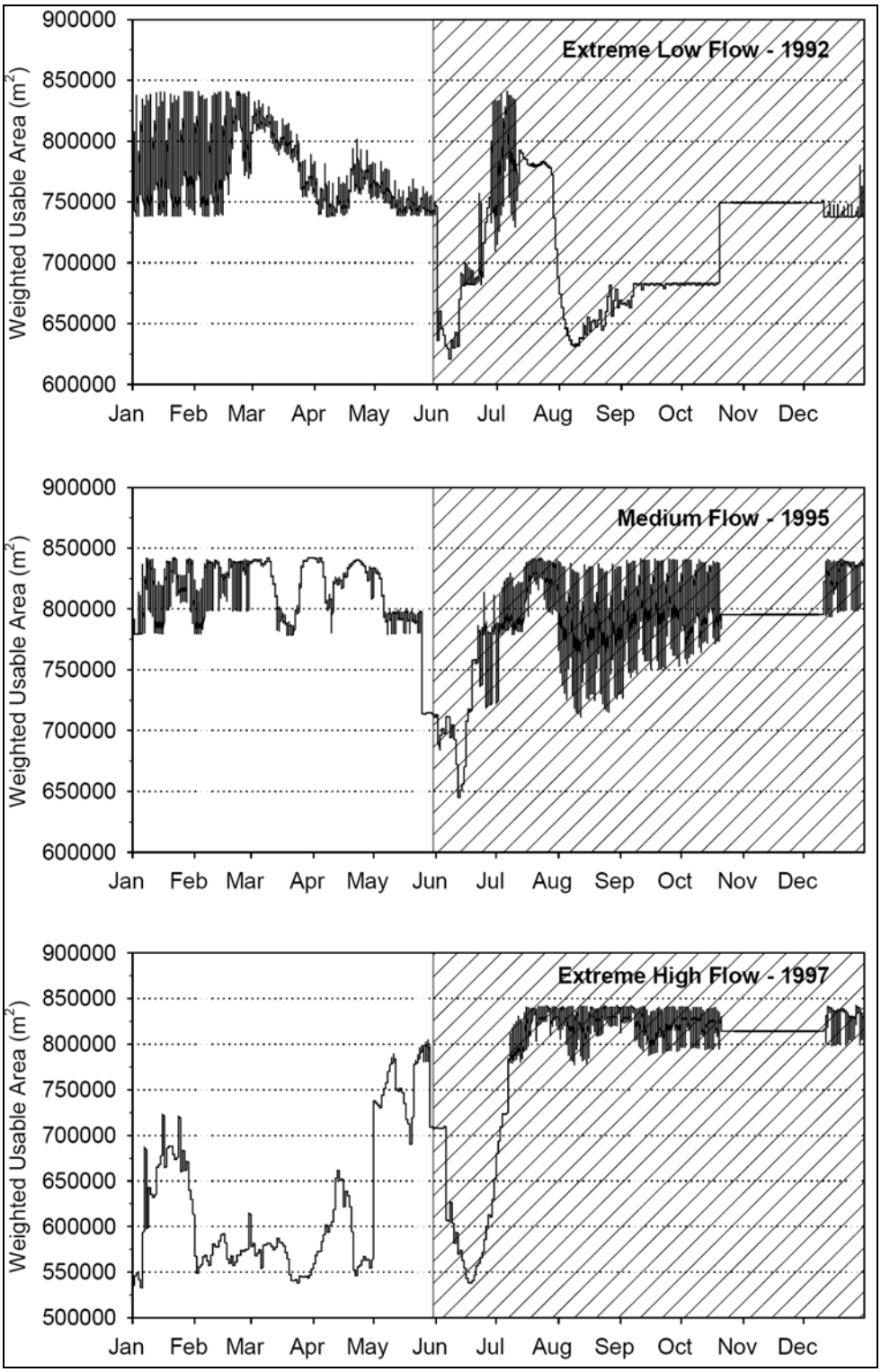

Figure 91. Hourly weighted useable area for white sturgeon young-of-year in the upper Hells Canyon reach (Hells Canyon dam to the Salmon River confluence) simulated for the Flow Augmentation Scenario for three water year types. (Source: Brink and Chandler, 2005)

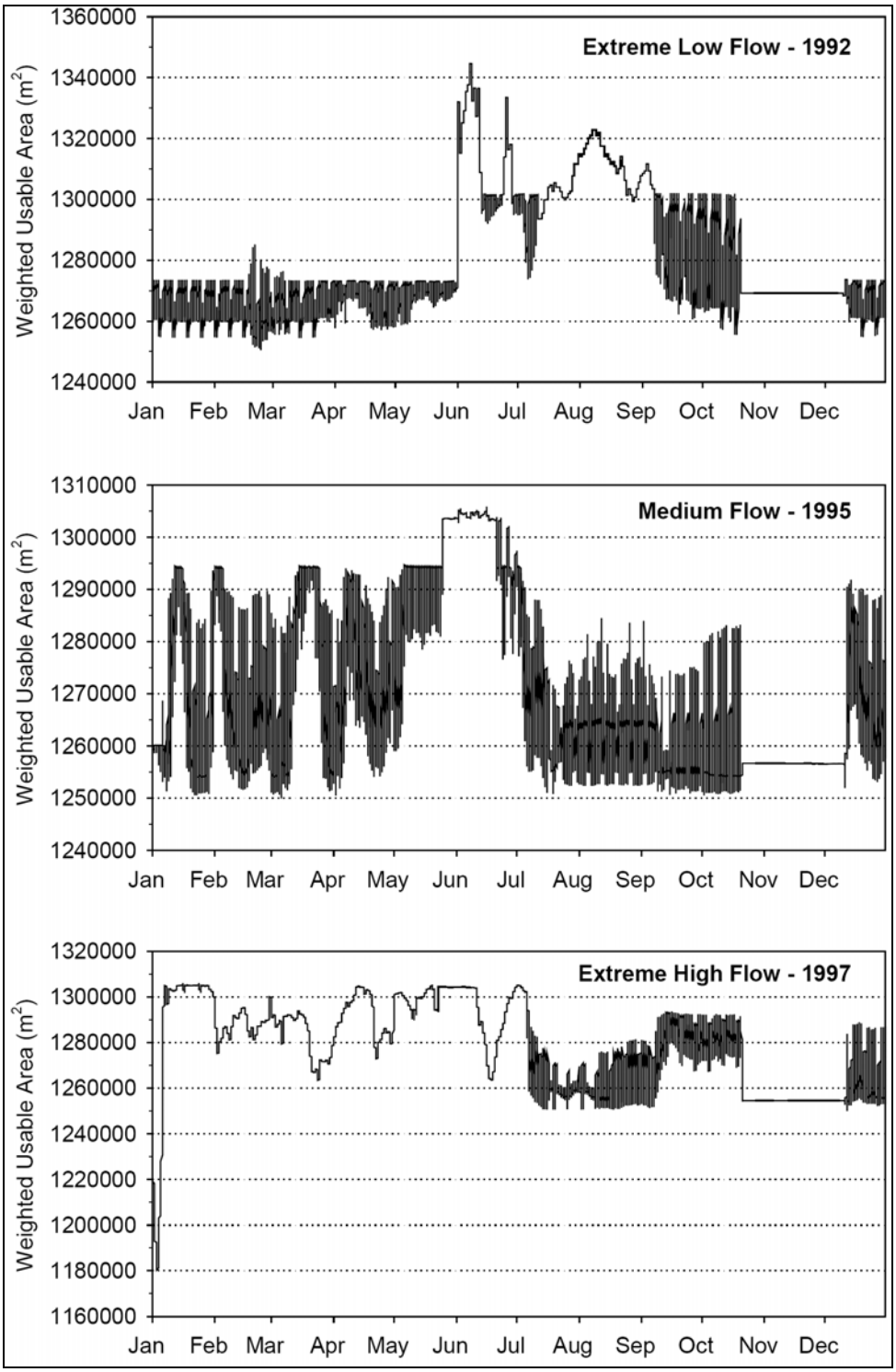

Figure 92. Hourly weighted useable area for white sturgeon juveniles in the upper Hells Canyon reach (Hells Canyon dam to the Salmon River confluence) simulated for Proposed Operations for three water year types. (Source: Brink and Chandler, 2005)

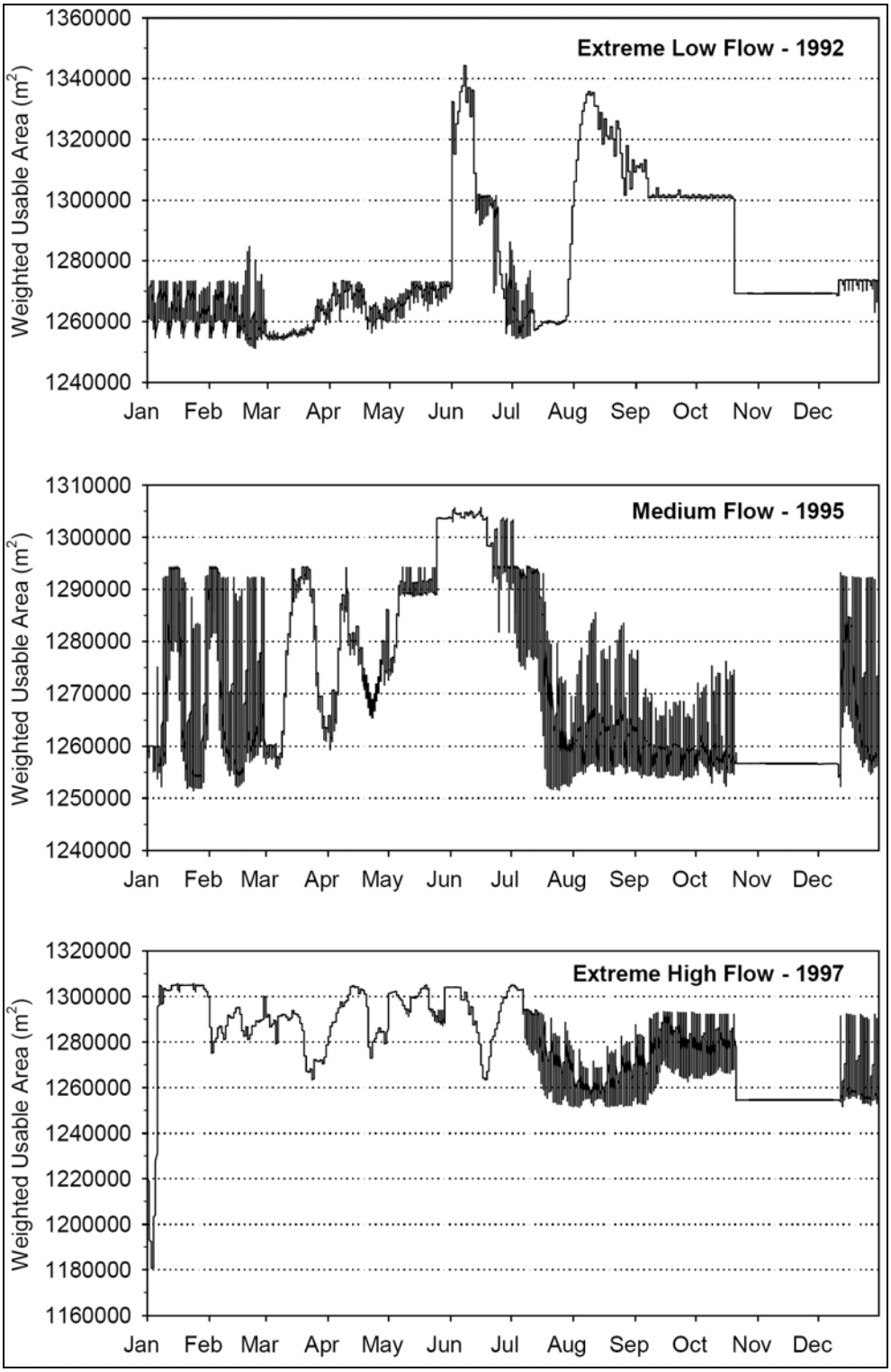

Figure 93. Hourly weighted useable area for white sturgeon juveniles in the upper Hells Canyon reach (Hells Canyon dam to the Salmon River confluence) simulated for the Flow Augmentation Scenario for three water year types. (Source: Brink and Chandler, 2005)

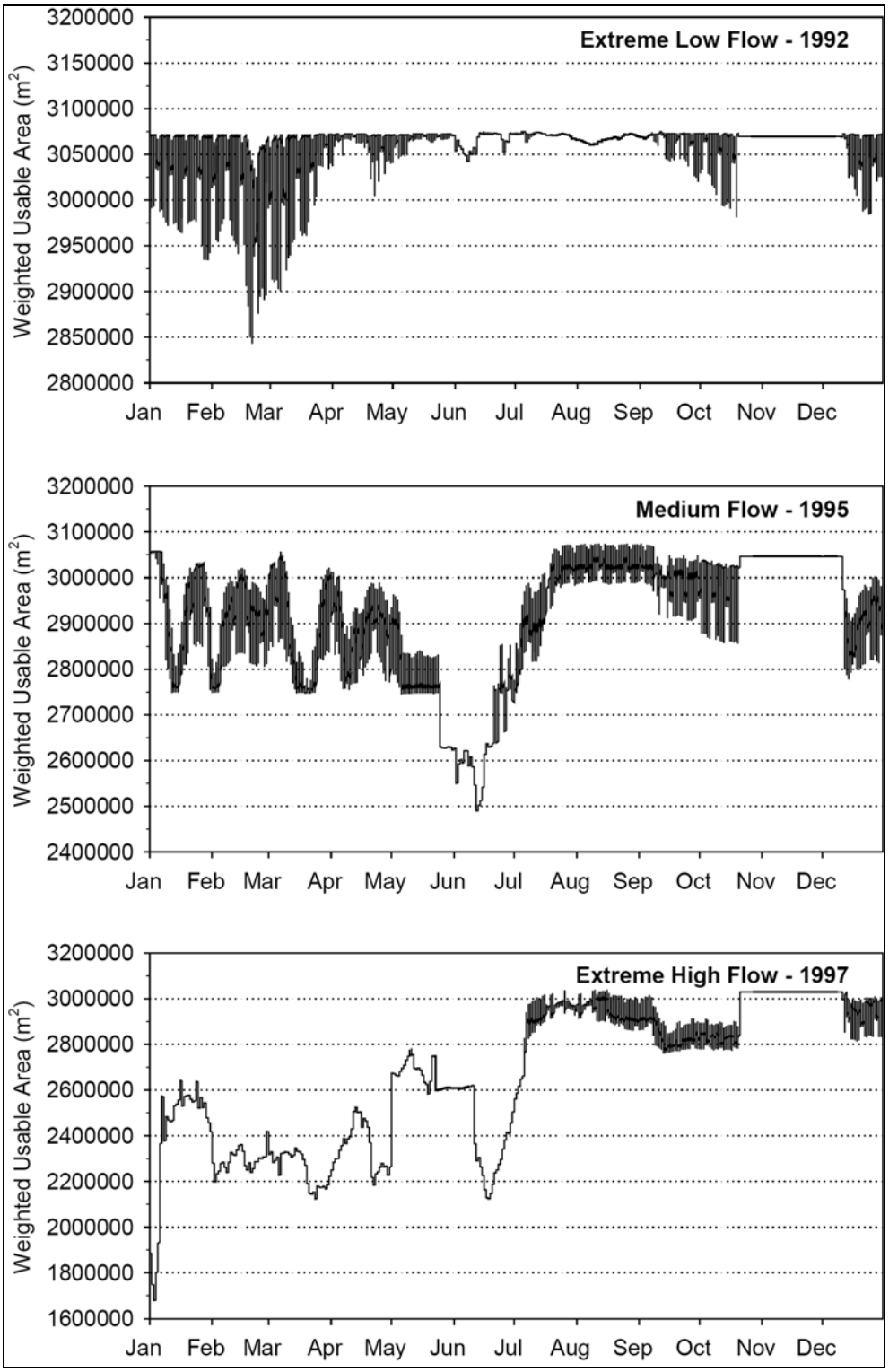

Figure 94. Hourly weighted useable area for white sturgeon adults in the upper Hells Canyon reach (Hells Canyon dam to the Salmon River confluence) simulated for Proposed Operations for three water year types. (Source: Brink and Chandler, 2005)

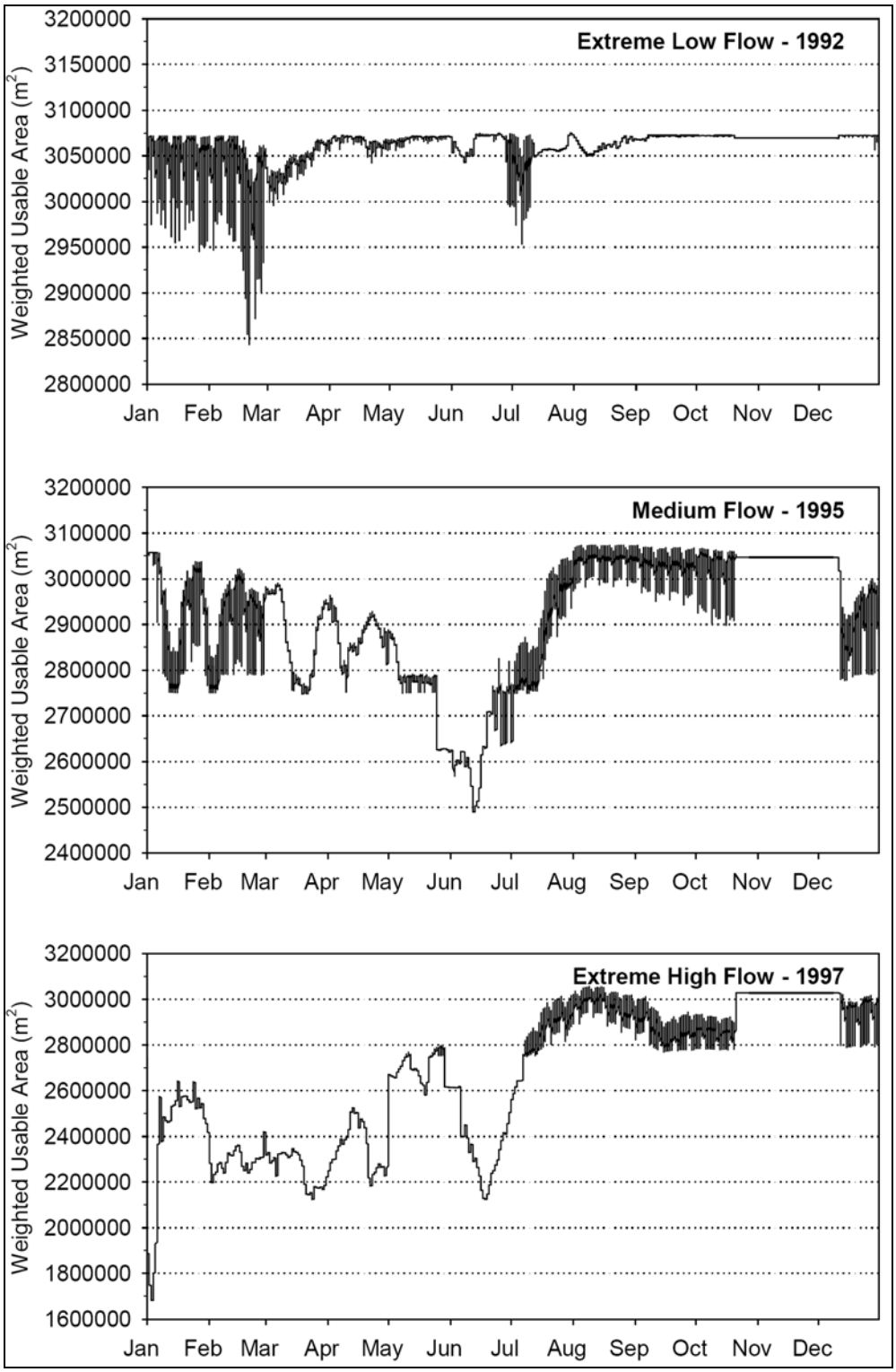

Figure 95. Hourly weighted useable area for white sturgeon adults in the upper Hells Canyon reach (Hells Canyon dam to the Salmon River confluence) simulated for the Flow Augmentation Scenario for three water year types. (Source: Brink and Chandler, 2005)

Table 53. Estimated minimum, maximum, and maximum percent daily fluctuation in WUA for white sturgeon in the upper Hells Canyon reach (Hells Canyon dam to the Salmon River). (Source: Brink and Chandler, 2005, as modified by staff)

		Spawning			Incubation			Larvae		
Scenario	**Year**	**Min WUA[a]**	**Max WUA[a]**	**% Fluct.**	**Min WUA[a]**	**Max WUA[a]**	**% Fluct.**	**Min WUA[a]**	**Max WUA[a]**	**% Fluct.**
Proposed Operations	Extremely low	575	2,500	29.4	100	1,100	50.0	220	1,720	42.2
	Medium	2,600	5,100	25.0	1,200	2,020	36.8	1,650	2,350	19.1
	Extremely high	4,000	5,750	< 1.0	1,380	2,020	< 1.0	1,520	2,350	25.4
Scenario 1a (Reregulating)	Extremely low	900	1,900	< 1.0	100	680	< 1.0	220	1,200	< 1.0
	Medium	3,250	5,100	< 1.0	1,650	2,050	< 1.0	1,600	2,350	< 1.0
	Extremely high	4,200	5,750	< 1.0	1,380	2,020	< 1.0	1,600	2,350	< 1.0
Scenario 1b (Year-round 2-Inches-Per-Hour Ramping Rate)	Extremely low	875	2,125	13.3	100	750	27.6	220	1,350	22.7
	Medium	3,250	5,200	< 1.0	1,600	2,050	< 1.0	2,080	2,380	< 1.0
	Extremely high	4,200	5,750	< 1.0	1,380	2,020	< 1.0	1,600	2,350	< 1.0
Scenario 1c (Year-round 6-Inches-Per-Hour Ramping Rate)	Extremely low	875	2,375	15.5	100	1,010	50.0	220	1,620	37.5
	Medium	2,800	5,200	8.3	1,350	2,020	23.2	1,300	2,350	30.0
	Extremely high	4,000	5,750	< 1.0	1,380	2,050	< 1.0	1,600	2,350	20.9
Scenario 2 (Flow Augmentation)	Extremely low	875	2,125	13.3	100	780	27.6	200	2,050	55.1
	Medium	3,200	5,200	< 1.0	1,600	2,020	< 1.0	1,500	2,350	30.0
	Extremely high	4,000	5,750	< 1.0	1,380	2,050	< 1.0	1,600	2,350	< 1.0
Scenario 3 (Navigation)	Extremely low	875	2,750	25.0	100	1,300	24.0	200	1,900	36.0
	Medium	2,500	5,100	28.6	1,110	2,020	29.2	1,050	2,350	44.7
	Extremely high	3,800	5,750	< 1.0	1,380	2,050	< 1.0	1,450	2,350	29.8

Scenario	Year	Young-of-Year			Juvenile			Adult		
		Min WUA[a]	Max WUA[a]	% Fluct.	Min WUA[a]	Max WUA[a]	% Fluct.	Min WUA[a]	Max WUA[a]	% Fluct.
Proposed Operations	Extremely low	620	830	17.6	1,250	1,345	3.1	2,770	3,075	5.4
	Medium	640	835	11.3	1,251	1,305	2.4	2,500	3,075	6.1
	Extremely high	535	835	4.8	1,180	1,305	2.7	1,680	3,020	6.0
Scenario 1a (Reregulating)	Extremely low	625	790	< 1.0	1,255	1,345	< 1.0	2,960	3,075	< 1.0
	Medium	640	835	< 1.0	1,252	1,305	< 1.0	2,500	3,050	< 1.0
	Extremely high	535	835	< 1.0	1,180	1,305	< 1.0	1,680	3,020	< 1.0
Scenario 1b (Year-round 2-Inches-Per-Hour Ramping Rate)	Extremely low	625	810	3.3	1,252	1,345	< 1.0	2,945	3,075	< 1.0
	Medium	640	840	4.2	1,252	1,305	< 1.0	2,500	3,050	< 1.0
	Extremely high	535	835	< 1.0	1,180	1,305	< 1.0	1,700	3,020	< 1.0
Scenario 1c (Year-round 6-Inches-Per-Hour Ramping Rate)	Extremely low	625	825	12.3	1,252	1,345	2.3	2,900	3,075	2.0
	Medium	640	835	7.3	1,252	1,305	1.3	2,500	3,050	4.3
	Extremely high	535	835	5.4	1,180	1,305	1.7	1,700	3,020	4.1
Scenario 2 (Flow Augmentation)	Extremely low	625	835	11.4	1,250	1,345	1.0	2,840	3,075	4.1
	Medium	640	835	8.4	1,252	1,305	2.7	2,500	3,075	7.0
	Extremely high	535	835	6.0	1,180	1,305	3.2	1,700	3,050	6.7
Scenario 3 (Navigation)	Extremely low	625	835	12.0	1,250	1,345	1.2	2,850	3,075	4.9
	Medium	640	840	11.9	1,250	1,305	2.5	2,500	3,060	6.6
	Extremely high	535	835	6.0	1,180	1,350	2.7	1,700	3,020	6.6

[a] WUA values are shown in 1,000 square meters

The results of Idaho Power's habitat modeling indicates that under Proposed Operations, load following causes substantial daily variations in WUA for the spawning, incubation and larval life stages of white sturgeon during extremely low and medium water years. However, population sampling reported in Lepla et al. (2003) indicates that all size groups are well represented in the sturgeon population in the Hells Canyon reach (figure 96), indicating that successful reproduction and recruitment occurs in most years. Furthermore, there is no indication that sturgeon growth is adversely affected. Idaho Power reports that condition factors have not declined since surveys conducted in the 1970s and 1980s, despite steady increases in the abundance in the number of fish larger than 92 cm, and Everett et al. (2003, as cited in Chandler et al., 2006) report that growth rates below Hells Canyon dam exceed rates that are observed in the lower Snake River and in the Columbia River.

Warmwater Fisheries

Seasonal changes in water levels in Brownlee reservoir may affect the reproductive success of warmwater species including smallmouth bass, black crappie, white crappie, and channel catfish. These species support a substantial recreational fishery that is important to the economy of local communities.

To promote spawning success for warmwater fish species, Idaho Power proposes to limit the drawdown of Brownlee reservoir during the spawning period. Beginning on May 21, reservoir spawning habitat would be protected for a 30-day period, during which time the reservoir would not be drafted more than 1 foot from the highest elevation reached during the 30-day period, although exceptions would be allowed for system or economic emergencies. From the end of the 30-day period though July 4, the reservoir could be drafted more than 1 foot, but an elevation of at least 2,069 feet msl would be maintained through July 4. Idaho Power also proposes to continue warmwater fish population monitoring to detect long-term effects on fish populations, including annual electrofishing surveys in all three project reservoirs and surveying the Swan Falls-to-Brownlee reach every fifth year.

ODFW (ODFW-51) and IDFG (IDFG-27)support the same operating constraints that Idaho Power proposes to protect warmwater fish spawning, although ODFW recommends that drawdown of Brownlee reservoir to levels below elevation 2,069 msl be allowed if flow augmentation (for salmon migration) occurs before July 4. Recommendations directed at providing water to augment flows during the salmon smolt outmigration, listed in table 9, may also affect water levels during the spawning season for warmwater fish species.

IDFG (IDFG-27) and ODFW (ODFW-50) support Idaho Power's proposal to continue warmwater fish population monitoring, but ODFW also recommends that Idaho Power conduct annual creel surveys in all three project reservoirs and study the food habits of Brownlee reservoir warmwater fish species, including effects of reservoir operations on zooplankton production. IDFG (IDFG-27) recommends that if economic or system emergencies occur that require deviation from Idaho Power's proposed operating regime, that Idaho Power consult with IDFG and ODFW to evaluate alternative strategies to protect warmwater fisheries.

Our Analysis

Water level fluctuations during spawning and early development may affect spawning success of nesting species by dewatering nests or by causing fish to abandon nests. Lowering of water levels during the spawning season may adversely affect crappie survival (Siefert, 1969; Ginelly, 1971) and smallmouth bass nests (Montgomery et al., 1980).

Idaho Power monitored spawning of smallmouth bass, white and black crappie, and channel catfish in Brownlee reservoir from 1991 through 1998. Scuba survey techniques were used to determine the timing and depth of spawning, and to assess incubation success as determined by observing fry in the nests. In each year, multiple surveys were conducted over the spawning season (6 surveys per week in 1992, 1 survey per week in 1993, and two surveys per week from 1994 through 1997).

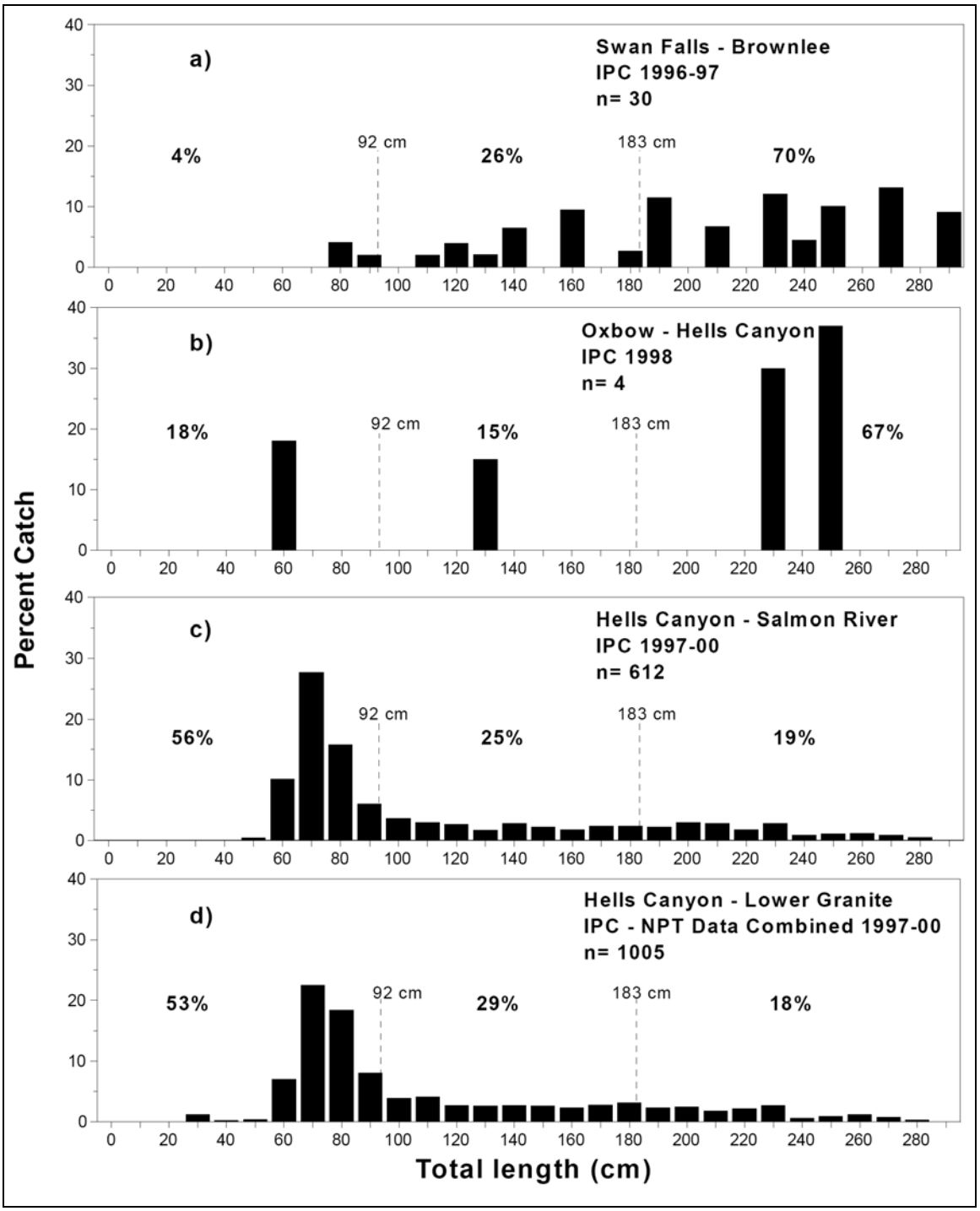

Figure 96. Length-frequency distributions (adjusted for gear selectivity) of white sturgeon sampled with setlines in the Snake River reaches from Swan Falls to Lower Granite dams. (Source: Lepla et al., 2003)

Idaho Power's findings regarding the time of spawn, nest duration and nesting depth is summarized in table 54. Because of difficulty distinguishing between black and white crappie and hybrids of the two species during scuba surveys, observations on these species were combined. Based on their evaluation of nesting success, Richter and Chandler (2001) concluded that drawdowns exceeding 4 feet during the nesting period caused a substantial reduction in nesting success for smallmouth bass, and a similar reduction was observed for crappie when drawdowns exceeded 5 feet. Although the number of channel catfish nests that were observed in Brownlee reservoir was small (N = 18), the data collected from these nesting sites indicate that catfish nest success did not show any relationship to the amount of draft (up to 12 feet) that was observed during the nesting period. Idaho Power's observations indicate that increasing water levels over active nests did not adversely affect nesting success.

Table 54. Spawning seasons, nesting duration and nest depths of smallmouth bass, crappie, and channel catfish in Brownlee reservoir. (Source: Richter and Chandler, 2001, as modified by staff)

Species	Peak Spawning Period	Mean Nest Duration	Typical Nest Depth
Smallmouth bass	May 19 to June 1	14.5 days	3 to 8 feet
White and black crappie	May 10 to May 21 and June 8 to June 24	7.3 days	7 to 15 feet
Channel catfish	Mid-June through July	16.5 days	6 to 18 feet

Idaho Power modeled Brownlee reservoir elevations under each of the evaluation scenarios. A comparison of reservoir elevations for each scenario indicates that Scenario 2 (Flow Augmentation) is the only scenario where seasonal elevations in Brownlee reservoir differ substantially from Proposed Operations. Simulated reservoir elevations for three water year types under these two flow scenarios are shown in figures 97 through 99. The spawning period for smallmouth bass, crappie, and channel catfish are indicated by hatch marks.

As shown on figure 97, simulated reservoir levels during the smallmouth bass spawning period declined slightly in the extremely low flow water year under both Proposed Operations and the Flow Augmentation Scenario, but reservoir levels did not decline by more then 3 feet during the 14-day nest duration at any time during the spawning period. In the medium and extremely high flow water years, reservoir levels increase during the spawning season and through the 7-day period when later-spawned eggs would still be in the nest. Since level reductions exceeding 4 feet are not likely to occur, our analysis indicates that nest success for smallmouth bass should not be adversely affected under any of the scenarios regardless of water year type.

As shown on figure 98, simulated reservoir levels during the crappie spawning period decline slightly in the extremely low flow water year under both scenarios. Reservoir levels increase slightly within the 7-day period after spawning ends when nests would still be active (prior to hatching). The maximum reduction in water level for an active nest is 2.1 feet for both scenarios, and the maximum increase in water level is just under 2 feet. In the medium flow year, water levels increase rapidly during the crappie spawning period, and decline slightly after the spawning season ends in both scenarios. The maximum reduction in water levels during the 7-day active period for nests constructed at any time during the spawning season is 2.1 feet. Similarly, in the extremely high flow year, simulated water levels increase rapidly during most of the crappie spawning season, and then hold steady after the maximum pool elevation is attained. Since level reductions exceeding 5 feet are not expected to occur, our analysis indicates that nest success for crappie should not be adversely affected under any of the scenarios regardless of water year type.

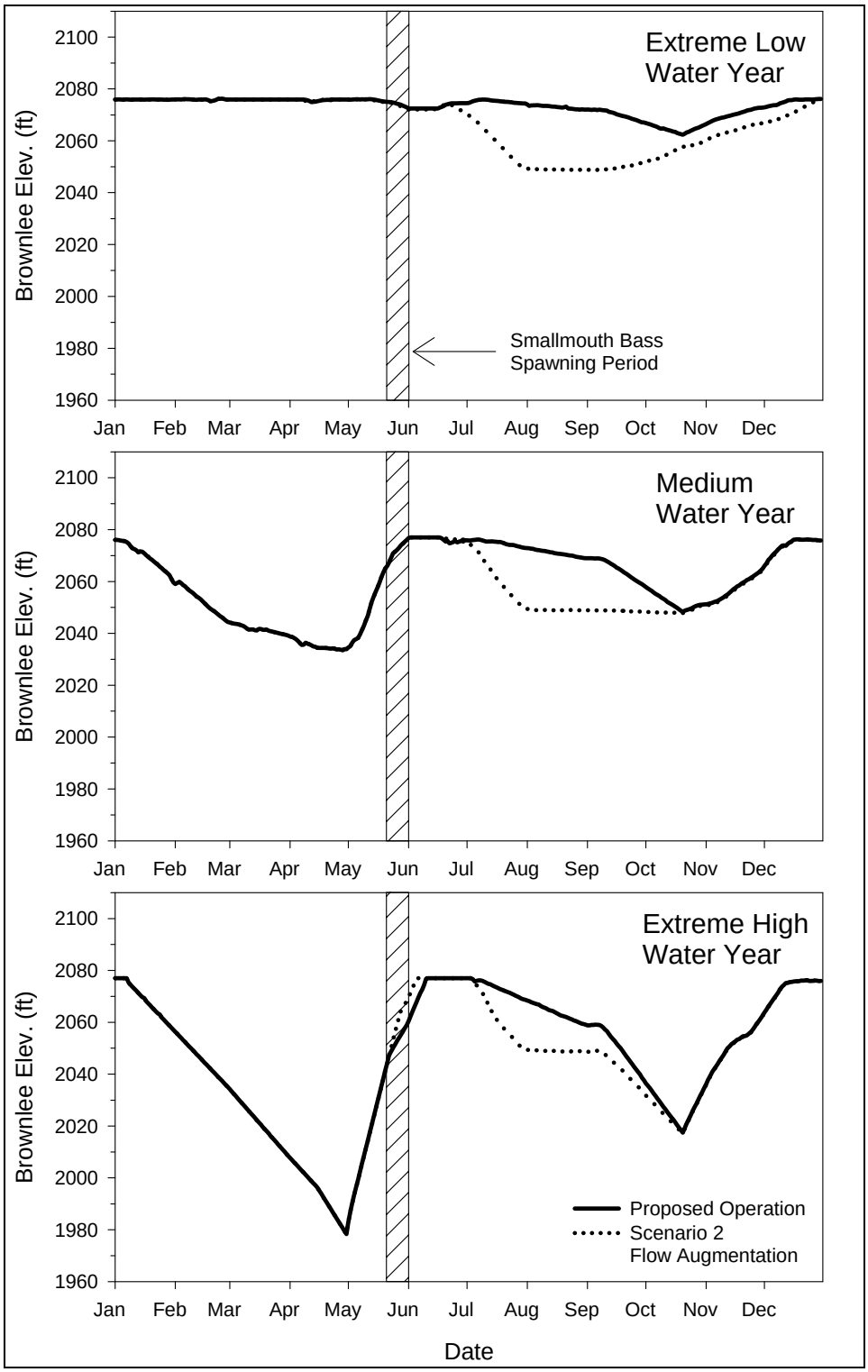

Figure 97. Smallmouth bass spawning period and Brownlee reservoir elevations predicted for three water year types for Proposed Operations and for Scenario 2, Flow Augmentation. (Source: Brink and Chandler, 2005, as modified by staff)

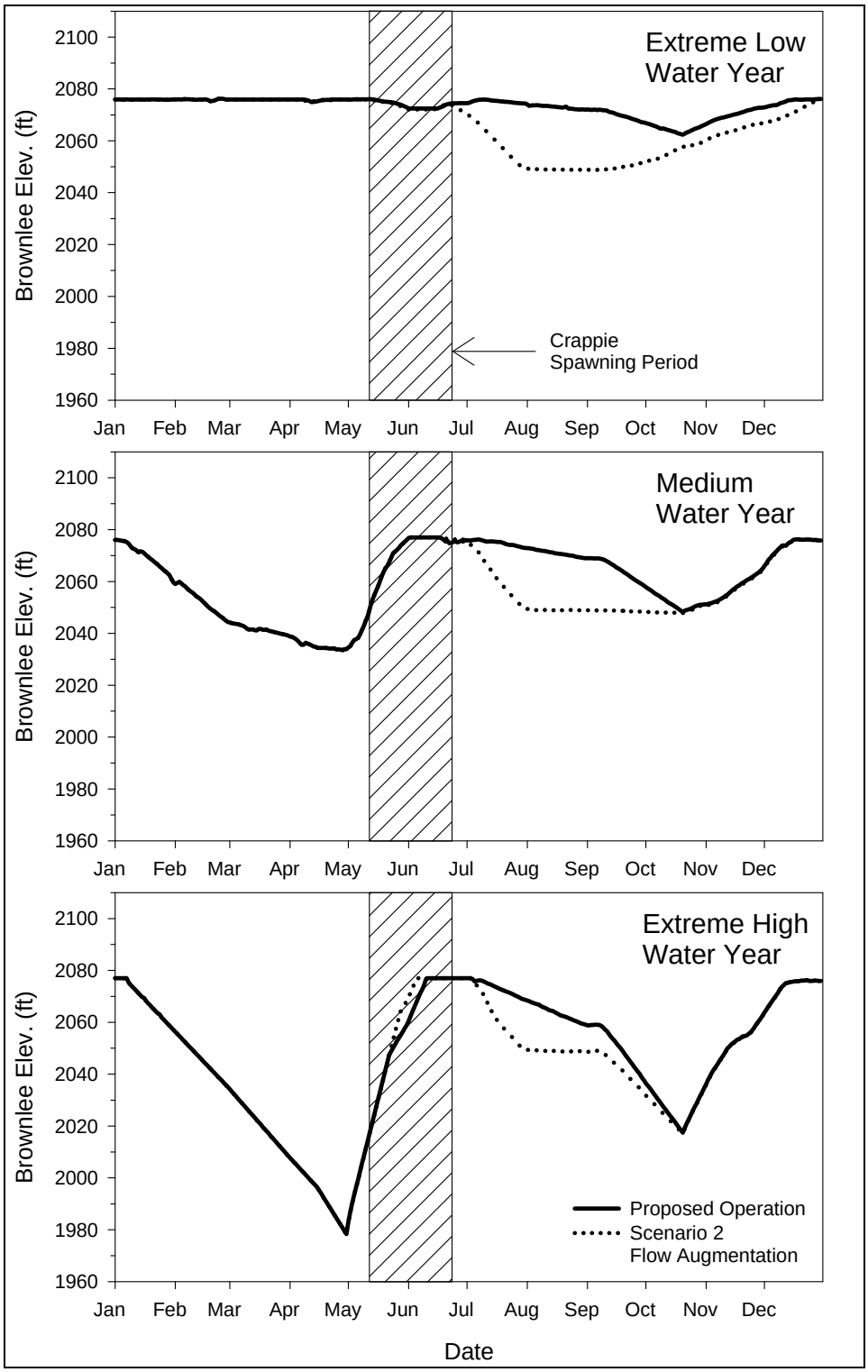

Figure 98. Crappie spawning period and Brownlee reservoir elevations predicted for three water year types for Proposed Operations and for Scenario 2, Flow Augmentation. (Source: Brink and Chandler, 2005, as modified by staff)

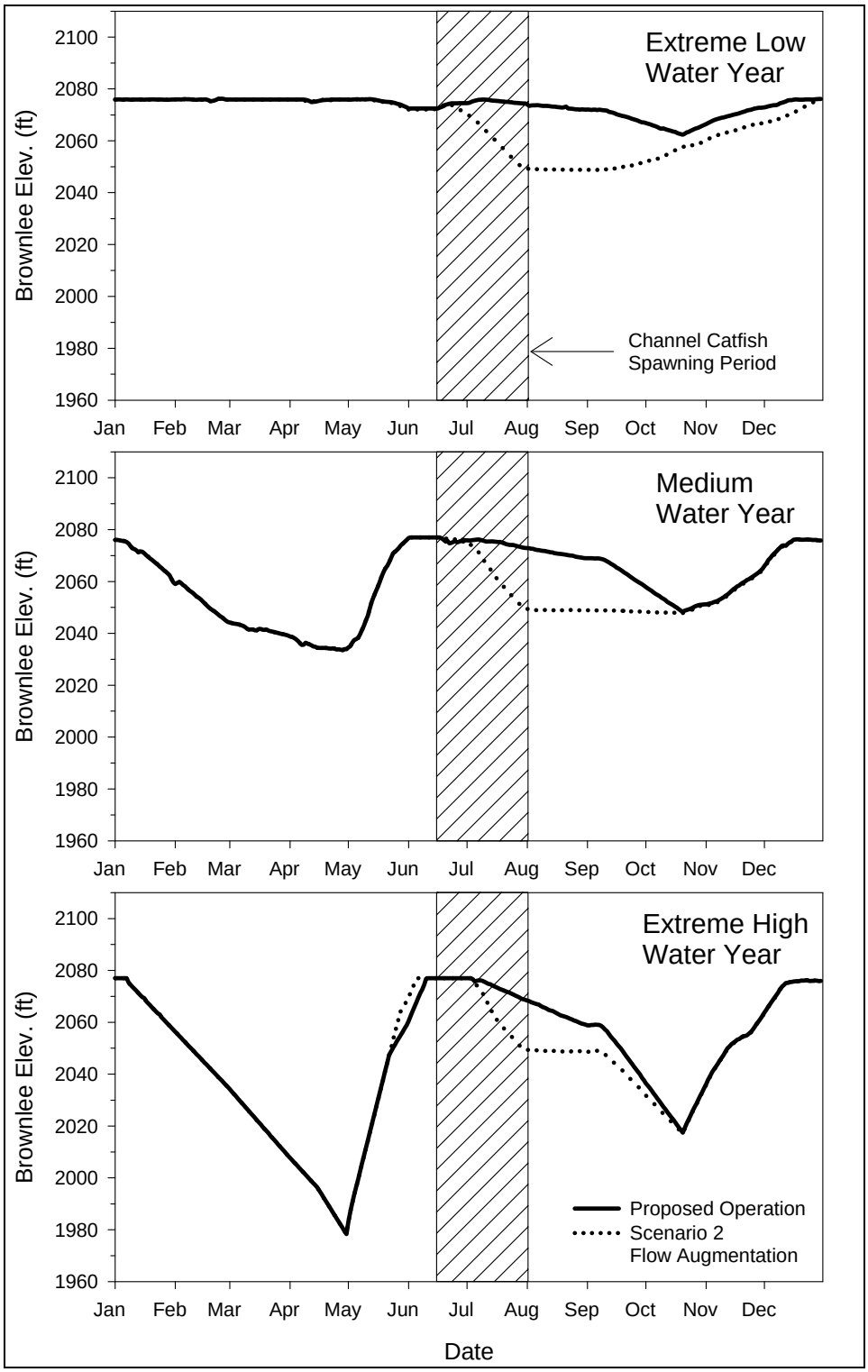

Figure 99. Channel catfish spawning period and Brownlee reservoir elevations predicted for three water year types for Proposed Operations and for Scenario 2, Flow Augmentation. (Source: Brink and Chandler, 2005, as modified by staff)

Because they spawn later in the summer, channel catfish nests are exposed to greater reductions in water levels, especially under the Flow Augmentation Scenario (figure 99). To evaluate the change in reservoir level that individual nests would be exposed to while they are active, we plotted the change in simulated reservoir elevation that each nest would be exposed to over the 17 days between when spawning occurred and when fry would emerge from the nest. These values are plotted for each scenario by the date spawned for each water year type in figure 100. The figure shows that while drawdowns would be more substantial in the Flow Augmentation Scenario, the extent of elevation change that occurs during the 17-day period when any nest is active would not exceed 8 feet. Because channel catfish are relatively deep spawners, it appears that relatively few channel catfish nests would be adversely affected. As noted above, Richter and Chandler (2001) did not observe any reduction in channel catfish nesting success under drawdowns of up to 12 feet, but this was based on a relatively small number of observations (18 nests).

Based on the preceding analysis, the alternative scenarios representing the range of agency recommendations, including flow augmentation, should not have any substantial adverse effects on warmwater fish spawning. Limiting reservoir fluctuation to a maximum of 1 foot from May 21 through June 20, as proposed by Idaho Power and recommended by ODFW, would minimize adverse effects to smallmouth bass over their entire spawning season and minimize adverse effects to crappie in the latter half of their spawning season. Limiting drawdown to elevation 2,069 (an 8-foot drawdown from full pool) through July 4 would protect early-spawning channel catfish but would afford little protection to later spawning fish, since their spawning period extends to the end of July and nests may remain active until mid-August. However, based on our analysis, there is a relatively small potential for adversely affecting channel catfish, even under the Flow Augmentation Scenario.

Idaho Power proposes to conduct annual warmwater fish population monitoring at established electrofishing sites in each reservoir, and every fifth year between Swan Falls dam and Brownlee reservoir. This measure would provide a mechanism to monitor changes in species composition and abundance in response to environmental conditions, project operations and recreational fishing effort. This information would be useful for guiding reservoir fisheries management decisions and to determine whether operational restrictions included in the license are effective in promoting consistent recruitment. Creel surveys would require a considerably greater level of effort, and angler success can be affected by a range of factors including weather and level of angler skill that make them a less consistent measure of fish populations than electrofishing. Thus, annual creel surveys recommended by ODFW (ODFW-50) likely would be a more costly and less useful approach for monitoring fish population trends.

In addition, ODFW's recommendation (ODFW-52) that Idaho Power conduct a study of warmwater fish species food habits in Brownlee reservoir, including effects of project operations on zooplankton production, would be of little benefit. As indicated by relative weights exceeding 85 for all species (Richter and Chandler, 2003), Idaho Power's studies indicate that warmwater fish in Brownlee reservoir do not appear to be limited by their food supply.

IDFG (IDFG-27) recommends that Idaho Power consult with IDFG and ODFW to evaluate alternative strategies to protect warmwater fisheries in the event that economic or system emergencies occur that require deviation from its proposed operating regime. In its April 11, 2006, reply comments, Idaho Power reports that most, if not all, situations can be handled within existing license constraints. As a standard license condition, licensees are required to report departures from operational requirements and the effects of the departures. Such reports would provide a mechanism for identifying the need for alternative warmwater fish protection strategies.

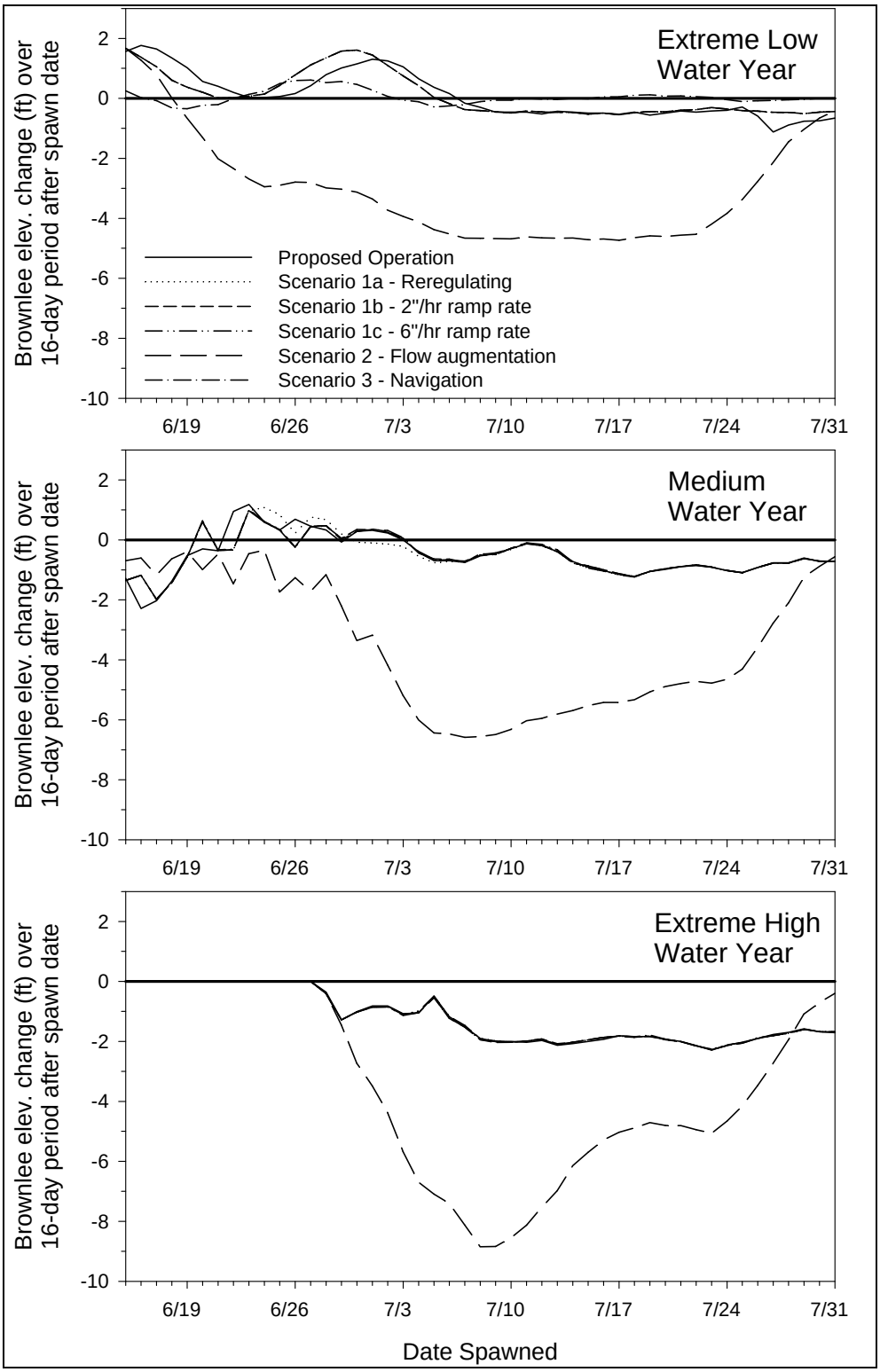

Figure 100. Elevation change during an estimated active nest duration of 16 days for channel catfish nests constructed between June 15 and July 31. (Source: Brink and Chandler, 2005, as modified by staff)

In its comments on the draft EIS, ODFW indicated that it supported staff's recommendation for warmwater fish monitoring, provided Idaho Power coordinated annually with ODFW and included appropriate sampling techniques for monitoring the abundance of channel catfish, which were identified in Idaho Power's angler survey effort as a key target species for anglers. During the 10(j) meeting, Idaho Power indicated that its sampling effort could be modified to include gill netting for sampling catfish at minimal additional cost. Coordination with ODFW in the development of the sampling program would ensure that appropriate protocols for sampling this important recreational species is included in the monitoring program, and would help to determine whether any changes in the health of catfish populations may be related to project operations.

Drawdown of Brownlee reservoir for other project purposes (i.e., flood control, power generation, and flow augmentation) would likely continue to have some adverse effects on the warmwater fishery in Brownlee reservoir. Drawdowns can adversely affect nesting success and can flush larvae and juvenile lifestages of the warmwater species from the reservoir. However, annual consultation with ODFW, IDFG, and BLM on the results of warmwater fisheries monitoring efforts would provide a forum to discuss the effects of project operations on the warmwater fishery. Such consultation may identify opportunities for reservoir levels to be managed in ways that minimize adverse effects on the warmwater fishery.

3.6.2.2 Dissolved Oxygen

Aquatic organisms require varying amounts of DO in the water to thrive. The amount of DO present in water is related to water temperature, atmospheric pressure, and the presence of plants, nutrients, and bacteria that produce and consume oxygen during photosynthesis and respiration. For most fish and aquatic organisms, as temperatures rise, metabolic demand also rises, increasing the need for oxygen to maintain respiratory and metabolic functions. Salmonids generally require DO concentrations of at least 7 mg/L and are less tolerant of low DO concentrations than warmwater fishes, which can tolerate DO concentrations as low as 3 to 4 mg/L.

Water quality criteria and TMDL targets for the Snake River-Hells Canyon area are presented in table 17. The TMDL targets for DO range from a minimum of 6.5 mg/L for coolwater life to 8 mg/L water column DO or not less than 90 percent saturation for coldwater aquatic life and salmonid rearing in the downstream Snake River (RM 247 to 188) (table 17). Following development of the TMDL, EPA approved new water quality standards for both Idaho and Oregon. Oregon's DO criteria for coldwater aquatic life and spawning are essentially the same as the TMDL targets. Although Idaho's DO criteria are less restrictive that the TMDL targets, the Idaho criteria are not controlling; water quality must satisfy the most restrictive applicable standard, which, in this case, is the TMDL target. DO concentrations measured between the Snake River inflow to Brownlee reservoir and about 10 miles downstream of Hells Canyon dam are presented in figures 28 and 31.

Increasing DO levels in project reservoirs and downstream of Hells Canyon dam would increase the usable habitat in the project reservoirs, reduce the incidence of fish kills, and improve conditions for spawning of fall Chinook salmon downstream of Hells Canyon dam. Increasing DO levels in project reservoirs would also reduce the exposure of aquatic organisms to contaminants by expediting the degradation of organochlorine compounds and reducing the availability of methylmercury (the biologically available form of mercury) in reservoir sediments.

Idaho Power's proposed measures and recommendations of agencies, tribes, and others are discussed, along with their effects on the physical environment, in section 3.5.2.2, *Dissolved Oxygen*.

Our Analysis

As noted in section 3.5.1.3, *Biological Productivity,* results of monitoring DO concentrations in the Hells Canyon dam tailwater showed that DO concentrations were less than the water quality targets on

more than half of the days in each of the years between 1991 and 2000. The DO targets were not met during 58 percent of the days in the high flow year of 1997 or during 98 percent of the days in the lower flow years of 1991 and 1993 (Myers et al., 2003a). The measured DO concentrations never met the 11.0-mg/L spawning criterion in the fall (October 24 through December 31) and did not meet the criterion between 17 to 100 percent of the time in the spring (January 1 through May 10). At least one of the coldwater criteria was not met 59 to 98 percent of the time during the remainder of the year (Myers et al., 2003c). High levels of nutrient and organic matter loading appear to be the primary cause of low DO concentrations.

Figure 28 shows that in the medium flow year of 1995, DO was less than 8 mg/L at all measurement points in Brownlee, Oxbow, and Hells Canyon reservoirs, except for a few measurements near the surface of the reservoirs in July. Bottom-dwelling channel catfish are most susceptible to DO levels near zero at depth; however, they may move to shallower littoral zones to avoid these areas (Idaho Power, 2003a). The persistence of low DO levels near the surface, and levels below 5 mg/L at depth could interfere with salmonid spawning success downstream of Hells Canyon dam.

Low DO levels in project reservoirs and downstream of Hells Canyon dam also may result in suboptimal or lethal conditions for white sturgeon. During low-flow years, low DO conditions lethal to sturgeon can comprise up to 80 percent of the bottom 2-meter layer in Brownlee reservoir. Low river inflows and excessive nutrient levels, likely exacerbated by high water temperatures (25–26°C), resulted in DO levels (< 0.86 mg/L) throughout the water column that were lethal for sturgeon near the upper end of Brownlee reservoir (RM 324) in 1990 and caused the deaths of 28 adult white sturgeon (Lepla and Chandler, 2003).

Although no sturgeon mortalities have been attributed to poor water quality in Oxbow or Hells Canyon reservoirs, low DO levels that are potentially lethal to sturgeon can comprise up to 73 percent of the bottom 2-meter layer in Oxbow reservoir and 42 to 55 percent in Hells Canyon reservoir during summer months in low-flow years (Lepla and Chandler, 2003). Downstream of Hells Canyon dam, DO concentrations measured in the tailrace can also drop to as low as 2.8 mg/L for several weeks during late summer months, especially in low flow years. These conditions likely persist for a few miles downstream of the dam, but no sturgeon mortality has been attributed to these events (Lepla and Chandler 2003). Although population trends observed in the Bliss reach indicate that sturgeon recruitment is impeded in low flow years, Lepla and Chandler (2003) report that this trend was not observed in the population downstream of Hells Canyon dam.

Low DO concentrations and high water temperatures were also implicated in a kill of approximately 100 adult hatchery steelhead and one channel catfish that were isolated in a pool downstream of Hells Canyon dam. This event occurred when flows were reduced in the fall of 2002 (letter from N.F. Gardiner, Idaho Power, Boise, ID, to M.R. Salas, Secretary, FERC, Washington, D.C., dated October 31, 2002).

Modeling conducted by Idaho Power indicates that DO levels that are below optimal for bull trout may persist for up to 20 miles downstream of Hells Canyon dam (see figures 48, 49, and 50 in section 3.6.1.4). However, modeled water temperatures throughout the reach are also unsuitable for bull trout from early July through mid-October, as shown in figures 51, 52, and 53 in section 3.6.1.4. Most redband and bull trout likely move into tributaries during the summer months, although Idaho Power's radio telemetry studies (Chandler et al., 2003a) show that some bull trout remain in the mainstem Snake River during the summer, using temperature refugia where coolwater tributaries enter the river.

An analysis of the effectiveness of Idaho Power and agency/tribal recommendations in increasing DO levels is presented in section 3.5.2.2, *Dissolved Oxygen.* Idaho Power's proposed reservoir supplementation would not increase DO concentrations of Brownlee or Hells Canyon discharges to above the 6.5-mg/L coolwater target, although it would fulfill the intent of the TMDL load allocation (IDEQ and ODEQ, 2004) and would be responsive to the Nez Pierce Tribe recommendation for reservoir

supplementation. Any incremental increase in DO provided where it is currently below the target level would likely benefit aquatic species; however, the extent of such benefit would depend on the location, duration and timing of any increase realized.

Idaho Power's proposed reservoir aeration system was designed for the current level of nutrient loading from upstream sources. As loadings of nutrients and organic matter experience slow long-term reductions from implementing the TMDL, the extent of algae blooms would be reduced and the sediment oxygen demand would tend to decrease. This would result in higher DO levels, particularly near the bottom of Brownlee reservoir's transition zone. The long-term effects of these changes are expected to incrementally improve fish habitat in the upper end of the reservoir over a new license period. However, it is expected to take decades for implementation of the TMDL to substantially reduce nutrient and organic matter loadings. Thus related improvements in water quality are also not expected for decades.

As noted in section 3.5.2.2, *Dissolved Oxygen,* the analysis of oxygen supplementation measures provide a basis for Idaho Power to develop a DO enhancement plan, in consultation with IDEQ, ODEQ, and other federal, state, and tribal agencies responsible for managing fish and wildlife, to refine the proposed reservoir DO supplementation measure and evaluate the need for additional or alternative aeration measures. Implementing the plan would help Idaho Power confirm whether reservoir supplementation is cost effective and evaluate whether alternative measures, including reducing nutrient and organic matter loadings from tributaries and injecting oxygen into forebay waters, would be more cost-effective or provide a greater overall level of benefit to habitat conditions for fish in the project area.

In its January 31, 2007, application for water quality certification, Idaho Power proposes to implement the following measures to increase DO levels in the project area: (1) in-reservoir aeration or upstream phosphorus trading to meet the 1,125 tons/yr DO load allocation in Brownlee reservoir; (2) aerating turbines at Hells Canyon or Brownlee dam to add 1,500 tons per year DO downstream of Hells Canyon dam; and (3) installing a destratification system in the deep pool in the Oxbow bypass to address thermal stratification and anoxic conditions within the deeper waters of the pool.

Of the two potential measures intended to meet Idaho Power's load allocation for Brownlee reservoir, Idaho Power would evaluate phosphorus trading first. This option would be pursued only if an appropriate trading partner can be found. The phosphorus trading program could provide substantial benefits to aquatic resources in upstream habitat and within the project area, especially in the project reservoirs. These benefits would increase over time, as the amount of nutrients retained in sediments and aquatic vegetation is reduced. Reservoir aeration, in comparison, would provide a more localized and temporary benefit. Phosphorus trading measures implemented in project tributaries could act in concert with other tributary habitat enhancements proposed by Idaho Power and recommended by other stakeholders (addressed in section 3.6.2.10, *Tributary Habitat Enhancements*) to substantially improve habitat conditions for native resident salmonids and improve the prospects for the eventual restoration of salmon and steelhead to these tributaries. Phosphorus trading could also expedite progress toward attaining water quality conditions in the Marsing reach, which would (1) support restoration of fall Chinook salmon, (2) improve habitat conditions for white sturgeon in the Swan Falls to Brownlee reach, and (3) improve habitat conditions for white sturgeon and native resident salmonids in all three of the project reservoirs.

Turbine aeration at Hells Canyon dam would benefit aquatic resources by addressing the DO deficit that extends approximately 10 to 20 miles downstream of Hells Canyon dam on a seasonal basis. Aerating turbine discharge at Brownlee dam would have the additional benefit of increasing DO levels in Oxbow and Hells Canyon reservoirs, as well as in the Oxbow bypassed reach. Idaho Power proposes to implement the measure at Brownlee dam if it is found that this measure would provide reasonable assurance that targets below Hells Canyon dam would be met.

Installation of a destratification system in the deep pool in the Oxbow bypassed reach would reduce anoxic conditions that currently occur in the pool. This has the potential to benefit aquatic

resources that use the bypassed reach, including bull trout and redband trout. The system would provide compressed air to bubble diffusers that would be anchored on the bottom of the pool.

3.6.2.3 Total Dissolved Gas

TDG levels above 110 percent of saturation can be injurious to fish by causing gas bubble trauma (GBT). When TDG levels in water are high, gas-permeable membranes of fish, most often gills, eyes, skin and yolk sacs, absorb the excess gas and develop bubbles that interfere with blood flow, causing hemorrhages and blood clots. Smaller fish are more permeable than larger fish because their membranes are thinner; therefore, they are more susceptible to GBT, while larger fish can tolerate somewhat higher levels before they begin to be affected. Fish affected by GBT often swim upside down or vertically, sometimes looking as if they are gasping for air at the surface.

TDG levels decrease approximately 10 percent for every meter of depth, so as fish go deeper in the water column, the effects of GBT are reduced. Similarly, as fish swim closer to the surface, TDG levels are higher and the potential for GBT is greater. Therefore, bottom-dwelling fish and fish that swim lower in the water column are less susceptible to GBT.

As we noted in section 3.5.1.4, *Total Dissolved Gas*, TDG levels as high as 136.3 percent of saturation have been measured 1.5 miles downstream of Hells Canyon dam. TDG levels exceeding 110 percent persist up to 47 miles downstream when spills at Hells Canyon dam are between 9,000 and 13,400 cfs, and levels exceeding 110 percent may persist for up to 67 miles downstream of Hells Canyon dam when spills at the dam exceed 19,000 cfs (Myers and Parkinson, 2003). Maximum TDG levels in Brownlee reservoir measured just upstream of the dam were just below the 110 percent criterion. Spill events greater than 3,000 cfs at Brownlee resulted in TDG levels above 110 percent saturation, with a maximum TDG level measured at 143 percent during spills greater than 55,000 cfs. High TDG levels persist through the Oxbow reservoir to Oxbow dam. Comparisons of TDG levels upstream and downstream of Oxbow dam showed that TDG levels both increased and decreased after passing Oxbow dam. Spill rates less than 2,000 cfs and greater than 24,000 cfs appear to reduce TDG, while spills between 5,000 and 24,000 appear to increase TDG downstream of Oxbow dam (section 3.5.1.4). Spills at Oxbow dam can elevate TDG up to at least 128 percent of saturation even when Oxbow forebay TDG levels are less than 110 percent.

Proposals and recommendations relevant to TDG abatement are discussed in section 3.5.2.3, *Total Dissolved Gas*. Idaho Power proposes to continue preferential use of crest (upper spillway) gates for passing spills at Brownlee dam. They also propose to install flow deflectors on the Hells Canyon and Brownlee dam spillways that would alter the flow characteristics from the spillway to reduce air entrainment deep in the tailrace during spill episodes of up to the 10-year, 7-day average flood flows. In addition, Idaho Power proposes a yet unknown TDG abatement structure to meet the TMDL TDG load allocation for Oxbow dam. NMFS, Interior, AR/IRU, and the Umatilla Tribes also recommend that Idaho Power design and construct gas abatement structures at Hells Canyon and Brownlee dam spillways to reduce TDG levels in Oxbow and Hells Canyon reservoirs and the free-flowing Snake River downstream of Hells Canyon dam.

AR/IRU (AR/IRU-18a) recommend that Idaho Power conduct real-time TDG monitoring either during periods of high spill or consistent with Idaho Power's water quality certification once is it issued (whichever is more rigorous). They recommend the monitoring program be designed to detect TDG violations and quantify the affected reaches downstream of Hells Canyon Project dams. They further recommend that a Technical Advisory Committee develop a compensation program to quantify and address losses of aquatic biota in years when attaining the TDG standards is not feasible.

Our Analysis

In its comments on the draft EIS, Interior notes that historical information confirms that spill at the project has caused GBT in fish and fish kills. However, Idaho Power observed few effects to fish related to high levels of TDG, with occasional symptoms of GBT disease identified in adult anadromous salmonids returning to Hells Canyon dam during recent spill periods. Idaho Power also reports that FWS sampling of juvenile salmonids 20 miles below Hells Canyon dam showed no signs of GBT (Idaho Power, 2003a). However, no party has conducted any sampling to evaluate the incidence of GBT closer to Hells Canyon dam. Sampling conducted by Idaho Power at locations upstream of Hells Canyon dam, however, found that a wide range of fish species showed evidence of GBT during the sampling period (table 55). Fish sampled when TDG levels were less than 120 percent did not show evidence of GBT, but severe GBT was observed in some fish when TDG levels exceeded 125 percent (Richter et al., 2006). The incidence of severe GBT was the highest in the Brownlee tailrace, but fish with severe GBT were also observed in the Oxbow bypassed reach, Oxbow forebay, and in Hells Canyon reservoir near the Oxbow tailrace when high TDG levels occurred (figures 101 through 104).

Idaho Power's proposal, and the recommendations of others, to address TDG abatement cover a variety of approaches including: (1) operational changes at Brownlee dam; (2) designing and constructing TDG abatement structures at Hells Canyon, Brownlee, and/or Oxbow dams; (3) monitoring; (4) adaptive management; and (5) developing a compensation program for high TDG levels. The effects of these proposals on TDG levels are discussed in more detail in section 3.5.2.3, *Total Dissolved Gas*.

The current design of Hells Canyon spillway deflectors proposed by Idaho Power are not expected to be effective at spills of greater than 30,000 cfs. However, Idaho Power proposes to quantitatively optimize the final design so that it would be effective up to the 10-year 7-day average flood flow. This should reduce the frequency and severity of most supersaturation events, thus reducing the potential for fish to be exposed to high TDG levels downstream of Hells Canyon dam. Reductions in TDG that result in meeting the TMDL load allocations and water quality standards would be beneficial to aquatic resources by decreasing the chances of exposure to TDG levels above 110 percent saturation and therefore the likelihood of fish developing GBT disease.

AR/IRU's recommendation to conduct real-time monitoring would help quantify TDG levels and affected reaches downstream of project dams. Knowing when and where TDG levels are exceeding the 110 percent saturation level, coupled with knowledge of fish presence in those reaches during those times, would facilitate assessments of the potential mortality from GBT disease. AR/IRU's recommendation to develop some type of compensation program for identified losses from effects of TDG would potentially mitigate for these unavoidable losses. However, without more information on the nature of the compensation being recommended, we cannot assess its effect on aquatic resources in project waters.

In its January 31, 2007, application for water quality certification, Idaho Power (2007a) proposes to implement several measures in addition to the measures proposed in its license application (preferential spilling through the upper spill gates at Brownlee dam and installing spillway flow deflectors at Hells Canyon dam). These are: (1) evaluation of TDG reduction measures at Oxbow dam as an early implementation measure; (2) installation of Brownlee dam spillway flow deflectors; and (3) installation of the most effective, safe and economically feasible measure designed to reduce TDG levels at Oxbow dam. Implementing these additional measures should help reduce the incidence of gas supersaturation within and downstream of the project, and reduce the risk of gas bubble trauma on aquatic resources within Oxbow and Hells Canyon reservoirs and downstream of Hells Canyon dam.

Table 55. The ercentage of each species collected during the 2006 sampling season (January–June) by the rank of GBT. Ranks 1 through 4 represent percentages of skin area covered with bubbles of 0. 1 to 5, 6 to 25, 26 to 50, and >50. (Source: Richter et al., 2006)

	Percentage by Rank					Total Number Collected
Species	**0**	**1**	**2**	**3**	**4**	
Black crappie	90.9	9.1	0	0	0	11
Bluegill	91.8	5.2	1	0	2	97
Brown bullhead	0	100	0	0	0	1
Channel catfish	95.4	1.2	0	1.2	2.3	87
Chiselmouth	89.4	4.3	0	6.4	0	47
Common carp	91.6	3.5	2.1	2.1	0.7	143
Fall Chinook	100	0	0	0	0	1
Kokanee	100	0	0	0	0	2
Largemouth bass	0	0	0	100	0	1
Mottled sculpin	100	0	0	0	0	2
Pumpkinseed	100	0	0	0	0	3
Rainbow trout	83.3	4.5	3.4	3.7	5.0	378
Northern pikeminnow	93.9	2.7	2.7	0.7	0	295
Bridgelip sucker	97.5	1	1	0.5	0	198
Largescale sucker	96.8	2.1	0	0.5	0.5	377
Steelhead	100	0	0	0	0	13
Smallmouth bass	85.7	6.4	3.2	2	2.7	1,022
White crappie	78	5.5	7.7	4.4	4.4	91
Mountain whitefish	91.7	0.9	1.8	0.8	4.6	109
Yellow perch	91.8	5.2	0.8	0.8	1.5	134
Total Percentage for Each Rank	**89.5**	**4.3**	**2.3**	**1.8**	**2.2**	**3,012**

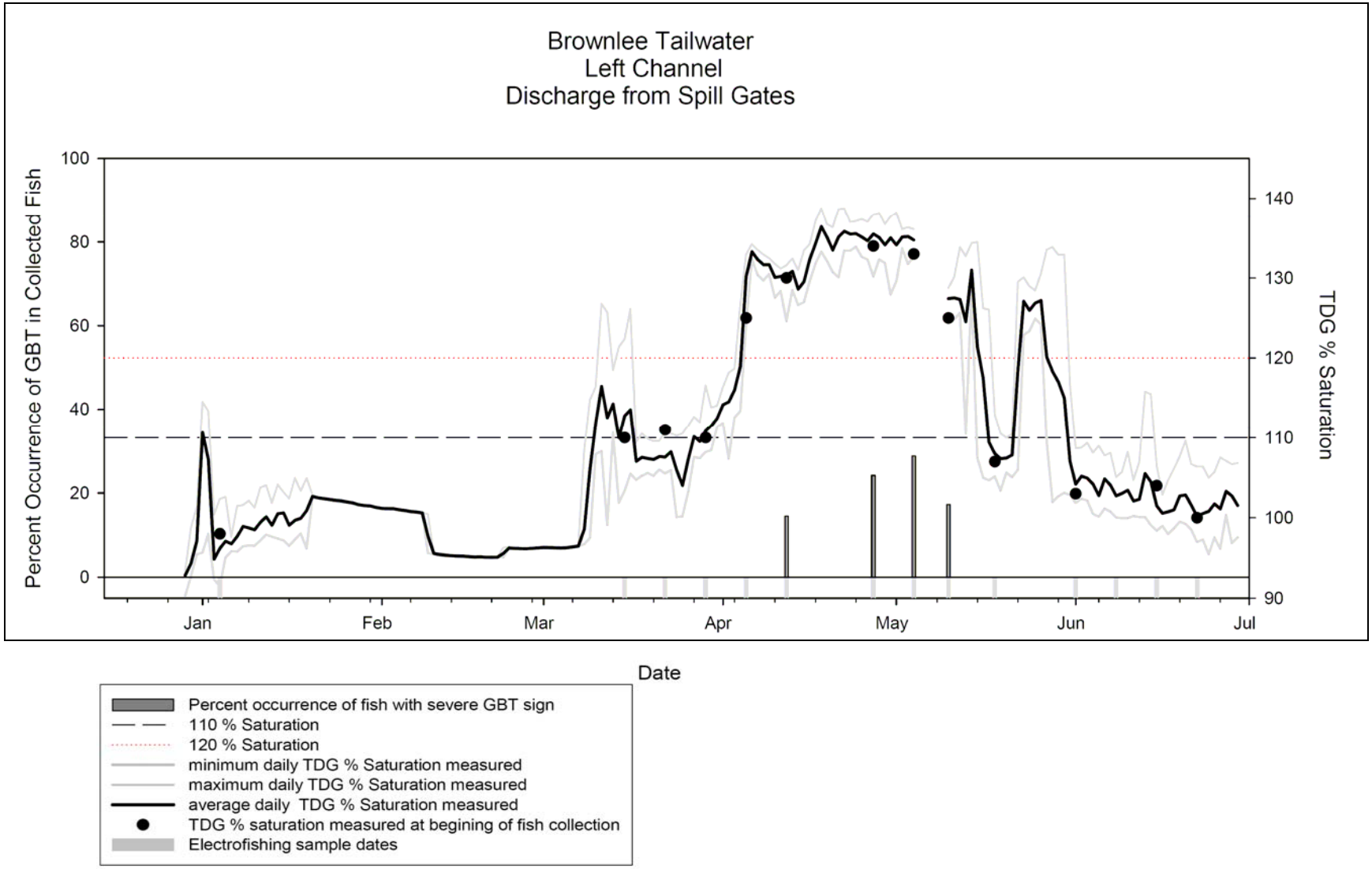

Figure 101. Percent occurrence of fish with severe gas bubble trauma (GBT) and percent saturation of TDG taken during weekly sampling in the Brownlee tailwater in the spring of 2006. (Source: Richter et al., 2006)

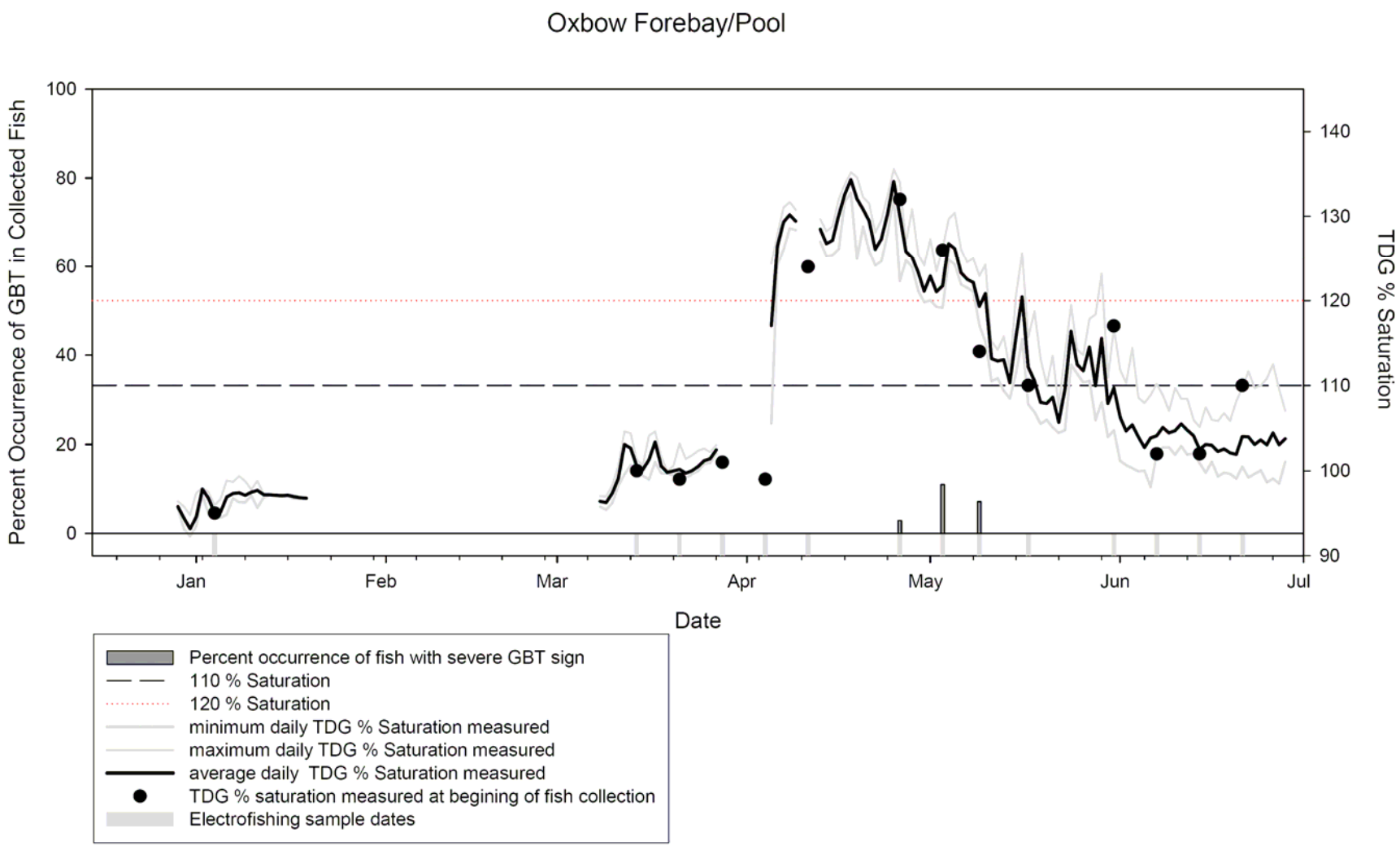

Figure 102. Percent occurrence of fish with severe gas bubble trauma (GBT) and percent saturation of TDG taken during weekly sampling in the Oxbow forebay/pool in the spring of 2006. (Source: Richter et al., 2006)

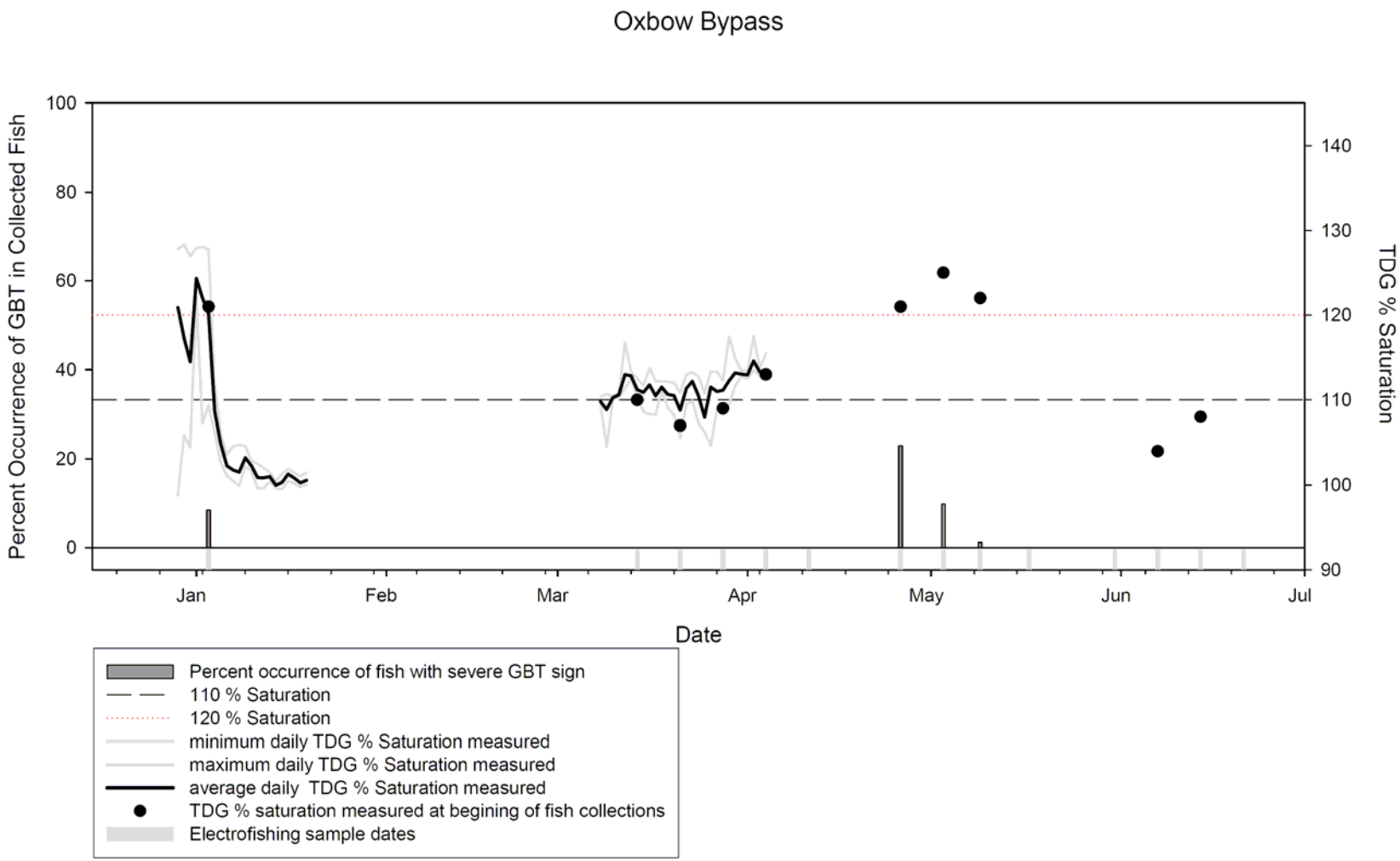

Figure 103. Percent occurrence of fish with severe gas bubble trauma (GBT) and percent saturation of TDG taken during weekly sampling in the Oxbow bypassed reach in the spring of 2006. (Source: Richter et al., 2006)

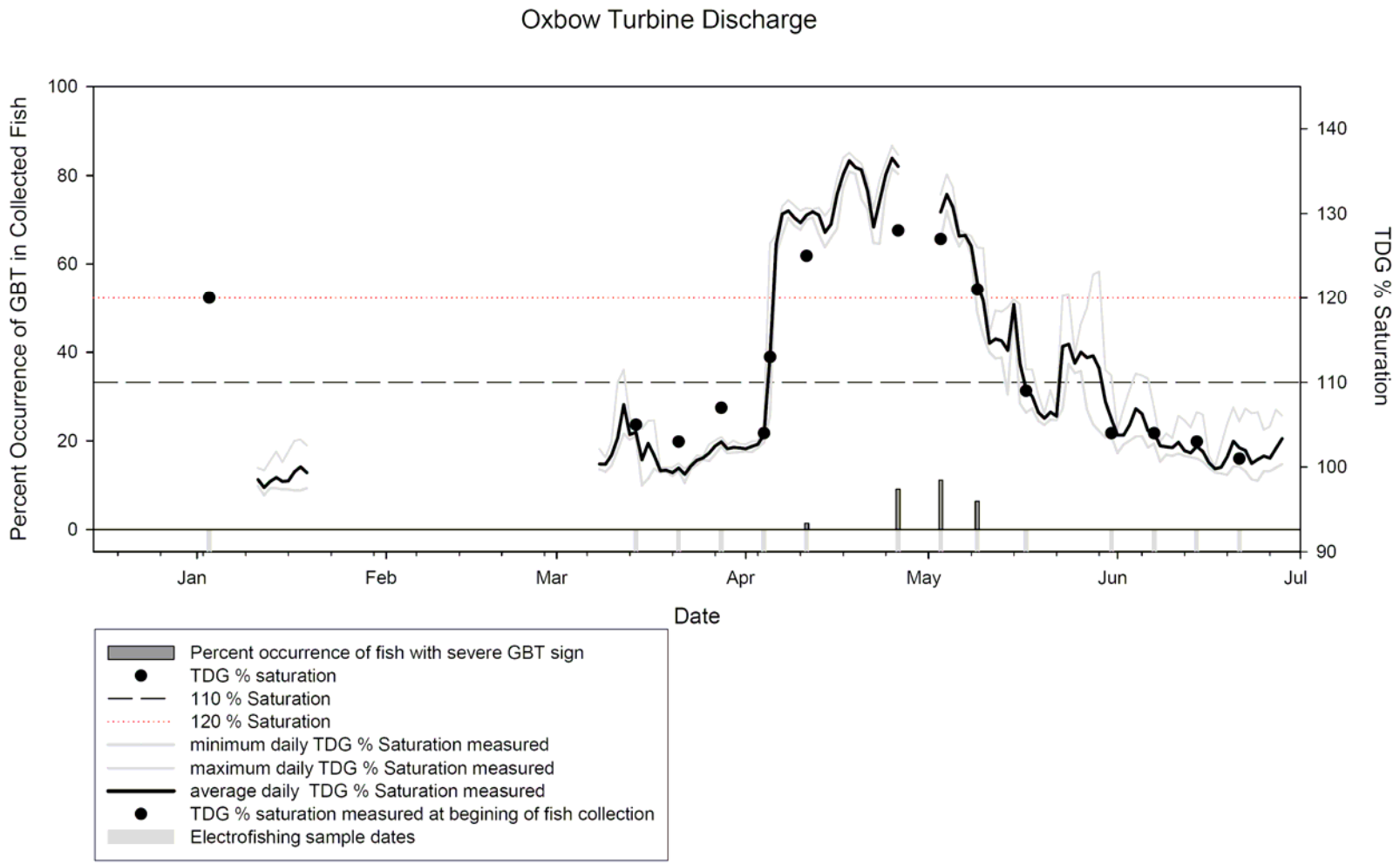

Figure 104. Percent occurrence of fish with severe gas bubble trauma (GBT) and percent saturation of TDG taken during weekly sampling in Hells Canyon reservoir near the Oxbow powerhouse discharge in the spring of 2006. (Source: Richter et al., 2006).

3.6.2.4 Water Temperature

As described in section 3.5.1.2, *Temperature*, Brownlee reservoir substantially alters Snake River temperatures. Storage of water in the reservoir and the depth of the powerhouse intake delay seasonal warming and cooling of water downstream of Brownlee dam compared to conditions that would occur without the project in place. Compared to inflows, this thermal lag reduces exceedances of criteria for supporting coldwater aquatic life during the summer, but increases the exceedances of temperature criteria for salmonid spawning at the start of the spawning season for fall Chinook salmon (figure 29).

The seasonal shift in the water temperature regime downstream of Hells Canyon dam may affect white sturgeon in some years by delaying the attainment of water temperatures that are considered optimum for sturgeon spawning (10 to 16°C) until slightly after peak flows have occurred, which could adversely affect spawning conditions for this species. However, as we note in section 3.6.2.1, population sampling reported in Lepla et al. (2003) demonstrates that all size groups are well represented in the sturgeon population in the Hells Canyon reach, indicating that successful reproduction and recruitment occurs in most years.

Alteration of the thermal regime caused by the project also shifts the time period that water temperature is optimal for bull trout rearing (6 to 12°C) later by about 2 weeks, but provides more suitable habitat conditions for bull trout during the summer and early winter by moderating the temperature extremes of inflowing water. Water temperatures downstream of Hells Canyon dam are particularly important to fall Chinook salmon, which are the only salmonid species that spawns and rears primarily in the mainstem river downstream of Hells Canyon dam. The seasonal shift in water temperatures caused by the project has the potential to adversely affect fall Chinook salmon by causing water temperatures to be above optimal during the start of the spawning season and by causing fish to emerge into a cooler environment with reduced growth potential. Later in the spring and early summer, fall Chinook salmon may benefit from delayed warming, which delays the onset of stressfully high water temperatures.

In its license application, Idaho Power did not propose any measures to address the effects of the project on water temperatures. However, in its application for water quality certification (Idaho Power, 2007a), Idaho Power proposes to use an adaptive approach to identify the project's responsibility for elevated temperatures downstream of Hells Canyon dam. Based on an evaluation of measures, Idaho Power would then implement identified watershed measures (which may include hydrologic measures or restoration of riparian vegetation or channel morphology) or a bubble upwelling system in Brownlee reservoir to address the project's contribution to the thermal load downstream of Hells Canyon dam.

Proposals and recommendations relevant to the installation of a temperature control device are discussed in section 3.5.2.4, *Water Temperature*. Some of the stakeholders expressed interest in continued investigation of a temperature control structure at Brownlee dam. The most extensive analysis of Idaho Power's temperature control structure modeling is presented by the Umatilla Tribes. In their recommended terms and conditions, the Umatilla Tribes (CTUIR-22) request additional studies to further investigate the potential benefits of constructing a temperature control structure at Brownlee dam, and present an analysis, prepared by CRITFC, that raises several questions about the approach and results of Idaho Power's modeling. In its April 10, 2006, reply comments, Idaho Power addressed many of the questions raised by CRITFC. CRITFC provided responses to Idaho Power's reply comments; these responses were filed with the Commission as appendix 1 to the Umatilla Tribe's November 3, 2006 comments on the draft EIS. At a meeting held with FERC staff on March 6, 2007, the Nez Perce Tribe also discussed the CRITFC analysis. Finally, Idaho Power filed a white paper on July 30, 2007, which provided a detailed literature review on the potential thermal effects of the project on fall Chinook salmon. We discuss pertinent aspects of these filings below.

Our Analysis

Water temperatures in the Snake River downstream from Hells Canyon dam may affect the survival, development, and timing of spawning and outmigration of anadromous salmonids. For example, multivariate models indicate that water temperature exerts a greater effect than any other factor on the survival of yearling Chinook salmon as they migrate through the Snake River (Williams et al., 2004). In addition to altering developmental timing and outmigration, water temperature alterations may affect salmonid metabolism, growth rate, and disease resistance, as well as the timing of adult migrations, fry emergence, and smoltification (EPA, 2001b). Water temperatures downstream of Hells Canyon dam are particularly critical for fall Chinook salmon, which are the only salmonid species that spawns and rears primarily in the Hells Canyon reach, downstream from Hells Canyon dam.

In the draft EIS, we focused our analysis on the potential benefits of using a temperature control structure to enhance thermal conditions for fall Chinook salmon downstream of Hells Canyon dam. These benefits could include: (1) reducing stress, prespawning mortality, and adverse effects on gamete viability by reducing water temperatures just prior to and during the fall Chinook salmon spawning season; or (2) promoting faster growth and earlier outmigration of rearing fall Chinook salmon juveniles by providing warmer water temperatures during the spring to accelerate the emergence and growth rate of fry. In this final EIS, we expand our analysis to include our consideration of the alternative measures proposed by Idaho Power in its application for water quality certification, which include implementing watershed measures or a bubble upwelling system in Brownlee reservoir to reduce water temperatures downstream of Hells Canyon dam during the fall Chinook spawning season.

In the following subsection, we evaluate the potential benefits of the measures proposed by Idaho Power and recommended by other stakeholders for key lifestages of fall Chinook salmon, as well as any incidental effects on other aquatic species.

Fall Chinook Spawning and Incubation

Idaho Power acknowledges in its license application that elevated fall temperatures could contribute to stress on adult fall Chinook salmon and reduced gamete viability. However, based on its review of the literature and of the temperatures that occur during the spawning season, it concludes that the temperature lag caused by the project is unlikely to have a substantive effect on spawning or incubating fall Chinook salmon. Idaho Power reported that less than 2 percent of fall Chinook salmon spawn before temperatures have diminished to levels below 16.0°C (Groves, 2001), and states that the results of most laboratory studies suggest that spawning at water temperatures of up to 16.5ºC does not have deleterious effects on the incubation survival of fall Chinook salmon.

On July 30, 2007, Idaho Power filed a white paper with the Commission outlining the thermal effects of the project on fall Chinook salmon (Idaho Power, 2007c). The white paper includes a detailed review of studies on the effect of water temperatures on the incubation survival of fall Chinook salmon eggs, as well as effects on other lifestages. Idaho Power concluded that the applicability of most studies to survival rates in the Hells Canyon reach was limited because they were conducted under uniform water temperatures, which is very different from the declining temperature regime that occurs during the spawning and incubation period of fall Chinook salmon. Idaho Power identified three studies, however, that were conducted under a declining temperature regime. Combining the data from these studies, Idaho Power noted that the survival trends shown in all three studies were very consistent (figure 105), and concluded that the thermal shift created by the project has had little effect on the success of incubation survival for those redds spawned at initial temperatures between 16 ºC and 16.5 ºC.

Our review of the available literature, including Idaho Power's white paper, leads us to conclude that adverse effects may occur at initial spawning temperatures less than 16.5 ºC. First, in figure 105, two out of three data points where the highest exposure temperature was 16.5 ºC showed elevated rates of mortality, between approximately 28 and 37 percent. Second, the results of the study by Olson et al.

(1970) suggest that adult fall Chinook salmon that acclimated to higher water temperatures were less able to tolerate high incubation temperatures. Olson et al. (1970) used four groups of salmon eggs spawned at temperatures between 8.9 and 12.6 ºC. For fish spawned at the highest temperature of 12.6 ºC, the incubation mortality increased progressively at higher initial incubation temperatures, even under a declining temperature regime. For example, the mortality rate of fish spawned at 12.6 ºC increased from 3.6 percent at an initial incubation temperature of 13.7ºC to 28.1 percent at an initial incubation temperature of 15.9ºC. Of the other two studies that Idaho Power used to generate figure 105, Geist et al. (2006) used an adult acclimation temperature of 12ºC, and Olson and Foster (1955) did not report the adult acclimation temperature. Based on these results, we conclude that elevated water temperatures, which sometimes exceed 16ºC at the initiation of fall Chinook salmon spawning in the Hells Canyon reach, are likely to adversely affect the incubation survival of fall Chinook salmon that spawn at the beginning of the spawning season.

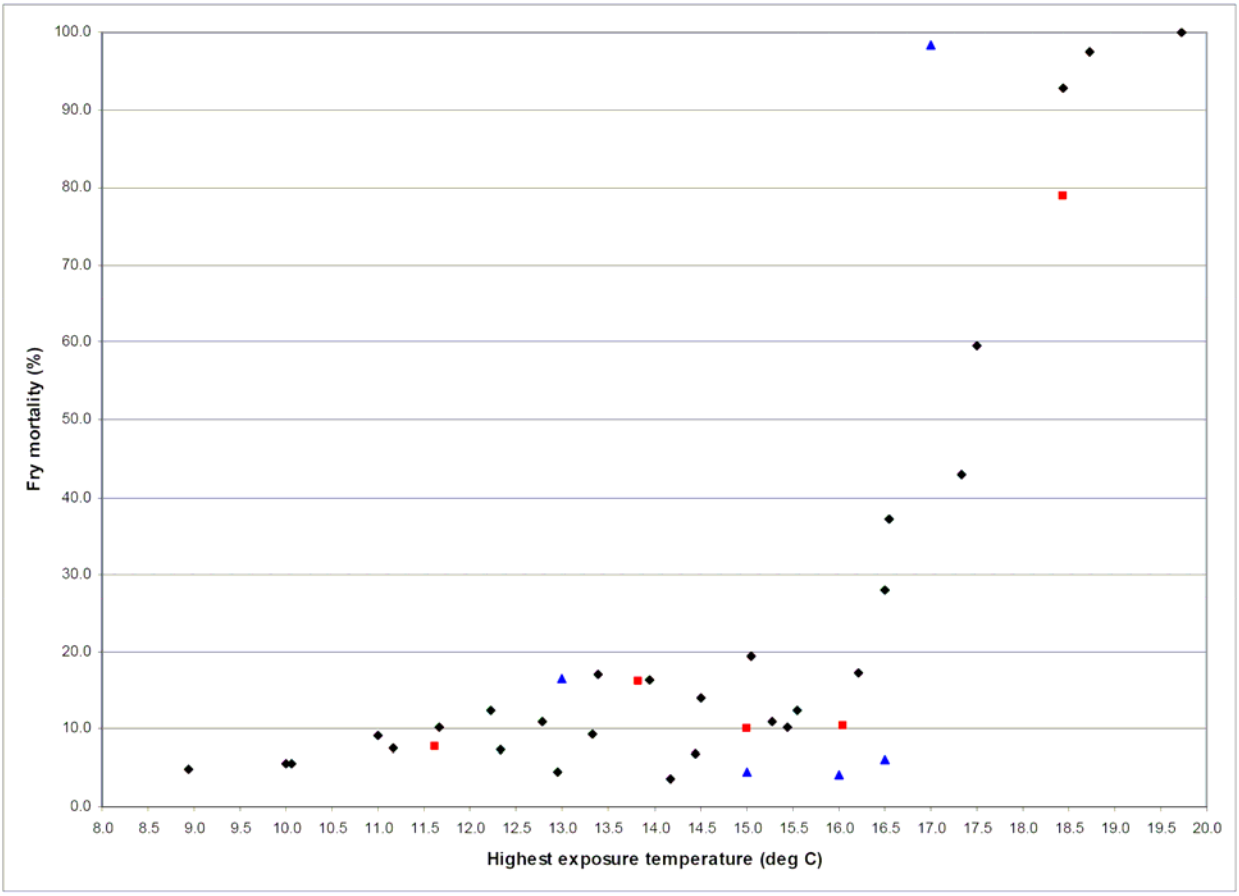

Figure 105. Final fall Chinook salmon fry mortality relative to the highest water temperature (ºC) that embryos were exposed to during natural/variable temperature experiments (data from Olson and Foster [1955] shown in square symbols, Olson et al. [1970] shown in diamonds, and Geist et al. [2006] shown in triangles). (Source: Idaho Power 2007c)

Our analysis in section 3.5, *Water Quality*, subsection 3.5.2.4, *Water Temperature*, indicates that each of the alternative Brownlee temperature control structures that Idaho Power evaluated has the potential to reduce water temperatures during the fall Chinook spawning season. Based upon our preceding analysis, we conclude that this would benefit fall Chinook salmon by increasing the incubation survival of fish that spawn in the early part of the spawning season, when water temperatures are

relatively high. However, our analysis in section 3.5.2.4 also identifies several potential adverse effects of installing and operating a temperature control structure to reduce water temperatures in the fall. These include the likelihood of increasing water temperatures in the summer months and the potential for increasing the release of hypolimnetic water that may have low DO and elevated concentrations of ammonia, mercury, or organochlorine compounds. Idaho Power's analysis of the effects of operating a temperature control structure to reduce fall water temperatures indicates that resulting elevated summer water temperatures may extend downstream to Lower Granite reservoir (Idaho Power, 2005j), where it could cause a slight reduction in outmigration survival.

Our analysis in section 3.5, *Water Quality*, subsection 3.5.2.4, *Water Temperature*, also indicates that installing a bubble upwelling system in Brownlee reservoir could reduce water temperatures downstream of the project during the fall Chinook salmon spawning period. However, our analysis indicates that this technique may not be sufficient, by itself, to meet the project's full temperature responsibility. We also identified several potential adverse effects of the bubble upwelling system. These include the potential for increased mixing of water within the reservoir, thereby increasing the exposure of reservoir fish to hypolimnetic water that may have low DO and/or high concentrations of ammonia, mercury, or organochlorine compounds; and the release of these waters into the river downstream of the project. Low DO and increased ammonia concentrations could have adverse effects on the health and survival of aquatic species. In addition, increased exposure of aquatic organisms to mercury and organochlorine compounds could have adverse effects on fish-eating wildlife, anglers that consume warmwater fish species caught in the project reservoirs, and tribal members that consume sturgeon harvested in subsistence fisheries.

Finally, our analysis in section 3.5.2.4 indicates that watershed measures, such as temperature trading, offer an alternative approach for meeting the project's temperature responsibility. This approach involves implementing measures in the watershed upstream of the project that would act to cool inflows to, and outflows from, the project. Potential methods for reducing fall temperatures in upstream reaches include increasing shade by restoring or enhancing riparian vegetation, altering channel morphology to reduce warming, and altering the hydrologic regime by reducing the volume of warm agricultural return flows or by augmenting existing flows. These measures would tend to reduce water temperatures in and downstream from the tributaries where they are implemented for a more prolonged period, potentially extending throughout the warm summer and fall seasons. In addition to reducing water temperatures, some watershed measures have the potential to enhance water quality and aquatic habitat by (1) reducing sediment and nutrient loads, and (2) improving the quantity and quality of instream and riparian habitat. We conclude that implementing watershed measures has the potential to benefit fall Chinook salmon by reducing water temperatures downstream of Hells Canyon dam during the fall Chinook salmon spawning season without the potential adverse effects that we identify for temperature control and bubble upwelling systems. We also conclude that implementing watershed measures would provide a broad array of habitat and water quality benefits that could enhance other aquatic resources including native resident salmonids, white sturgeon, and warmwater fisheries.

Fall Chinook Rearing and Outmigration

As we conclude in section 3.5.2.4, the installation of a temperature control structure has some potential to enhance the growth rates of rearing fall Chinook salmon by increasing water temperatures in the spring, counteracting the temperature lag that is caused by the project. Increased growth rates could contribute to earlier outmigration or outmigration at a larger size, both of which could improve outmigration survival. However, our analysis shows that the ability to increase water temperatures using a temperature control structure is primarily limited to years with below average flows, and that increases prior to March 14 would be minimal in all years. In addition, increasing water temperatures during the spring could adversely affect the survival of yearling spring Chinook salmon and steelhead produced in tributaries downstream of Hells Canyon dam. Also, Idaho Power, in commenting on the draft EIS, notes

that the analysis presented by NMFS in its 2005 biological opinion on operation and maintenance of the BOR's upper Snake River basin projects suggests that cooler springtime (April 3–June 20) temperature conditions in the Snake River are beneficial to spring migrating yearling salmonids.

Implementing watershed measures is unlikely to expedite warming in the spring. Rather, such measures would likely reduce warming in the spring, which could benefit yearling smolts migrating from downstream tributaries. In addition, implementing watershed measures would likely reduce water temperatures later in the late spring and summer, when water temperatures are above optimal for rearing salmonids, which would improve rearing and migration conditions for outmigrating juvenile fall Chinook salmon.

3.6.2.5 Oxbow Bypassed Reach Flows

Diversion of flow through the Oxbow powerhouse reduces flow in the 2.5-mile-long bypassed reach immediately downstream of the dam, affecting the quantity and quality of habitat available to bull trout. Idaho Power currently releases a minimum flow of 100 cfs through the bypassed reach. Idaho Power proposes to continue releasing minimum flows of 100 cfs from the Oxbow dam spillway to maintain existing conditions in the bypassed reach.

Interior (Interior-43) recommends that, within 1 year of issuance of a new license, Idaho Power develop and implement a plan to provide sufficient flow in the Oxbow bypassed reach to meet water quality standards and life history requirements for bull trout. The plan would identify the duration, timing, and quantity of flow necessary to provide for the movement, foraging, and rearing of adult and sub-adult bull trout in the Oxbow bypassed reach, including unrestricted access to Pine and Indian creeks. Interior (Interior-63) also recommends that Idaho Power provide adequate flows and oxygen supplementation to maintain water quality parameters in the Oxbow bypassed reach. AR/IRU (AR/IRU-11c) recommend that Idaho Power provide sufficient flows in the Oxbow bypass to allow physical access to the proposed Oxbow fish trap as well as to maintain adequate water quality for bull trout.

In its April 10, 2006, reply comments, Idaho Power states that Interior's recommendation to meet water quality standards, specifically to provide year-round water temperatures of 16°C or less in the Oxbow bypassed reach, is unrealistic and unnecessary based on the fluvial life history of bull trout and redband trout. Idaho Power also states that Interior's concern regarding limited attraction flow to the base of Oxbow dam, the site of a prospective upstream migrant trap, is without merit because bull trout and other species have been documented downstream of the Oxbow dam. In its April 26, 2007, filing with the Commission and its January 31, 2007, application for water quality certification, Idaho Power (2007a) proposes to install and operate a destratification system for the deep pool in the Oxbow bypassed reach just upstream of the Indian Creek confluence.

Our Analysis

The Oxbow bypassed reach currently provides overwintering habitat for bull trout and redband trout. However, high temperatures and low DO concentrations render this area unsuitable for native resident salmonids during warmer months when they typically seek refuge in Pine and Indian creeks. As discussed in section 3.5.2.5, *Oxbow Bypassed Reach Flows*, the poor water quality conditions in this reach are largely a result of the quality of the water released from Oxbow reservoir and, at higher reservoir elevations, inundation from the upper end of Hells Canyon reservoir. Idaho Power's proposal to continue releasing minimum flows of 100 cfs would have little effect on the existing water quality issues in the bypassed reach.

Increasing DO and reducing water temperatures in the bypassed reach to levels suitable for redband trout and bull trout would provide additional habitat that could be used during warmer months. However, increasing bypass flows are not likely to have a substantial beneficial effect because current

conditions in the bypassed reach are primarily influenced by the condition of water released from Oxbow reservoir. While increasing spill flows may provide some increase in DO within the bypassed reach, Myers and Chandler (2003) found that water temperatures in the bypassed reach rise to levels that are unsuitable for native resident salmonids before DO conditions become adverse. This finding is supported by Idaho Power's telemetry studies, which indicated that all bull trout moved out of the bypassed reach by the middle of May and did not return until October (Chandler et al., 2003a).

As part of the study, Idaho Power examined the effect that different flows would have on habitat conditions for resident salmonids (Myers and Chandler, 2003). Study results indicate that increasing flow would provide little improvement in water quality conditions in the bypassed reach (see section 3.5.2.5, *Oxbow Bypassed Reach Flows*). Likewise, increasing bypass flow did not substantially increase the amount of habitat suitable for native resident salmonids. Although increasing flow would increase the wetted width of the bypassed reach, the study found that corresponding increases in velocity reduced the suitability of available habitat. Thus, increasing flows in the Oxbow bypassed reach are not likely to improve habitat conditions for native resident salmonids. In addition, the proposed minimum flow release of 100 cfs appears sufficient to provide overwintering habitat for these species.

To address Interior's concern regarding access to, and passage through, the bypassed reach for migrating bull trout under existing minimum flow conditions, Idaho Power cites observations of bull trout and steelhead in the bypassed reach near the base of the dam as evidence that this concern is unwarranted. Although this proves that fish can access this area, it is based on few observations and anecdotal evidence. The presence of fish in the bypassed reach does not disprove that other fish could have difficulty accessing this area. Following construction of the Oxbow trap, radio-tracking studies would be necessary to demonstrate accessibility conclusively and to ensure that a high percentage of fish are able to locate and enter the trap.

Interior also expressed concern regarding the accessibility of Pine and Indian creeks to bull trout seeking refuge from the bypassed reach. Chandler et al. (2003a) evaluated tributary access for resident salmonids and did not identify any obstruction at the mouths of Pine and Indian creeks. However, the possible remediation of obstructions caused by alluvial deposits are included in the discussion of potential tributary habitat enhancement measures (see section 3.6.2.10, *Tributary Habitat Improvements*). In developing plans for tributary habitat enhancement measures, re-evaluation of the accessibility at the mouths of Pine and Indian creeks at low bypassed reach flows and low Hells Canyon reservoir water levels would ensure that resident salmonids are allowed access to these tributaries.

In its January 31, 2007, application for water quality certification, Idaho Power proposes to install a destratification system in the deep pool in the Oxbow bypassed reach. This has the potential to benefit aquatic resources that use the bypassed reach, including bull trout and redband trout, by reducing anoxic conditions that currently occur in the pool. The system would provide compressed air to bubble diffusers that would be anchored on the bottom of the pool.

3.6.2.6 Anadromous Fish Restoration

The Hells Canyon Project has blocked anadromous fish from accessing spawning and rearing habitats upstream of Hells Canyon dam since initial attempts to provide passage were discontinued several years after Brownlee dam was constructed. Idaho Power proposes to develop actions and measures that are targeted toward the restoration of passage and habitat for bull trout, but does not propose to restore passage for anadromous fish to habitat within and upstream of the project. State and federal agencies, tribes, and NGOs propose a range of specific approaches for restoring anadromous fish to areas upstream of Hells Canyon dam. The Burns Paiute and Shoshone-Paiute Tribes also provide general recommendations for habitat improvement and for the restoration of anadromous fish to historical habitat, but they do not recommend any specific approach or priority for restoration activities. None of

these entities provided any type of comprehensive resource plan for restoring anadromous fish to the upper Snake River basin.

Fish passage-related measures, including a preliminary section 18 fishway prescription filed by Interior, are summarized in table 56. We summarize recommendations directed at improving water quality and habitat conditions to foster restoration of anadromous fish in table 57.

Our Analysis

A successful anadromous fish restoration effort above Hells Canyon dam would restore self-supporting runs in historically available habitat as well as increase the size, and maintain the genetic diversity, of Snake River populations. Idaho Power proposes several measures to benefit native resident salmonids in the project area (see section 3.6.2.8, *Resident Salmonid Passage,* and section 3.6.2.10, *Tributary Habitat Improvements*). While these measures could also provide some benefit for anadromous fish, they are not targeted toward restoring anadromous fish populations.

During the pre-filing period, Idaho Power conducted extensive studies to evaluate the potential for anadromous fish restoration, and concluded that restoring self-supporting runs was possible only in certain tributaries and under the most optimistic assumptions (Chandler and Chapman, 2003b). In most tributaries, habitat and water quality conditions have been degraded by land use practices and development of the basins to support irrigated agriculture, and to provide municipal water supply. Water quality in the mainstem of the Snake River upstream of the project is degraded, and the existence of eight mainstem dams in the downstream migratory corridor cause mortality during the upstream and downstream migration of all anadromous species. NMFS chose not to issue a section 18 fishway prescription at this time, stating that poor water quality severely limits the potential for fall Chinook salmon to incubate through emergence, and the degraded habitat in most tributaries would similarly limit the possibilities for successful reintroduction of spring Chinook salmon and steelhead into most areas upstream of the project. Nonetheless, state and federal resource agencies, tribes, and NGOs recommend numerous measures for upstream and downstream passage, mainstem studies, and habitat and water quality improvements as part of an overall restoration effort.

While the Idaho Power analysis is informative, there is enough uncertainty in the evaluation of restoration options that a phased restoration plan warrants consideration. These uncertainties include assumed survival rates for all lifestages, including incubation, freshwater rearing, migration, and ocean rearing. Accordingly, after assessing the various agency, tribe, and NGO recommendations in the following paragraphs, we present and evaluate a phased restoration approach that addresses the uncertainties surrounding restoration, while incorporating many of the agency, tribe, and NGO recommendations.

Providing upstream passage for anadromous fish would allow access to historically available spawning and rearing habitat within and upstream of the project. Upstream passage facilities would also allow gene flow between isolated native resident salmonid populations and enhance fluvial life histories within the project area (see section 3.6.2.8, *Resident Salmonid Passage*). In addition, the return of anadromous species to nutrient-poor tributaries containing native resident salmonids would provide supplemental marine-derived nutrients and increased forage (see section 3.6.2.11, *Marine-derived Nutrients*). Pursuant to ESA take restrictions, however, the reintroduction of ESA-listed stocks above Hells Canyon dam could impose economic consequences on upstream land and water users. The use of suitable, unlisted steelhead and spring Chinook salmon stocks currently maintained in Idaho Power's hatchery system would avoid such consequences.

Table 56. Anadromous fish restoration recommendations.[a] (Source: Staff)

Component	NMFS (NMFS-14c, 16, 17)	Interior[b] (Interior-46a, 46b, 46c, 47a, 47b, 49, 60)	IDFG (IDFG-9)	ODFW (ODFW-1 to -17, 22, 24, 40)	Umatilla Tribes (CTUIR-11a, 11b, 11c, 12a to 12f)	Nez Perce Tribe (NPT-8b, 8c)	AR/IRU (AR/IRU-1 to 7)
Upstream Passage Facilities							
Hells Canyon trap modifications	Yes	**Yes**	Yes	Yes	Yes	Yes[c]	Yes
Oxbow trap	Yes [c]	**Yes**	Yes[d]	Yes	Yes	Yes[c]	Yes [c]
Brownlee trap	Yes [c]	Yes[d]	No	No	Yes	Yes[c]	Yes [c]
Downstream Passage Facilities							
Tributary traps	Study feasibility at 3 tributaries	**Weirs at Pine Creek, Indian Creek, Wildhorse River**, and Eagle Creek	No	Weirs at Pine Creek, Powder River (Eagle, Daly, and Goose creeks)	Weirs at Pine Creek, Powder River (Eagle Creek), Weiser and Payette rivers	Weirs at Pine Creek, Eagle Creek, Weiser and Payette rivers	Weirs at Pine Creek, Powder River (Eagle, Daly, and Goose creeks), evaluate restoration in other reaches incl. Weiser and Payette rivers
Hells Canyon fish screen	No	No	No	Yes	Yes, or weir at Pine Creek	No	Yes, if most effective method to provide passage from Pine and Indian creeks
Brownlee smolt trap	No	Develop and refine plans for transporting fall Chinook around project reservoirs	No	No	Not specified	No	Yes
Mainstem Passage Studies							
Hells Canyon passage	No	No	No	Yes	Yes, including drawdown	No	Yes
Oxbow passage	No	No	No	No	Yes, including drawdown	No	Yes

Component	NMFS (NMFS-14c, 16, 17)	Interior[b] (Interior-46a, 46b, 46c, 47a, 47b, 49, 60)	IDFG (IDFG-9)	ODFW (ODFW-1 to -17, 22, 24, 40)	Umatilla Tribes (CTUIR-11a, 11b, 11c, 12a to 12f)	Nez Perce Tribe (NPT-8b, 8c)	AR/IRU (AR/IRU-1 to 7)
Brownlee passage	No	No	No	No	Yes, including drawdown	No	Yes, including drawdown
Swan Falls incubation monitoring	Yes	Yes	Yes	Yes	Not specified	No	Yes
C.J. Strike incubation monitoring	Yes	Yes	Yes[e]	No	Not specified	No	Yes
Bliss reach incubation monitoring	Yes	No	Yes[e]	No	Not specified	No	Yes
Swan Falls migration studies	Yes	No	No	Yes	Not specified	No	Yes
C.J. Strike migration studies	Yes	No	No	No	Not specified	No	Yes
Bliss reach migration studies	Yes	No	No	No	Not specified	No	Yes
Other							
Stock assessments	No	Yes	No	Yes	Not specified	No	Yes
Monitoring effects on resident fish	No	No	No	Yes	Not specified	No	Yes

[a] Table does not include general recommendations made by the Burns Paiute and Shoshone-Paiute Tribes to restore anadromous fish to historical habitats.

[b] Items shown in **bold** are part of FWS section 18 preliminary fishways prescription.

[c] Not explicitly recommended, but is implied by the recommendation to restore anadromous fish to upstream tributaries.

[d] IDFG recommends that if the Oxbow trap is not constructed, the estimated $7 million cost of this measure be allocated to tributary habitat improvements.

[e] IDFG recommends monitoring egg survival in the Marsing reach every 5 years, but does not specify whether Bliss or C.J. Strike reaches should be included.

Table 57. Water quality improvement recommendations related to anadromous fish restoration. (Source: Staff)

NMFS	Interior [b]	IDFG	ODFW	Umatilla, Shoshone-Bannock and Burns Paiute Tribes	Nez Perce Tribe	AR/IRU
NMFS-14. Provide $10 million per year for the first 5 years, $5 million per year during years 6 through 30 to fund TMDL implementation. Measures to be selected, evaluated and prioritized by a review committee, with funds to be redirected to alternative measures if water quality or egg-to-fry survival goals are not met.	Interior-33. Acquire and restore 14.6 miles of tributary habitat (BLM)	IDFG-11, 14, 16. Increase funding from levels proposed by Idaho Power, includes provisions for re-allocating funding if fish passage measures are not implemented; if the Oxbow trap is not constructed re-allocate $7 million to habitat restoration measures.	ODFW-33. Implement alternative habitat improvement measures to compensate for any species or reaches where reintroduction efforts are terminated, up to $5 million per year, if passage is abandoned; implement a separate plan to compensate for continued effects and unavoidable losses; provide $100,000 per year to fund water quality improvement projects in Swan Falls reach.	CTUIR-1, BPT-6, SBT-1a. Provide a mitigation fund directed toward artificial production and habitat enhancements to compensate for unavoidable effects.	NPT-8a. Provide $150 million over 30 years to fund TMDL implementation in lieu of providing passage for fall Chinook to habitat upstream of Brownlee reservoir.	AR-IRU-12g, 27. Establish trust fund for onsite and offsite mitigation directed at habitat enhancement and restoration efforts to address ongoing effects; implement water quality improvement measures to aid in sturgeon recovery

[a] Table does not include general recommendations made by the Burns Paiute and Shoshone-Paiute Tribes to restore anadromous fish to historical habitats.

[b] Section 10a recommendation; not included as part of the FWS preliminary fishway prescription.

Modifications to the Hells Canyon trap as proposed by Idaho Power for improved hatchery system operations (McMillen et al., 2005) would allow the on-site sorting of fish and eliminate the need to transport fish to the hatchery for identification. The Hells Canyon trap could also facilitate the passage of adult spring Chinook salmon and steelhead to project tributaries (e.g., Pine and Indian creeks) and the immediate release of fall Chinook salmon. Providing passage over Hells Canyon dam and subsequently monitoring reproductive success and habitat use in Pine and Indian creeks would be a relatively low cost means of evaluating the assumptions and feasibility of restoring spring Chinook salmon and steelhead.

Construction and operation of an adult fish trap at Oxbow dam could be used to provide access to the Wildhorse River for spring Chinook salmon and steelhead. Likewise, construction and operation of an adult fish trap at Brownlee dam could provide spring Chinook salmon and steelhead access to Powder River tributaries including Eagle, Goose and Big creeks. Once spring Chinook salmon and steelhead runs were reestablished, adult fish traps at each of the three project dams could allow fish to move volitionally to their natal tributary.

Although upstream fish passage facilities would provide access to historical habitat, successful restoration would be dependent upon adequate water quality and habitat in spawning, incubation, and rearing locations, as well as in the migratory corridors that lead to and from these locations (see section 3.6.2.10, *Tributary Habitat Improvements*). In addition, providing passage and reintroduction to previously inaccessible habitat may expose anadromous and resident salmonid populations to certain risks. The risk of pathogen exposure to other anadromous stocks or resident fish (see section 3.6.2.9, *Fish Pathogen Assessment*) and the risk of genetic introgression with other stocks require consideration (Chandler and Abbott, 2003).

Following production through stocking or natural reproduction, steelhead and Chinook salmon smolts would require safe and timely passage downstream through the project to maximize their recruitment potential. Although fish screens or other collection devices at the Hells Canyon, Oxbow and Brownlee dams could potentially accomplish this, these alternatives would require very substantial facilities. An alternative approach is for steelhead and spring Chinook smolts to be collected using traps at the mouths of tributaries and transported downstream of the project, which would require much smaller and less expensive installations. In addition, collecting and transporting smolts directly from tributaries would eliminate their exposure to predation, adverse water quality conditions, and migratory delays associated with reservoir passage. Idaho Power proposes to install a weir at the mouth of Pine Creek for the purpose of collecting and monitoring bull trout. While this installation could also be used for smolt collection, its effectiveness would require operability at high spring flows during which smolt migration occurs. The installation and effective use of tributary traps at Pine Creek, Indian Creek, and the Wildhorse River would collect the majority of smolts entering the project below Brownlee dam and therefore render a fish screen or collection system at Hells Canyon and Oxbow dams unnecessary. Likewise, if steelhead and spring Chinook salmon were reintroduced to Eagle Creek, collecting smolts with a trap at the creek mouth would facilitate their transport below the project and eliminate passage through the project reservoirs.

Idaho Power does not propose mainstem downstream fish collection or bypass facilities at any of the project dams. The only downstream passage routes that are available to migrating fish at Brownlee dam are through turbine or spill passage, which can cause substantial injury and mortality. Because nearly all of the production of fall Chinook smolts above Brownlee dam would occur in the mainstem Snake River, a mainstem collection and transport facility would be required to maximize passage survival through the project. By collecting smolts at a collection point upstream of, or at the head of, Brownlee reservoir and transporting them below the project, mortality and delay caused by passage through Brownlee, Oxbow and Hells Canyon reservoirs would be avoided. This facility could also provide passage for steelhead and spring Chinook salmon if they were eventually restored to upstream tributaries.

State and federal agencies, tribes, and NGOs recommend several specific monitoring and evaluation measures, including passage, incubation, and migration studies. Because the feasibility of restoration is largely uncertain, many of these studies would help in prioritizing and, subsequently, evaluating the success of initial efforts as well as identifying triggers for implementing further actions. Tracking radio-tagged adult Chinook salmon and steelhead would help determine the effectiveness of upstream passage facilities, as well as the percentage of each species that safely reach spawning habitat and successfully spawn. Similarly, marked, PIT-tagged or radio-tagged smolts could be used to help quantify collection efficiencies and survival at traps.

The Umatilla Tribes, Shoshone-Bannock Tribes, and AR/IRU recommend that passage studies include an evaluation of reservoir drawdowns as a means of enhancing downstream passage. Drawdowns would increase reservoir water velocities and the rate of downstream migration as a result. However, in Oxbow and Hells Canyon reservoirs this benefit would be negligible if smolts were collected in traps before entering the reservoirs. Despite drawdowns, the travel distance required to pass project reservoirs would remain long, particularly in Brownlee reservoir, and smolts would still be exposed to predation and adverse water quality conditions associated with reservoir passage. Drawdowns would also cause substantial reductions in electrical generation, and could adversely affect recreation and warmwater fish spawning in project reservoirs.

Successful reintroduction of fall Chinook salmon to the mainstem Snake River between Swan Falls dam and Brownlee reservoir appears to be limited by water quality conditions in the intragravel incubation environment. A study conducted by Idaho Power using simulated redds to assess the condition of historical fall Chinook spawning habitat in this reach found toxic levels of hydrogen sulfide and low levels of DO, suggesting that incubation survival would be variable and low (Chandler et al., 2003b, Groves and Chandler, 2005). Subsequent incubation monitoring in egg baskets within the same reach confirmed low survival, especially relative to concurrent incubation monitoring downstream from Hells Canyon dam (Groves et al., 2006).

As a means to improve water quality in the Brownlee to Swan Falls reach and other mainstem reaches, NMFS and the Nez Perce Tribe recommend that Idaho Power provide funding to support TMDL implementation, as developed by ODEQ and IDEQ. Providing TMDL funding as recommended by NMFS and the Nez Perce Tribe would expedite improvements in water quality by reducing nutrient loads, which would over time alleviate toxic hydrogen sulfide and low DO levels in the intragravel incubation environment. The NMFS approach would include funding an aquatic resource committee to evaluate and prioritize projects, to identify opportunities to coordinate efforts with other conservation plans or programs, and to re-direct funding if water quality or egg-to-fry survival levels do not show substantial improvement over time. These measures would help return the historical fall Chinook spawning habitat upstream of the project to a condition that would be suitable for reintroduction, and would provide ancillary benefits by improving water quality conditions for other aquatic species, including resident native salmonids and white sturgeon within and upstream of the project. However, the vast majority of nutrient loading upstream of the project is not related to the continuing operation of the Hells Canyon Project or to the operation of Idaho Power's upstream hydroelectric projects. Nonetheless, we recognize the substantial benefits of these measures. However, we conclude that the condition of spawning habitat upstream of the project is not attributable to the Hells Canyon Project or to Idaho Power's upstream projects on the Snake River.

Some agencies, tribes, and NGOs recommend studies to monitor fall Chinook egg incubation and smolt migration in the Swan Falls, C.J. Strike, and Bliss reaches. In the draft EIS, we acknowledged the historical importance of fall Chinook production areas upstream of Brownlee dam, but we concluded that the information already collected by Idaho Power indicates that these types of studies do not need to be repeated until there has been a substantial improvement in water quality upstream of the project, and we included in the Staff Alternative a measure that would require Idaho Power to consult with NMFS, IDFG, ODFW, ODEQ, IDEQ and the tribes to determine what ongoing water quality monitoring programs in the

basin[72] can provide information that would be useful for tracking improvements in water quality, and to file a report every 5 years that summarizes the available and relevant monitoring information. Provisions would be made in the project license for the Commission to reconsider the initiation of fall Chinook reintroduction studies when the management agencies have determined that water quality conditions have improved to a point where they could support self-sustaining runs of fall Chinook salmon upstream of the project. In addition, we expect to re-assess water quality conditions as they relate to the condition of historical fall Chinook spawning habitat when the Swan Falls Project license comes up for renewal in 2010.

In their comments on the draft EIS, agencies and tribes stated their view that conditions in the water column are a poor predictor of water quality conditions within the intragravel incubation environment that is influenced by other factors such as the amount of fine sediment that is present in the substrate. Comments filed by the Shoshone-Bannock Tribes also pointed to a study (Keller Bliesner & Associates, 2005), which indicated that water quality conditions in the Snake River upstream of Brownlee reservoir have not deteriorated substantially since the 1960s when fall Chinook were successfully spawning upstream of Brownlee reservoir. The report concluded that conditions in the C.J. Strike reach are not much different now than they were at the time of project construction, and that conditions are beginning to improve (Keller Bliesner & Associates, 2005).

Certainly, the amount of sediment in the substrate affects DO levels within the gravel by affecting the flow of water through the substrate and through biological oxygen demand from decomposing organic material. The reduction in seasonal peak flows caused by water storage at upstream reservoirs operated by BOR has likely contributed to the build-up of fine sediment in the intragravel environment and the establishment of rooted aquatic vegetation. Because of these factors, we maintain that substantial improvements in the condition of the intragravel incubation environment in the Swan Falls reach would require a sustained improvement in overall water quality (i.e., reduced nutrient loading), followed by one or more substantial high flow events to dislodge rooted aquatic vegetation and to cleanse fine sediments from potential spawning areas.

Habitat in many of the tributaries that steelhead and spring Chinook salmon would potentially be able to access has been degraded through various land and water use activities, particularly in basins above Brownlee dam, in which irrigation is extensive (Chandler and Chapman, 2003a). Because degraded tributary habitat could limit the restoration of spring Chinook salmon and steelhead, state and federal agencies, tribes, and NGOs recommend a variety of tributary habitat enhancement measures. As part of a plan to benefit native resident salmonids, Idaho Power proposes many similar measures in Pine Creek, Indian Creek, the Wildhorse River, and other smaller tributaries to the project (see section 3.6.2.10, *Tributary Habitat Improvements*). Prospective measures such as conservation easements, land acquisition, riparian corridor fences, purchase or lease of water rights, culvert passage improvements, screening of irrigation diversions, and instream habitat enhancement would improve access to, and the productive capacity of, habitat for steelhead and spring Chinook salmon.

Chapman and Chandler (2001) estimated the potential smolt yields that would result from providing passage at the Hells Canyon Project, as well as upstream mainstem projects owned by Idaho Power. Table 58 shows estimated smolt yields by mainstem river section and tributary basin, assuming that passage was provided at Idaho Power dams but without passage being provided at other manmade

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[72] The licenses issued for Idaho Power's Upper Salmon Falls, Lower Salmon Falls, Bliss, and C.J. Strike projects all require continuous monitoring of water temperature and DO. Year-round monitoring is required at the Bliss Project, while monitoring at C.J. Strike is required from June 15 through November 15, and monitoring at Upper and Lower Salmon Falls is required from March 1 through November 25.

barriers in the tributary subbasins. These estimates are based on existing conditions, as well as the assumptions that water quality would not be limiting and that reintroduction would be successful.

Table 58. Incremental smolt yields with fish passage provided at Idaho Power's mainstem Snake River dams under various passage scenarios. (Source: Chapman and Chandler, 2001, as modified by staff)

Passage Scenario	Spring Chinook	Steelhead	Fall Chinook	Sockeye
1. Hells Canyon dam				
Pine Creek	58,473	23,234	0	0
Indian Creek	0	3,295	0	0
Subtotal	58,473	26,529	0	0
2. Oxbow dam				
Wildhorse River	37,736	14,774	0	0
Subtotal	37,736	14,774	0	0
Cumulative Subtotal (includes no. 1)	96,209	41,303	0	0
3. Hells Canyon Project, No Action at other dams				
Mainstem Snake River	0	0	1,839,626	0
Eagle Creek	40,007	16,653	0	0
Weiser River	65,008	31,204	0	0
Lower Snake River tributaries (e.g., Brownlee Creek)	0	15,683	0	0
Goose and Big creeks	0	11,025	0	0
Subtotal	105,015	74,565	1,839,626	0
Cumulative subtotal (includes no. 2)	201,224	115,868	1,839,626	0
4. Swan Falls dam				
Mainstem Snake River	0	0	734,535	0
Subtotal	0	0	734,535	0
Cumulative subtotal (includes no. 3)	201,224	115,868	2,574,161	0
5. C.J. Strike dam				
Mainstem Snake River	0	0	1,700,000	0
Bruneau River	375,517	149,048	0	0
Subtotal	375,517	149,048	1,700,000	0
Cumulative Subtotal (includes no. 4)	576,741	264,916	4,274,161	0
6. Bliss dam				
Mainstem Snake River	0	0	0	0
Subtotal	0	0	0	0
Cumulative Subtotal (includes no. 5)	576,741	264,916	4,274,161	0

Passage Scenario	Spring Chinook	Steelhead	Fall Chinook	Sockeye
7. Lower Salmon Falls dam				
Mainstem Snake River	0	0	0	0
Billingsley Creek (11 km)	0	2,640	0	0
Subtotal	0	2,640	0	0
Cumulative Subtotal (includes no. 6)	576,741	267,556	4,274,161	0
8. Upper Salmon Falls dam				
Mainstem Snake River	0	0	0	0
Salmon Falls Creek	62,192	24,678	0	0
Rock Creek	60,740	24,163	0	0
Cedar Draw Creek (5 km)	0	600	0	0
Subtotal	122,932	49,441	0	0
Cumulative Subtotal (includes no. 7)	699,673	316,997	4,274,161	0

Given the uncertainty of successful restoration and based on the collective recommendations of resource agencies, tribes, and NGOs, we evaluate a phased approach to providing access to upstream habitats, based on the incremental reintroduction of fish to habitat as it is deemed suitable. This program could focus on tributaries within the project area that currently support resident salmonids and where good quality habitat is accessible without requiring passage at any major dams or reservoirs within the tributary. Based on our review of Idaho Power's reintroduction studies, tributaries that meet these criteria include Pine Creek, Indian Creek, the Wildhorse River, and several tributaries to the Powder River, especially Eagle Creek. These tributaries were also identified by many of the stakeholders as being suitable targets for an anadromous fish restoration effort.

The timing and details of each phase are presented in table 59. This approach could begin with the development of a fish passage plan in consultation with agencies and tribes. Initial passage efforts could involve providing upstream passage over Hells Canyon dam for spring Chinook salmon and steelhead and monitoring subsequent habitat usage in Pine and Indian creeks. When smolt production from these tributaries are deemed sufficient to warrant downstream passage provisions, smolt traps could be installed at the tributaries to collect smolts for transport downstream of Hells Canyon dam. If adult returns warrant expansion of the program to additional spawning and rearing habitat, the next step could be to install an adult fish trap for providing passage over Oxbow dam and access to the Wildhorse River. After smolt production from the Wildhorse River was deemed sufficient, a smolt trap could be installed at this location also. If adult returns warrant additional expansion, installing an adult trap at Brownlee dam could then be considered to provide access to rearing habitat in the Powder River basin. Again, after smolt production from the Powder River or one of its tributaries are found to be sufficient, a smolt trap could be installed at this location also.

Table 59. Phased anadromous fish passage plan. Source: developed based on the collective recommendations of resource agencies, tribes, and NGOs

Component	Timing or Trigger	Description
Fish Passage Plan	One year after license	Develop a plan, in consultation with agencies and tribes, to: (1) determine whether steelhead and spring Chinook should be re-introduced to Hells Canyon reservoir tributaries; (2) develop pathogen assessment plan if needed; (3) identify stocks/sources

Component	Timing or Trigger	Description
		of adult and/or juvenile fish to be used; (4) develop plan for conducting adult migration studies, spawning surveys, and juvenile production assessments in Hells Canyon reservoir tributaries; (5) develop a contingency plan for smolt acclimation if surplus adult fish do not migrate to, or spawn in, target tributaries; (6) identify triggers to implement design and construction of smolt trap and truck facilities at Indian and Pine Creek; (7) identify triggers to initiate habitat capacity and passage studies at the Wildhorse River and Powder River tributaries; (8) identify triggers to initiate habitat capacity and passage studies at historical fall Chinook habitat upstream of Brownlee reservoir (Swan Falls and Bliss reaches); and (9) develop guidelines for bull and redband trout passage and related monitoring efforts (see section 3.6.2.8, *Resident Salmonid Passage*).
Fall Chinook Water Quality Monitoring Reports	One year after license	Develop a plan in consultation with the management agencies and tribes to summarize data from ongoing water quality monitoring programs upstream of Brownlee dam to track improvements in water quality relevant to fall Chinook spawning and incubation habitat in historical spawning areas upstream of Brownlee dam. File a summary report with the Commission every 5 years starting in year 5.
Pine and Indian Creek production assessment	Approximately years 2 to 5, timing to be specified in plan	Conduct adult migration studies, spawning surveys, and juvenile production assessments in Hells Canyon reservoir tributaries.
First tributary smolt trap (first tributary to meet smolt production trigger)	Smolt production trigger	Design and construct a trap at Pine or Indian Creek capable of collecting 90% of outmigrating smolts under typical flow conditions (low to medium-high flow year). Initiate trap and truck transport of smolts downstream.
Second tributary smolt trap	Smolt production trigger	Design and construct a trap at Pine or Indian Creek capable of collecting 90% of outmigrating smolts under typical flow conditions (low to medium-high flow year). Initiate trap and truck transport of smolts downstream.
Oxbow adult trap	Seven years after license issuance, but only if surplus steelhead or spring Chinook are available (after meeting spawner targets in Pine and Indian creeks)	Design and construct an upstream migrant trap at Oxbow dam. Conduct adult migration studies to determine whether minimum flows are sufficient to enable passage through the Oxbow bypassed reach. Conduct spawning surveys and juvenile production assessments in the Wildhorse River.
Wildhorse River smolt trap	Based on smolt production trigger	Design and construct a trap at the Wildhorse River capable of collecting 90% of outmigrating smolts under typical flow conditions (low to medium-high flow year). Initiate trap and truck transport of smolts downstream.

Component	Timing or Trigger	Description
Brownlee adult trap	Twelve years after license issuance, but only if surplus steelhead or spring Chinook are available (after meeting spawner targets in Hells Canyon and Oxbow reservoir tributaries)	Design and construct an upstream migrant trap at Brownlee dam. Conduct spawning surveys and juvenile production assessments in the Powder River tributaries.
Powder River smolt trap(s)	Based on smolt production trigger	Design and construct a trap at the Powder River or at Eagle, Daly and Goose creeks capable of collecting 90% of outmigrating smolts under typical flow conditions (low to medium-high flow year). Initiate trap and truck transport of smolts downstream.

Because of the use of various triggers, this phased restoration approach would ensure that each phase proceeds only when the available information suggested that it would be successful. Upon successful completion, this approach could yield the following benefits: (1) restoration of spring Chinook salmon and steelhead production in Pine Creek, Indian Creek, the Wildhorse River, and possibly the Powder River basin (including Eagle Creek); (2) increased opportunities for tribal and recreational harvest of anadromous fish; and (3) benefits to other species, including bull trout and bald eagles. We provide our estimate of the smolt production and adult returns that could result from successful implementation of this approach in table 60. The estimates in table 60 are based on smolt production levels estimated in Chapman and Chandler (2003) and appear to be conservative, especially for steelhead. Based on adult steelhead trapped in the first 3 years of operation at Hells Canyon dam, Idaho Power estimated that there was a total adult return of 2,700 steelhead to Pine and Indian creeks alone. The number of adult salmon and steelhead could also increase over time as tributary enhancements and TMDLs are implemented, or as additional measures are implemented to increase survival rates in the lower Snake and Columbia river migration corridors.

Table 60. Estimated smolt production and adult returns from habitat made accessible under the phased restoration approach (assumes that no passage is provided at other dams in tributary streams). (Source: Chapman and Chandler, 2001, as modified by staff)

Stream/Reach	Spring Chinook	Steelhead
Pine Creek	58,473	23,234
Indian Creek	0	3,295
Wildhorse River	37,736	14,774
Eagle Creek (Powder River tributary)	40,007	16,653
Goose and Big creeks	0	11,025
Total smolts produced	136.216	68,981
Smolts surviving to Lower Granite tailrace (0.718 for spring Chinook, 0.741 for steelhead)[a]	97,803	51,115
Adult return under low smolt-to-adult return rate[b] (0.012)	1,174	613
Adult return under high smolt-to-adult return rate (0.039)	3,814	1,993

[a] Spring Chinook smolts surviving to the Lower Granite tailrace were calculated assuming 90 percent collection efficiency, 98 percent transportation survival to Hells Canyon tailrace, 88.5 percent survival from the Hells Canyon tailrace to Lower Granite reservoir, and 92 percent survival from Lower Granite reservoir to Lower Granite tailrace, or 71.8 percent survival overall. Steelhead smolts surviving to the Lower Granite tailrace calculated assuming 90 percent collection efficiency, 98 percent transportation survival to Hells Canyon tailrace, 92.3 percent survival from the Hells Canyon tailrace to Lower Granite reservoir, and 91 percent survival from Lower Granite reservoir to Lower Granite tailrace, or 74.1 percent survival overall. For both species, the first two values are staff estimates; the last two values are Idaho Power's best estimate from E.3.1-2, chapter 11, table 3.

[b] Values are Idaho Power's best estimates from E.3.1-2, chapter 11, pages 6 and 7.

In their comments on the draft EIS, ODFW and the Shoshone-Bannock Tribes provided information indicating that water quality and habitat conditions in some of the project tributaries, especially in Pine Creek and several tributaries to the Powder River, are sufficient to consider reintroducing steelhead and spring Chinook salmon at this time. Also, during the 10(j) meeting, the agencies stated that surplus hatchery steelhead and spring Chinook salmon have historically been planted in areas upstream of Hells Canyon dam to provide recreational fisheries in Hells Canyon reservoir and in the Boise River. IDFG reports that some of the steelhead planted in Hells Canyon reservoir have been observed spawning in Pine and Indian creeks.

Continuing the practice of stocking surplus adult steelhead in Hells Canyon reservoir, in conjunction with installation of a weir and trap fishway in Pine Creek as prescribed by FWS, provides an opportunity to evaluate the spawning and reproductive success of any adult steelhead that migrate into Pine Creek. This same approach could be used to evaluate the production of spring Chinook salmon, which have been stocked upstream in the Boise River in the past. This evaluation could also be expanded to include Indian Creek when a weir and trap is installed on that stream, and there is potential that the number of surplus hatchery steelhead and spring Chinook salmon that are released into Hells Canyon reservoir could be increased to facilitate this evaluation.

The utility of the planned Pine Creek weir and trap fishway for evaluating the production of steelhead and spring Chinook salmon could be limited if the facility is not capable of collecting most of the juvenile outmigrants, which would be expected to migrate primarily during the spring when flows are relatively high. It could be worthwhile to explore the potential benefits of constructing the Pine Creek weir in a manner that would allow the collection of juvenile anadromous fish during the high flow spring months. As we discuss in the next section, the Pine Creek weir and trap fishway could be designed to effectively screen the entire flow volume at least 90 percent of the time during an average water year. Constructing the facility to accommodate this higher level of flow would also enhance the ability to monitor the emigration of bull trout over most of the year.

Information obtained from the evaluation of the Pine Creek weir and trap, to promote the production of juvenile steelhead and spring Chinook salmon in Pine Creek, would be useful for guiding decisions regarding the design of any facilities that would be installed in the future at Indian Creek and on the Wildhorse River, as prescribed by FWS. If results suggest that expansion of the passage program to other tributaries should be considered, this could be accomplished through the license amendment process.

3.6.2.7 Fish Passage Facilities

The Hells Canyon Project blocks anadromous fish from accessing spawning and rearing habitats upstream of Hells Canyon dam and isolates local populations of the federally-listed bull trout. The Hells Canyon fish trap facility is currently used only to collect anadromous salmonids for hatchery broodstock

and, as designed and operated, cannot collect small resident species, such as bull trout. The Hells Canyon trap also limits the opportunity for on-site sorting and handling of anadromous fish.

Idaho Power proposes modifications to the Hells Canyon trap that would facilitate the collection of fish of any size that successfully migrate up the fish ladder and enter the trap. Additional modifications would allow the on-site handling and sorting of captured fish and provide a means of releasing fish back to the river or holding fish for transport to appropriate hatchery locations. Idaho Power also proposes the construction of a fish trap at Oxbow dam and a tributary trap (weir) at the mouth of Pine Creek.

Either implicitly in recommendations to restore anadromous fish to upstream tributaries, or explicitly, NMFS, Interior,[73] IDFG, ODFW, AR/IRU, Shoshone-Bannock Tribes, Umatilla Tribes, and Nez Perce Tribe support the structural modifications to the Hells Canyon fish trap proposed by Idaho Power. ODFW also recommends that Idaho Power operate the trap year-round, 24 hours per day, and ensure that trap modifications accommodate the passage of Pacific lamprey. Interior, IDFG, and ODFW recommend that, as part of a fish passage plan, Idaho Power develop design, operation/trapping, and evaluation plans in consultation with the agencies. Interior also reserves authority to prescribe the construction, operation, and maintenance of fishways at the project, including measures to determine, ensure, or improve fishway effectiveness. In its April 10, 2006, reply comments, Idaho Power states that operating the Hells Canyon trap during two discrete periods (October 15–December 1 and March 15–June 30) would be sufficient for the collection of anadromous and resident salmonids. Idaho Power also states that lamprey passage should not be considered in modifying the Hells Canyon trap because few lamprey currently return to the Snake River basin.

Management agencies, tribes, and NGOs recommend additional passage facilities for anadromous and resident salmonids, including tributary traps (e.g., at the mouth of Pine Creek) for collecting downstream migrants, and traps for upstream migrants at Oxbow and Brownlee dams. These prospective facilities and their respective benefits are discussed in detail in section 3.6.2.6, *Anadromous Fish Restoration*. The discussion herein is, therefore, limited to the modifications to the Hells Canyon fish trap and the merits of consultation between Idaho Power and agency and other stakeholders in designing, operating, and evaluating fish passage facilities.

Our Analysis

Initial restoration efforts proposed by Idaho Power, recommended by the agencies, NGOs, and tribes, and included in the FWS section 18 preliminary fishway prescription and Idaho Power's alternative to the FWS prescription, include modifications to the Hells Canyon fish trap. Currently, the Hells Canyon trap uses a fish separator to remove small fish before they enter the trap holding pool and is, thus, unsuitable for capturing small migrating resident fish such as bull trout and redband trout. The existing trap also requires the transport of captured anadromous fish to hatchery facilities where they are sorted to determine their origin. Hatchery-origin fish are retained for broodstock but wild fish require transport back to the river for release. Such a procedure imparts additional stress and migratory delay on wild fish, but is currently necessary because adequate handling and sorting facilities are lacking at the Hells Canyon trap.

Idaho Power developed detailed design drawings and operational plans for several alternative plans to facilitate the capture of smaller fish and provide onsite handling and sorting facilities, as well as other improvements (McMillen et al. 2005). In consultation with the agencies, Idaho Power selected Alternative 3 Revised as the most appropriate design (figure 106). This design eliminates the fish separator, such that smaller fish would be retained in the trap. Additional modifications under this design

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[73] Part of FWS section 18 preliminary fishways prescription.

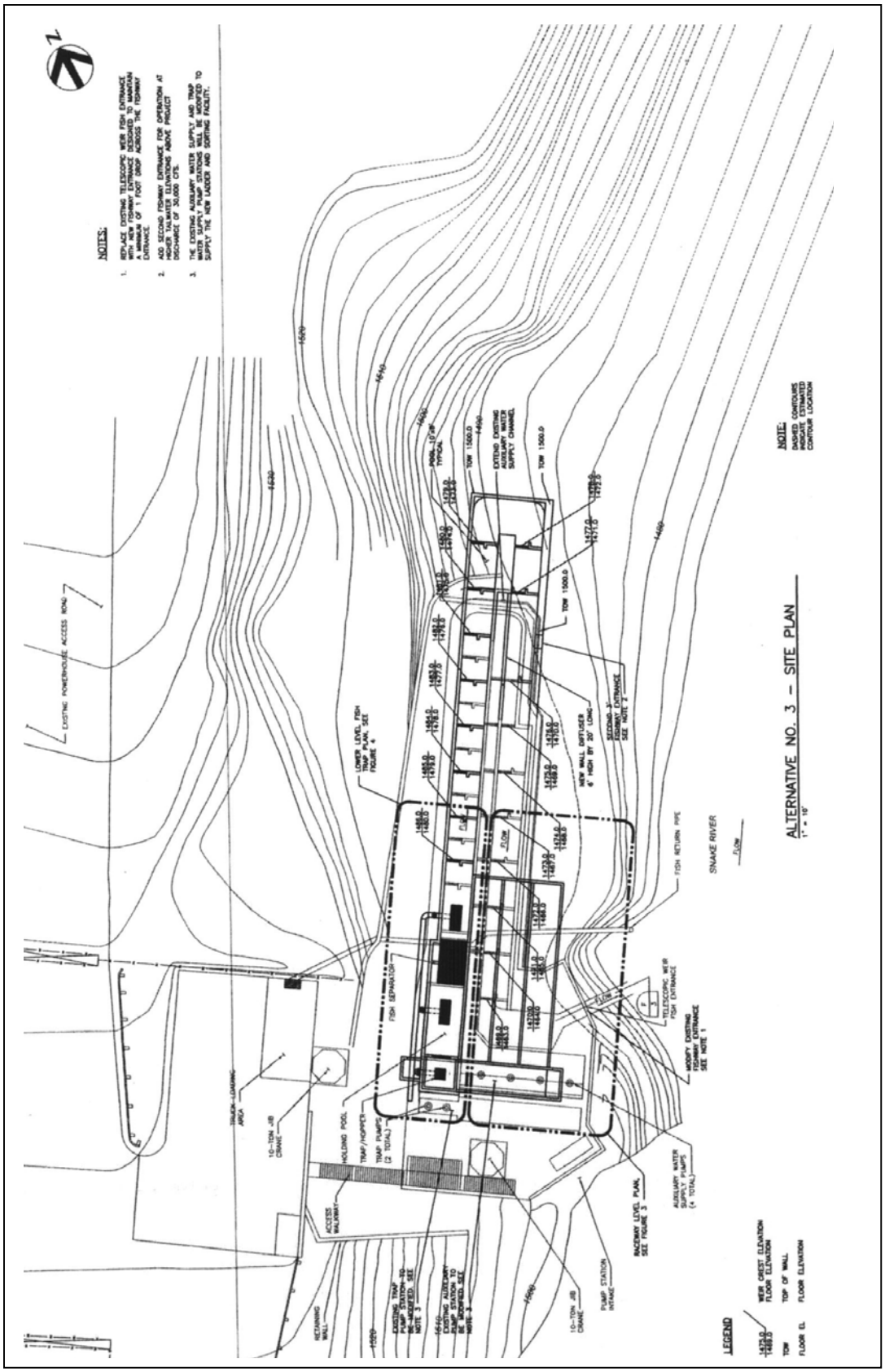

Figure 106. Plan view of Hells Canyon trap modification Alternative 3 revised.

would extend the existing ladder portion of the fishway, add a second fishway entrance, and raise the exterior wall nearest to the Snake River to ensure effective operation at river flows up to 50,000 cfs, while further protecting the facility during flood events. Modifications would also include a new pre-lock holding and counting area, a photoelectric fish counter, a new fish lock, and new sorting and holding areas. This design would allow for the sorting and holding of multiple species, the scanning of fish for marks and/or tags, and the safe and timely return of wild fish to the river after sorting.

Idaho Power's proposal to limit operation of the Hells Canyon trap to two discrete periods may be warranted based on the known timing of steelhead and Chinook salmon returns. However, the migration timing of resident salmonids is not as well understood. Initially operating the trap year round and 24 hours per day, as recommended by ODFW, would help identify the daily and seasonal timing of fish movement based on the presence or absence of trapped bull trout or redband trout. If observations made during continual operation suggest that changes in operation are appropriate, a modified operation schedule could be considered at that time.

Although the historical range of Pacific lamprey extended well upstream of the location of Hells Canyon dam, few are currently documented passing Lower Granite dam. Further, the best approach for passing lamprey remains unclear. As such, modifying the Hells Canyon trap to accommodate lamprey would have little benefit at this time. If restoration and passage efforts downstream of the project substantially increase the number of lamprey that pass Lower Granite dam, an effective means of providing upstream passage would be appropriate, at that time, to restore this species to habitat within and above the project. We consider the effects of the Hells Canyon Project on the population size of Pacific lamprey to be very limited. However, it is clear that the project blocks access to a substantial amount of habitat that was historically used by this species. Participation by Idaho Power in regional forums on Pacific lamprey restoration would help to identify opportunities for evaluating and implementing measures that could benefit Pacific lamprey in habitat that is currently blocked by the project or that is affected by project operations downstream from Hells Canyon dam.

The proposed modifications to the Hells Canyon trap were developed in consultation with, and are recommended by, the management agencies. However, details regarding the final design of the trap, operation of the trap, the destination of the various species trapped, and evaluation of the trap's effectiveness require further development. As recommended by ODFW, IDFG, and Interior, a fish passage plan that includes these details, developed in consultation with the agencies, would ensure that this facility is operated to meet the goals of the restoration program.

Idaho Power's proposed fish trap at Oxbow dam and tributary trap at Pine Creek, as well as the fish passage facilities recommended by the agencies, NGOs, and tribes for both anadromous and resident fish restoration, would also require further development depending on the ultimate progression of the overall restoration effort. These passage facilities are discussed in section 3.6.2.6, *Anadromous Fish Restoration*, and section 3.6.2.8, *Resident Salmonid Passage*, and many are part of the FWS preliminary fishway prescription and Idaho Power's alternative to the fishway prescription. A comprehensive plan for the implementation of fish passage facilities, developed in consultation with the agencies, would help to provide effective fish passage facilities. A successful plan would include schedules and implementation triggers for the design, construction, operation, evaluation, and modification of passage facilities that were effective, timely, and operated as intended.

3.6.2.8 Resident Salmonid Passage

Construction of the Hells Canyon Project has blocked upstream passage and impeded downstream movement of native resident salmonids, thereby isolating local populations, inhibiting fluvial life histories, and reducing access to additional habitat and thermal refugia. The primary native resident salmonid species of concern are redband trout and the federally listed bull trout.

Idaho Power proposes a two-phased Fish Passage Plan for transporting resident salmonids above Hells Canyon and Oxbow dams. The first phase would involve collecting bull trout, redband trout, and possibly other species in the Hells Canyon trap after it is modified (see section 3.6.2.7, *Fish Passage Facilities*) and transporting them to areas upstream of the Hells Canyon dam. The second phase would involve the construction of a new trap, similar in operation and design to the Hells Canyon trap, at the base of the Oxbow dam to collect fish for transport upstream. However, because of uncertainty surrounding the intent of fish collected in the trap and the status of habitat in tributaries such as the Wildhorse River, Idaho Power proposes delaying construction of the Oxbow trap for a minimum of five years following completion of the Hells Canyon trap modifications. Idaho Power also proposes to design, construct, and operate a permanent weir in Pine Creek to monitor the fluvial component of resident salmonid populations.

Interior filed a preliminary fishway prescription (Interior-87) that would require Idaho Power to develop a passage plan within 6 months of the issuance of a new license. The prescription would provide for: (1) the construction and operation of a weir at the mouth of Pine Creek; and (2) the identification of specific habitat conditions that would trigger implementation of passage-related actions in Indian Creek, the Wildhorse River, and the Oxbow bypassed reach. Interior prescribes that the plan include: (1) specifications for construction and operation of permanent weirs, as well as trap and haul fishways, on these tributaries; (2) suitable upstream and downstream release points for adult and juvenile fish; (3) a description of the location, functional design, and operating characteristics of all upstream and downstream fishways; and (4) schedules and milestones for their timely modification, operation, and evaluation. Interior also prescribes that within 1 year of license issuance, Idaho Power develop a post-construction monitoring plan and implementation schedule to monitor fishway effectiveness.

In response, Idaho Power submitted an alternative prescription that identifies the types of triggers that would be included in the passage plan and would control the timeline of construction of the Oxbow fish trap and the Indian Creek and Wildhorse River weir and trap fishways. Under Idaho Power's alternative, these triggers would be based on the status of bull trout within these tributaries in terms of their abundance, the potential for hybridization with non-native brook trout, the potential of the fishways to contribute toward recovery, and habitat conditions necessary to support bull trout. Idaho Power's alternative also specifies that development of functional designs and monitoring plans would not be initiated until the trigger criteria for a facility have been met. Under their alternative prescription, Idaho Power would file a Bull Trout Passage Plan within one year that would include: (1) final engineering design plans for modification of the Hells Canyon fish trap and the Pine Creek monitoring weir and trap, as well as operating protocols; (2) locations of release points and handling of all lifestages of bull trout and other fish collected at the two facilities; (3) provisions for bull trout transport between Pine Creek and Hells Canyon dam; (4) an assessment of monitoring needed to evaluate the risk of introducing deleterious pathogens; and (5) a post-construction monitoring plan.

On January 3, 2007, Interior filed its modified fishway prescription. The modified prescription requires that the Pine Creek monitoring weir and trap be constructed within 2 years, but adopts the triggers proposed by Idaho Power for construction of the upstream fish trap at Oxbow and the Indian Creek and Wildhorse River permanent weir and trap fishways. Interior's modified prescription maintains language regarding the need for appropriate upstream passage flows for the Oxbow fish trap that was not included in Idaho Power's alternative prescription. Interior states that the operational period for the Pine Creek fish weir and trap would be established in the Bull Trout Passage Plan. However, Idaho Power proposes to operate the weir and trap from October through December, when the downstream passage facilities would be operated.

The Forest Service (FS-32), IDFG (IDFG-14), ODFW (ODFW-10), and the Umatilla Tribes (CTUIR-12e) support Idaho Power's proposal to develop and implement a passage plan that would use the modified Hells Canyon trap and a newly constructed Oxbow trap to provide upstream passage for resident salmonids. The agencies, tribes, and AR/IRU also recommend that Idaho Power design,

construct, and operate tributary weirs, additional to the proposed Pine Creek weir. Prospective weir sites include Indian Creek, the Wildhorse River, and Eagle Creek. Most of these recommendations are intended to facilitate reintroduction of anadromous fish to these tributaries, and we discuss those recommendations in detail in section 3.6.2.6, *Anadromous Fish Restoration*. The agencies also state that the implementation of various plan components should be contingent upon the feasibility of passage measures and the suitability of habitat to which fish would gain access. To improve tributary habitat, such that the translocation of resident salmonids would be beneficial, Idaho Power proposes, and the agencies and AR/IRU recommend, specific tributary habitat enhancement measures, which are described in detail in section 3.6.2.10, *Tributary Habitat Improvements*.

ODFW (ODFW-18) recommends that Idaho Power conduct a population viability risk analysis of genetic and demographic costs incurred by donor and recipient bull trout populations. ODFW (ODFW 36-b and 37) also recommends that Idaho Power investigate bull trout mortality associated with spill or turbine passage.

Our Analysis

The provision of passage for native resident salmonids within the project would reestablish connectivity among currently isolated populations. Due to small population sizes and obstructed immigration and gene flow between populations, bull trout are particularly susceptible to extinction. Based on a population viability assessment conducted by Idaho Power (Pratt, 2003-E.3.1-7, Ch 2), enhancing movement between bull trout populations within the project was found to have the greatest chance of increasing population persistence, compared with any other management activity. Annual immigration rates of as little as one to six mature females into each subpopulation would significantly reduce the risk of extinction for these populations.

By tracking radio-tagged bull trout, Chandler et al. (2003a) provided some evidence that small fluvial components persist in populations in Indian Creek, Pine Creek, and the Wildhorse River. Providing passage between isolated tributaries and the Snake River would enhance fluvial life histories. Likewise, providing passage would allow bull trout to access additional thermal refugia and forage, as well as spawning and rearing habitat. Collectively, improving access to these habitats would increase growth, fecundity, and egg deposition and, consequently, abundance. Although redband trout populations are less susceptible to extinction, they would similarly benefit from increased connectivity.

Use of the Hells Canyon and Oxbow traps to provide passage would require the transport of collected fish to their appropriate destination. Collection and transport at the Hells Canyon dam would provide connectivity between bull trout populations below the dam and populations in Pine and Indian creeks, as well as any other smaller tributaries to the Hells Canyon reservoir with suitable habitat. Likewise, passage at the Oxbow dam would provide connectivity between the aforementioned populations and bull trout in the Wildhorse River and smaller tributaries to the Oxbow reservoir.

Despite the apparent benefits of providing passage for bull trout, uncertainties remain regarding the appropriate timing and destination for fish translocation. Of particular concern is the presence of brook trout and brook-bull trout hybrids in tributaries to which bull trout would gain access. Chandler et al. (2003a) documented brook trout in every drainage that contained bull trout and found that hybridization was particularly prevalent in the Indian Creek and the Wildhorse River basins. Thus, translocating bull trout may only be warranted subsequent to the brook trout eradication efforts described in section 3.6.2.10, *Tributary Habitat Improvements*. Similarly, habitat degradation and alteration within certain tributaries may require remediation before fish are translocated to maximize the associated benefits. Such habitat enhancement measures include the screening of irrigation diversions, improved passage at culverts, and other methods also described in section 3.6.2.10, *Tributary Habitat Improvements*.

Idaho Power's population viability assessment (Pratt, 2003) examined the viability of existing bull trout populations under current conditions and identified potential measures, such as increased connectivity, that would improve their status. However, the risks associated with implementing passage measures remain unclear. While increased connectivity would benefit recipient populations, it would coincide with losses from donor populations and potentially offset such a benefit. As recommended by ODFW (ODFW-18), a risk analysis that considers the genetic and demographic effects of increased immigration and emigration would be useful in developing procedures for translocation within the fish passage plan.

ODFW also recommends (ODFW-36b and 37) that Idaho Power evaluate mortality associated with spill and turbine passage. Depending on the release locations of bull trout collected in the dam traps or tributary weirs, evaluating turbine or spill mortality would help to quantify any losses associated with these passage routes. In addition, this information would be useful for guiding decisions on optimal release locations for fluvial fish that are collected as they emigrate from project tributaries. We anticipate that the need for a population viability risk analysis and evaluation of turbine or spill mortality would be determined during development of the bull trout passage plan associated post-construction facility evaluations and trigger-related monitoring required under Interior's modified fishway prescription.

Rather than establishing a fixed schedule for the implementation of resident salmonid passage measures, a phased approach, whereby the implementation of subsequent measures is contingent upon the success of initial measures, would help to promote the achievement of milestones for native resident salmonid restoration before reallocating efforts to other measures. Idaho Power's alternative prescription and the FWS revised prescription indicates that triggers would be based on: (1) the status of bull trout within these tributaries in terms of their abundance; (2) the potential for hybridization with non-native brook trout; (3) the potential of the fishways to contribute to recovery; and (4) habitat conditions necessary to support bull trout. Inclusion of these more detailed trigger elements would help to ensure that constructed facilities would provide a benefit to bull trout populations, and that the timeline is consistent with habitat enhancement and brook trout eradication efforts described in section 3.6.2.10, *Tributary Habitat Improvements*.

Likewise, postponing the design and construction of fish passage facilities and the development of monitoring plans until the appropriate trigger conditions have been met, as stated in Idaho Power's alternative prescription and adopted in the FWS modified prescription, would be consistent with an adaptive management approach. The design, construction, and operation of fish passage facilities is expected to require some modification over the course of the restoration effort. The information garnered from initial efforts, such as the modification and operation of the Hells Canyon trap, the construction and operation of a weir in Pine Creek, and the resulting movement of bull trout in the Hells Canyon reach, would help guide subsequent passage facilities and monitoring plans.

The FWS modified prescription requires that the Pine Creek monitoring weir and trap be constructed within 2 years, which would expedite the collection of information on fluvial populations of bull trout in Pine Creek. This compares to Idaho Power's alternative prescription, which did not specify a time frame for construction of the Pine Creek weir and trap. The FWS modified prescription also requires that the future fishway/trap at the base of Oxbow dam include measures and operations necessary to provide adequate attraction flow to safely attract bull trout into the trap for collection and transport upstream. This measure would ensure that conditions in the bypassed reach do not impede connectivity. Finally, Interior would require that the period of operation of the Pine Creek monitoring weir and trap fishway be established in the bull trout passage plan, while Idaho Power proposed an operating period of October through December. Based on our review, we conclude that additional consultation would help in determining the seasonality of operation. We also conclude that some flexibility may need to be retained to adjust the operational season based on the results of initial operation and monitoring.

3.6.2.9 Fish Pathogen Assessment

Prospective measures to restore anadromous fish, improve connectivity among resident fish populations, and supplement marine-derived nutrients through carcass outplants have the potential to introduce fish pathogens to areas within, and upstream of, the project. These pathogens could adversely affect resident fish populations, including the federally listed bull trout.

Before implementing prospective passage measures, Idaho Power proposes to develop, fund, and implement a pathogen risk assessment plan for the Pine-, Indian-, and Wildhorse core areas, in consultation with ODFW and IDFG fish pathologists. Following an initial assessment of pathogen risks, Idaho Power proposes follow-up surveys at 5-year intervals if the initial risks associated with upstream passage were deemed acceptable. In its April 10, 2006, reply comments, Idaho Power explicitly defines the scope of the proposed pathogen assessment as including the Snake River downstream of Hells Canyon dam (including the Imnaha River), Hells Canyon reservoir, and Oxbow reservoir during initial passage and restoration efforts.

IDFG, AR/IRU, and the Shoshone-Bannock Tribes (IDFG-12, AR/IRU-9c, and AR/IRU/SBT-6) support Idaho Power's proposal, but IDFG recommends that Idaho Power begin consultation with the IDFG Fish Health Laboratory prior to the issuance of a new license to discuss potential pathogens, sampling protocols, and priority sampling locations. Although supporting the measures proposed by Idaho Power, ODFW (ODFW-21), and AR/IRU (AR/IRU-7d) recommend the expansion of pathogen surveying and monitoring to both native resident and anadromous populations above, within, and below the project. In addition, ODFW recommends that the development of a pathogen assessment plan take place in the first year, and initial assessment in the third year, following issuance of a new license. ODFW also recommends that Idaho Power provide funding for a fish health specialist, supplies, and services associated with production of hatchery fish and the fish passage program, as well as fish health examination and storage areas.

Our Analysis

By increasing the connectivity among currently isolated native resident salmonid populations, fish passage measures proposed by Idaho Power (see section 3.6.2.8, *Resident Salmonid Passage*) would increase the risk of pathogen transfer among these populations. Although the distribution of pathogens within and above the project is poorly understood, the current isolation of resident fish populations suggests that they may host different pathogen assemblages. Increased movement among populations would therefore increase both the risk of exposure to new (or exotic) pathogens or different strains of endemic pathogens and the reintroduction of once-endemic pathogens. Pathogens of concern include several bacterial, viral, and parasitic species.

Idaho Power proposes to assess fish pathogens in the context of risks associated with resident salmonid passage. Based on a pathogen workshop held in 2000, Chandler and Abbott (2003) state that the introduction of pathogens that were not endemic to the area prior to project construction may pose the greatest risk to resident salmonids. Of particular concern is the introduction of the parasite *M. cerebralis* (whirling disease) to Pine Creek, Indian Creek, and the Wildhorse River where it has not been documented. In light of the concern regarding *M. cerebralis* and other pathogens, a comprehensive assessment of pathogen risks associated with resident salmonid passage would require the expansion of efforts beyond the Pine Creek, Indian Creek, and Wildhorse River basins if passage were provided beyond Oxbow and Hells Canyon reservoirs. Further, because resident fish from downstream of the project would potentially gain access to these tributaries, an assessment of the distribution of pathogens downstream of Hells Canyon dam would also be warranted.

In addition to the risks associated with resident fish passage, the prospective outplanting of salmon carcasses for nutrient supplementation (see section 3.6.2.11, *Marine-derived Nutrients*) represents an additional vector for the (re)introduction of pathogens to native resident salmonid habitat within and

above the project. Resident fish in any reach or tributary within, or above, the project, would be exposed to increased risks associated with pathogen introduction. These risks are not specifically addressed in Idaho Power's proposed measures described above. If either the passage of resident fish or carcass outplants are undertaken, the risks of disease transfer need to be considered through a pathogen risk assessment plan. To the extent possible, an understanding of the existing distribution of pathogens below, within, and above the project in both resident and anadromous salmonid populations would inform decision-makers of the risks associated with passage measures. Given the difficulty of completely understanding pathogen distributions, continued monitoring of pathogens among salmonid populations every 5 years, as proposed by Idaho Power, would facilitate an adaptive approach in which efforts could be expanded or modified based on the continued absence or spread of pathogens. Idaho Power's proposal to provide a full-time fish pathologist on its staff, if needed, would facilitate monitoring efforts and provide a logical interface between Idaho Power and management agencies regarding fish health issues.

3.6.2.10 Tributary Habitat Improvements

Construction and operation of the Hells Canyon Project has adversely affected bull trout and redband trout populations in the project area, primarily through a loss of habitat connectivity. These species require access to quality tributary habitat for every life stage and life history. Through a variety of causes, resident salmonid habitat in tributaries to the project has been degraded. In this section, we evaluate the effects that proposed and alternative tributary habitat enhancement measures would have on these bull trout and redband trout populations.

Idaho Power proposes to prepare and implement a Tributary Habitat Enhancement Plan within the Pine Creek, Indian Creek, and Wildhorse River basins and smaller tributaries to project reservoirs. They propose to assemble a Technical Advisory Committee including FWS, IDFG, and ODFW to work with landowners to identify, prioritize, and recommend actions and measures primarily targeting benefits to bull trout within the project area. Measures identified may include cooperative maintenance agreements in which Idaho Power would provide capital and construction costs, and the landowner would assume costs of O&M of the facility. Measures of priority would be those for which direct benefits to bull trout can be demonstrated. Such measures may be directed at the following types of impacts: (1) culvert passage at small tributaries that drain into the project reservoirs and that could provide coldwater refuge to native salmonids; (2) irrigation diversions that are along mainstem migration corridors or within primary spawning and rearing areas of bull trout (implementation of this measure would depend on landowner maintenance agreements); and (3) land use effects on key riparian corridors that are currently in bull trout spawning and rearing areas or those that may extend the present range of spawning and rearing areas of bull trout.

Potential measures that would be considered in Idaho Power's Tributary Habitat Enhancement Plan include: (1) construction of irrigation diversion screens; (2) conservation easement agreements; (3) construction of riparian corridor fences (implementation of this measure would also depend on landowner maintenance agreements); (4) purchase or lease of water rights from willing sellers (these water rights would have to be those that can be demonstrated to provide improved instream flow in critical areas, especially those extending the coldwater refuge potential near the upper portions of streams that serve as spawning and rearing areas, and would apply only in Oregon tributaries); (5) land acquisition along key riparian corridors; and (6) instream habitat enhancement measures in critical spawning and rearing areas.

Idaho Power proposes two other measures targeted to benefit bull trout within the project area: brook trout eradication efforts and conducting a presence/absence survey in Eagle Creek. We summarize Idaho Power's proposed measures, as well as the recommendations of ODFW, IDFG, Interior, and AR/IRU, in table 61.

Table 61. Tributary habitat enhancement recommendations. (Source: Staff)

Component	Idaho Power	ODFW	IDFG	Interior	AR/IRU
General	Prepare and implement a Tributary Habitat Enhancement Plan within Pine Creek, Indian Creek, and Wildhorse River basins and smaller tributaries to the Hells Canyon Project. Assemble an advisory committee to identify, prioritize, and recommend such measures as conservation easements, land acquisition, riparian corridor fences, purchase or lease of water rights, culvert passage improvements, screening of irrigation diversions, and instream habitat enhancement.	ODFW-38. Adopt measures proposed by Idaho Power, but include measures in the Powder River and Burnt River basins. Identify, evaluate, and implement actions to reduce negative effects of irrigation diversions in the Pine Creek, Powder River, and Burnt River basins.	IDFG-16. Adopt measures proposed by Idaho Power, but include a mechanism for re-allocating funds not used if fish passage and other proposed measures in Pine Creek, Indian Creek, or the Wildhorse River would not be successful or possible to implement. Idaho Power would re-allocate such funds to tributary enhancement projects in Hells Canyon and Weiser core recovery units. Expand geographic scope to allow habitat enhancement projects in Weiser River drainage.	Interior-37a, 38a, 39a, 59. Adopt measures proposed by Idaho Power. Complete an action plan and implementation schedule to correct fish passage barriers at road crossings and culverts described in Idaho Power's application (tables 11-12, technical appendix E.3.1-7, Chapter 4).	AR/IRU-11a. Adopt measures proposed by Idaho Power, but include tributaries downstream of the project, the Powder River basin, other tributaries above Brownlee reservoir, and any additional tributary or measures recommended by the advisory committee.
Brook trout eradication	Evaluate feasibility of, and possibly implement, a brook trout suppression program in Indian Creek. Such a program could be applied to the Wildhorse River in the future.		IDFG-20. Adopt measures proposed by Idaho Power.	Interior-37d, 38d, 39d. Determine whether the presence of brook trout limits bull trout populations in Pine Creek, Indian Creek, and the Wildhorse River, and if necessary, develop and implement appropriate control activities.	AR/IRU-9b. Implement a brook trout eradication program for tributaries into which bull trout would be moved - particularly Indian Creek and the Wildhorse River.

Component	Idaho Power	ODFW	IDFG	Interior	AR/IRU
Surveys and monitoring	Conduct surveys and operate a temporary weir to determine the presence/absence of bull trout in the Eagle Creek Basin. Design, construct, and monitor a permanent weir at Pine Creek.	ODFW-24, 41. Evaluate effects of anadromous fish reintroduction on resident fish populations. Monitor bull trout migration through the project and redband trout populations in Pine, Eagle, Goose, and Daly creeks. Conduct presence/absence surveys for bull trout in Eagle Creek Basin. Operate weir at mouth of Eagle Creek.	IDFG-18. Conduct surveys for bull trout in the Hells Canyon Project	Interior-37c, 38c, 39c, 40. Monitor bull trout populations in Pine Creek, Indian Creek and the Wildhorse River. Conduct presence/absence surveys, evaluate habitat conditions, and determine reintroduction feasibility for bull trout within Eagle Creek.	

Our Analysis

Several bull trout populations within the Hells Canyon Project are at risk of extinction because of low abundance, isolation, and limited suitable habitat (Pratt, 2003). Based on this assessment, any action taken to reestablish connectivity among populations and increase available habitat and population sizes would benefit and improve the viability of bull trout populations. Such measures would concurrently benefit redband trout populations.

The bull trout populations that constitute the Hells Canyon Recovery Unit include the Pine-, Indian-, and Wildhorse core area and the Powder River core area (FWS, 2002a). These core areas contain local populations, and are areas identified as containing potential spawning and rearing habitat. Chandler et al. (2003a) and others documented bull trout in Pine Creek, Indian Creek, and the Wildhorse River, and found evidence of at least small fluvial populations. However, brook trout and hybridized fish were also observed in all drainages containing bull trout. Buchanan et al. (1997) characterized the status of bull trout in the Pine Creek Basin as fragmented, extremely low in abundance, and at "moderate risk," citing increased water temperatures, riparian habitat loss, siltation of spawning and rearing areas, channel alteration, and loss of instream structure as factors limiting bull trout survival. Pine Creek, in particular, may be negatively influenced by habitat degradation caused by irrigation diversions, as well as land-use activities such as grazing, timber harvest, and mining (Chandler et al., 2003a). Pratt (2003) found that bull trout populations in Pine and Indian creeks are at risk of extinction due to low abundance, isolation, and limited suitable habitat. Indian Creek and the Wildhorse River are also listed as key watersheds in the Idaho Bull Trout Conservation Plan (State of Idaho, 1996).

Bull trout are extremely sensitive to environmental change because of their specific habitat requirements. Water temperature, in particular, may be the most critical factor affecting the suitability of habitat for bull trout (Chandler et al., 2003d). For this reason, water- and land-use practices that alter stream temperatures likely have the greatest adverse effect on bull trout habitat in tributaries to the Hells Canyon Project. The prospective habitat enhancement measures proposed by Idaho Power and recommended by the agencies would reduce the effects of these practices. Purchase or lease of water rights would increase instream flows, and conservation easements, land acquisition, and riparian corridor fences would increase shading by restoring and protecting riparian cover; both of these mechanisms would directly stabilize stream temperatures. Depending on the scope of the measures taken, curtailing certain land-use practices and increasing instream flow would also indirectly enhance physical instream habitat by increasing woody debris contribution and vegetative cover, reducing erosion and sedimentation, enhancing natural geomorphological processes, and increasing wetted area.

Idaho Power also proposes, and the agencies recommend, considering additional measures targeted directly toward instream habitat enhancement. While the measures described above would alleviate some of the causes of habitat degradation, efforts directed at restoring instream habitat would provide a more immediate benefit by directly increasing the amount of spawning, rearing, and adult habitat available to bull trout. Although redband trout have generally less-specific habitat requirements, the proposed and recommended physical habitat enhancement measures would similarly enhance habitat for this species.[74]

In addition to the barriers to native salmonid migration created by the Hells Canyon Project dams, culverts, alluvial deposits, and irrigation diversions can prevent movement between or within tributaries. Such barriers can restrict the fluvial life history component of redband trout and bull trout populations and prevent access to spawning and rearing habitat, forage, and thermal refugia. In addition, and of particular

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[74] These measures could also improve the prospects for any future program to reintroduce anadromous salmonids to the Snake River upstream from the Hells Canyon dam.

importance to small, isolated bull trout populations in the Hells Canyon Project area, barriers prevent gene flow between tributary populations. Reduced connectivity among tributary populations thus increases the risk of extinction among these populations. Irrigation diversions can also increase mortality by entraining fish into unsuitable habitat associated with irrigation canals. Reestablishing connectivity among tributary populations by eliminating barriers and reducing entrainment by screening irrigation diversions would improve the health of the fluvial component and reduce the risk of extinction among resident bull trout subpopulations.

Interior (Interior-59) recommends that Idaho Power complete an action plan and implementation schedule to correct barriers at the road crossings and culverts listed in Idaho Power's application (Chandler et al., 2003a). Although the elimination of these barriers would improve the potential for fish migration, the benefit for native resident salmonids would be dependent upon the suitability of habitat to which they would consequently gain access. In developing a tributary habitat enhancement plan, selecting and prioritizing tributary barriers for removal based on the suitability of surrounding habitat for native resident salmonids would maximize the potential of such efforts to benefit bull trout and redband trout. Idaho Power's proposal to work with agencies and landowners to identify and prioritize measures would help to direct efforts toward removal of the barriers that would provide the greatest benefit to bull trout populations.

Based on a population viability assessment conducted by Idaho Power (Pratt, 2003), enhancing movement between bull trout populations within the project was found to have the greatest chance of increasing population persistence, compared with any other management activity. Annual immigration rates of as little as one to six mature females into each subpopulation would significantly reduce the risk of extinction for these populations. Providing access to additional forage and spawning and rearing habitat could also increase growth, fecundity, and egg deposition, and consequently, abundance. In addition to the removal of physical barriers, the habitat enhancement measures described above could eliminate barriers caused by poor water quality or low flows.

Hybridization and competition with nonnative brook trout pose a serious risk to overlapping bull trout populations. These species overlap in many tributaries to the project, have similar habitat requirements, and spawn at similar times, which increase the probability of hybridization. Hybridization reduces the fertility and survival of progeny (Kanda et al., 2002) and brook trout may out-compete and displace bull trout when resources are limited (Gunckel et al., 2002). For this reason, hybridization with brook trout may be the most serious risk for bull trout populations within the Hells Canyon Project (Chandler et al., 2003a). Any action that effectively limits hybridization by eliminating or reducing brook trout numbers would reduce the risk of extirpation of bull trout populations. However, in tributaries to the project, the feasibility of various methods of brook trout suppression or eradication remains unknown. Undertaking an experimental approach in which the scope is initially limited to a single basin, such as Idaho Power proposes in Indian Creek, would help to identify the feasibility of such measures and assess the utility of expanding efforts to the Wildhorse River and Pine Creek basins.

ODFW (ODFW-38) and AR/IRU (AR/IRU-11a) recommend that tributary enhancement measures include the Powder River basin (including Eagle Creek). The Powder River core area contains several isolated bull trout populations in the upper part of the basin, as well as one presumably unoccupied area (Eagle Creek) with potential spawning and rearing habitat (FWS, 2002a; Buchanan et al. 1997). Idaho Power did not propose tributary habitat enhancement measures in the upper Powder River basin because these populations are isolated in headwater areas above Thief Valley dam and are not affected by the Hells Canyon Project. Idaho Power does propose an intensive survey to determine whether bull trout are present in Eagle Creek, including (1) surveys of all major tributaries and operation of a temporary weir during the fall months to monitor for any remnant fluvial fish in the Eagle Creek basin, and (2) genetic sampling to examine the extent of hybridization with brook trout. Because of its proximity to the inundated portion of the Powder River, bull trout populations in Eagle Creek, if they occur, are more likely to be affected by the project than are populations in the upper watershed.

Determining the location of any bull trout populations in Eagle Creek would help the management agencies and Idaho Power develop and implement appropriate protective measures for any populations that are found to be at risk.

ODFW also recommends that these efforts include the Burnt River basin. FWS includes the Burnt River basin as part of the Hells Canyon Recovery Unit but does not currently consider it a core area (FWS, 2002a) because bull trout have not been observed in the Burnt River basin. However, it has not been intensively surveyed and its potential to support bull trout is unknown.

Although bull trout have not been found in the Powder or Burnt River basins, both of these basins include tributaries that provide habitat for redband trout, and restoration of redband trout has been identified as an important management objective by the state resource agencies and tribes. It is also clear that habitat in the lower portions of these tributaries has been adversely affected through inundation, and that poor water quality conditions in the reservoirs during the summer months adversely affect connectivity between populations of redband trout. Much of the habitat in these basins has been degraded. However, given the large drainage area of the basins and the presence of redband trout in some tributaries, there are likely to be areas within the basin where enhancement efforts could expand the abundance and distribution of redband trout in habitat adjacent to areas that currently support this species.

IDFG (IDFG-16) recommends that tributary habitat enhancement measures include the Weiser River, which is also designated as a core area in the FWS Bull Trout Recovery Plan and a key watershed in the Idaho Bull Trout Conservation Plan. Although the proposed and recommended enhancement measures would similarly benefit bull trout (and redband trout) populations if implemented in the Weiser River basin, it is considered a separate recovery unit from the Hells Canyon Recovery Unit. In addition, the Weiser River has not been as directly affected by the project as the other tributaries under consideration for enhancement.

3.6.2.11 Marine-Derived Nutrients

Construction of the project and the failure of initial attempts to provide passage for anadromous fish eliminated anadromous fish carcasses as a source of marine-derived nutrients to aquatic habitats upstream of Hells Canyon dam. This reduced the productivity of tributary habitats that are used by bull trout and redband trout. Idaho Power proposes, and others recommend, specific measures to address the lack of marine-derived nutrients in the system We summarize Idaho Power's proposed measures, as well as the recommendations of ODFW, IDFG, Interior, and AR/IRU, in table 62.

Table 62. Recommendations for providing marine-derived nutrients. (Source: Staff)

Idaho Power	ODFW	IDFG	Interior	AR/IRU
Distribute carcasses or alternative nutrient supplements within known bull trout rearing areas in the Pine-Indian-Wildhorse core area.	ODFW-39. Investigate, fund and implement nutrient supplementation in all tributaries to the project	IDFG-17. Supplement nutrients for resident salmonids using spawned carcasses or carcass analogs. Consider focusing initial nutrient supplementation efforts in the Weiser River core area until brook trout suppression efforts in Indian Creek and the Wildhorse River have been effective.	Interior-41. Develop and implement a program to provide bull trout within the project area access to anadromous fish as prey by providing access for anadromous fish to Pine and Indian creeks	AR/IRU-11b. Reintroduce anadromous salmon and steelhead to restore marine-derived nutrients. Carcass outplants may be beneficial in streams where anadromous fish are not reintroduced, but only if nutrients are needed to benefit native species.

Our Analysis

In unobstructed systems, the return of Pacific salmon can represent an important source of nutrients for local biota, particularly in otherwise nutrient-poor systems. Native resident salmonids can benefit from marine-derived nutrients through increased primary production or direct consumption of eggs, fry, and carcasses, (Cedarholm et al., 1999). As proposed by Idaho Power and recommended by ODFW and IDFG, efforts to provide supplemental nutrients to replace those from naturally spawning salmon that have been lost would increase the growth rates, and consequently fecundity, of bull trout and redband trout. Fish populations in tributaries currently receiving considerable nutrient loads from natural sources or due to human activities would experience little benefit from nutrient supplementation. However, because bull trout populations are largely restricted to relatively pristine tributary reaches in the project area, nutrient supplementation targeted toward tributaries that currently support bull trout would likely benefit these populations.

Studies show that carcass outplants increased growth in juvenile coho salmon and steelhead (Bilby et al., 1998) and in resident trout and char (Wipfli et al., 2003). Nutrient supplementation methods other than carcass outplants, however, have not been evaluated. Regardless of the supplementation method, monitoring would be required to determine the effectiveness and utility of continued efforts.

Although fish populations in project tributaries may benefit from supplemental contributions of nutrients, the poor water quality in project reservoirs, particularly in Brownlee reservoir, is largely a result of high nutrient loads (see section 3.5, *Water Quality*). Carcass outplants or other methods of nutrient supplementation would contribute additional nutrient loads to project reservoirs. However, the magnitude of this effect would depend on the scope of tributary supplementation efforts. Considering the discharge volume of the Snake River, the relatively small loads resulting from point-source carcass outplants would likely have a minimal effect on reservoir water quality. Further, because it would be contingent upon the bulk of the nutrient load remaining in tributaries for organism uptake, a successfully implemented nutrient supplementation program would, by definition, contribute minimally to nutrient loads in project reservoirs.

As discussed in section 3.6.2.10, *Tributary Habitat Improvements*, the presence of brook trout adversely affects resident bull trout populations through competition and genetic introgression. In nutrient-poor basins where resources are limited, the re-establishment of marine-derived nutrients could similarly benefit brook trout populations, resulting in increased hybridization and competition with bull trout. Therefore, to maximize the net benefit for bull trout populations, carcass outplants could be targeted for habitats occupied by bull trout, and could avoid areas that are occupied by brook trout. This approach would provide benefits to bull trout without causing an associated increase in brook trout numbers. In addition, if bull trout are found in Eagle Creek, nutrient supplementation could be implemented in this drainage as part of habitat enhancement efforts.

Rather than relying on carcass outplants or other artificial means of nutrient supplementation, Interior and AR/IRU recommend the re-establishment of marine-derived nutrients by facilitating the passage and spawning of steelhead and spring Chinook salmon in tributaries to the project. This approach would distribute marine-derived nutrients more widely and in a more natural manner than carcass outplants. The spawning of anadromous fish would also directly provide forage for resident salmonids in the forms of eggs, fry, and juvenile steelhead and salmon that would otherwise be unavailable. Chandler et al. (2003a) also state that optimal foraging temperatures for bull trout historically coincided with smolt migration, providing an important early season forage base for adult bull trout at a time when energy reserves are depleted. The energy and growth accumulated from this food source likely allowed bull trout to return to tributary habitat as temperatures rose in the summer. Chandler et al. (2003a) also postulate that the additional forage provided by anadromous fish is important for the maintenance of the fluvial life history of resident salmonids. However, as discussed in section 3.6.2.6, *Anadromous Fish Restoration,* Idaho Power's analysis of restoration options concluded that establishing self-sustaining runs of

anadromous fish is not likely to be feasible at this time due to several factors, including degraded habitat conditions and low rates of adult returns associated with migration losses during passage through eight mainstem reservoirs and dams in the lower Snake and Columbia rivers. Similarly, NMFS elected not to prescribe fishways for anadromous fish based on the degraded water quality and habitat conditions in both mainstem and tributary habitats.

It is possible to transport and release live surplus adult fish into Hells Canyon reservoir, and IDFG has done this in the past to provide opportunities for a recreational fishery for steelhead. Between 1987 and 1997, IDFG stocked an estimated 3,761 adult steelhead into Hells Canyon reservoir (see table 30). Continuation of this practice, while not expected to produce self-sustaining runs of anadromous fish, would increase forage opportunities for bull trout from the eggs, fry, and carcasses of any fish that spawn in Pine and Indian creeks.

During prospective efforts to eradicate brook trout in tributaries to the project (see section 3.6.2.10, *Tributary Habitat Improvements*), IDFG recommends carcass outplants be distributed in the Weiser River basin. Carcass outplants to this basin would benefit bull trout populations in the Weiser River core area. However, because of the distance of this basin from the Hells Canyon Recovery Area, it is unclear how such a measure would directly benefit bull trout populations in tributaries that have been directly affected by the project.

Regardless of whether marine-derived nutrients are supplied to tributaries through introducing live anadromous fish into Hells Canyon reservoir, as IDFG has done in the past, or through carcass outplants, there are risks associated with the introduction of fish pathogens. Several pathogens have the potential to adversely affect salmonid populations, in and upstream of, the project if they are introduced via upstream passage or carcass vectors (see section 3.6.2.9, *Fish Pathogen Assessment*). Whether these risks are outweighed by the potential benefits associated with the reestablishment of marine-derived nutrients requires careful consideration by management agencies and other stakeholders.

3.6.2.12 Hatchery Production

Idaho Power's hatchery system has been in operation since initial attempts to provide passage were discontinued several years after Brownlee and Oxbow dams were constructed. The intent of the hatchery production was to mitigate for the loss of upstream production of salmon and steelhead and provide fish for harvest. According to the terms of the 1980 Hells Canyon Settlement Agreement and the existing license, current hatchery production goals include annually releasing 1 million fall Chinook salmon, 4 million spring/summer Chinook salmon, and 400,000 pounds of steelhead smolts annually.

Genetic interactions between hatchery and wild stocks may have a negative effect on wild stocks by decreasing their genetic diversity and fitness. Hatchery-produced fish may compete with naturally-spawned fish for prey and habitat in spawning and rearing areas and in migration corridors. This competition may be increased in areas where density is greatest, such as smolt-release areas, or areas where natural spawning habitat is limited. Operational guidelines for producing and releasing hatchery fish, however, would minimize potential negative interactions with wild fish. For example, fish releases can be timed to decrease the potential interactions with wild fish that may be present in the release area.

Marking hatchery releases can allow for selective recreational fisheries that target hatchery fish. In addition, marking would aid in returning natural fish to the river to spawn rather than adding them to hatchery brood stock, thereby decreasing mortality of naturally-spawning stocks.

Idaho Power proposes to continue anadromous fish production at hatchery facilities at the same levels specified in the 1980 Hells Canyon Settlement Agreement and the current license. This includes producing 3 million spring Chinook salmon smolts at the Rapid River Hatchery, 1 million summer

Chinook salmon smolts at the Pahsimeroi Hatchery, 1 million fall Chinook salmon smolts at the Oxbow hatchery, and 400,000 pounds of steelhead smolts[75]. Idaho Power also proposes to make improvements to their hatchery facilities and to hire a full-time biologist to conduct monitoring and evaluation studies of their hatcheries' performance.

We describe Idaho Power's proposed measures for each hatchery below.

- **Pahsimeroi Hatchery**—To control pathogens, particularly *Myxobolus cerebralis*, which causes whirling disease, Idaho Power proposes to develop a pathogen-free source of water for the hatchery by constructing groundwater wells. Idaho Power also proposes to develop a locally-adapted steelhead brood stock that may better survive conditions in the upper-Salmon River-Pahsimeroi Basin. Idaho Power also proposes to monitor and evaluate the performance of hatchery-produced fish relative to state, tribal and federal management goals.
- **Oxbow Hatchery**—Idaho Power proposes to make improvements to the Oxbow fish hatchery by constructing an adult holding pond and spawning facilities, expanding the fall Chinook rearing program to accommodate rearing 1 million smolts annually, and completing general upgrades to the hatchery facilities. Idaho Power also proposes to distribute carcasses to tributaries within the Hells Canyon Project, remove the existing floating barge trap, and conduct studies to monitor and evaluate hatchery performance for smolt-to-adult survival, straying rates, harvest contribution, and other criteria.
- **Niagara Springs Hatchery**—Idaho Power proposes to make improvements to the Niagara Springs hatchery by expanding the hatchery to accommodate rearing up to 2.1 million 2.5-inch steelhead, and upgrading employee housing to accommodate four employees. Idaho Power also proposes to acquire an additional smolt tanker to transport spring Chinook salmon, fall Chinook salmon, and steelhead to various release sites, acquire a fish marking unit capable of clipping adipose fins and tagging fish with coded wire, and monitor and evaluate the performance of hatchery-produced fish relative to state, tribal and federal management goals.
- **Rapid River Hatchery**—Idaho Power proposes to make improvements to the Rapid River Hatchery by upgrading employee housing, constructing an adult holding pond and spawning facilities, and generally upgrading hatchery facilities to improve operational efficiency and safety. Idaho Power also proposes to distribute carcasses above and within known bull trout rearing areas in the Pine-Indian-Wildhorse core area, construct an offsite smolt acclimation/adult collection facility on the Little Salmon River near Stinky Springs (RM 18.6 to RM 21.1), and monitor and evaluate hatchery performance relative to state, tribal and federal management goals.

We summarize agency recommendations pertinent to hatchery production and operations in tables 63 and 64, below.

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[75] The original target production of 4 million spring Chinook salmon was changed (in compliance with rules set out in the 1980 Settlement agreement) by IDFG in 1985 to 3 million spring Chinook salmon and 1 million summer Chinook salmon. This change was meant to focus Idaho Power's hatchery programs on propagation of indigenous Pahsimeroi River summer Chinook salmon rather than the Rapid River spring Chinook salmon, which was not native to the drainage.

Table 63. Hatchery recommendations. (Source: Staff)

Component	Idaho Power	NMFS	ODFW	IDFG	AR/IRU	Nez Perce Tribe	Interior
Production	IPC-9 Continue current production levels: 3 million spring Chinook at Rapid River Hatchery; 1 million fall Chinook at Oxbow Hatchery, 1 million spring/summer Chinook at Pahsimeroi Hatchery, and 400,000 pounds steelhead smolts at Niagara Springs Hatchery.	NMFS-13 Same as Idaho Power.[a]	ODFW-30 Ensure production of current hatchery goals proposed by Idaho Power. Modify production goals to be based on adult returns and societal use.	IDFG-3 Continue current level of smolt production, but identify broader goals for adult return and societal use that can be incorporated in hatchery planning documents	AR/IRU-10 Hatchery program should support naturally reproducing, harvestable anadromous salmonids, to facilitate reintroduction above project. Modify production goals to include adult returns.	NPT-10, 11, 12 Develop management agreement with Nez Perce Tribe, ODFW, IDFG, and NMFS for hatchery production at each hatchery.	Interior-48 Modify production goals to be based on escapement or returns to sport and commercial fisheries.
Planning, monitoring, and evaluations	IPC-8, 9, 10, 11 Monitor and report hatchery performance relative to management goals, including analysis of straying, optimal smolt release size and timing, harvest contributions. Improve operations as necessary to minimize identified negative effects on natural and ESA-listed populations.	NMFS-15 Provide funding to develop or update HGMPs for each hatchery, and operate hatcheries according to the HGMPs. Fund monitoring and evaluation program to evaluate smolt survival, contribution to fisheries, straying to natural spawning areas.	ODFW-25, 26 Develop Hatchery Production Plan that complies with *US v. Oregon* and provides enough Chinook and steelhead to conduct studies and implement reintroduction. Develop long-term monitoring and evaluation program with ODFW and FPRC consultation and approval.	IDFG-3,4,5 Fund fish health monitoring and testing. Monitoring and evaluation should have adaptive management component. Develop monitoring and evaluation program that identifies Idaho Power's mitigation objectives and responsibilities	AR/IRU-10 Develop adaptive management hatchery program Conduct annual assessments. Update every 5 years. Independent consultant evaluate every 5 to 10 years.	NPT-10 Coordinate Snake River fall Chinook production and releases through *US v. Oregon*	

Component	Idaho Power	NMFS	ODFW	IDFG	AR/IRU	Nez Perce Tribe	Interior
		Assess and implement actions to minimize impacts of hatchery steelhead to ESA-listed ESUs.		relative to harvest and recovery goals. Implement identified actions. Fund studies to assess potential adverse effects of hatchery program on ESA-listed steelhead.			
Marking		NMFS-13 Mark all releases with adipose fin clip.		IDFG-6 Fund marking programs that support ESA recovery evaluations and programs			
Staff levels	IPC-8,9,10,11 Fund full-time Idaho Power hatchery evaluation biologists		ODFW-29 Fund full-time hatchery evaluation biologist	IDFG-5 Fund additional staff to conduct monitoring and evaluation evaluations, may require more than one full-time hatchery evaluation biologist.			
Broodstock	IPC-10 Develop locally adapted steelhead broodstock for Pahsimeroi Hatchery over 10-year period.			IDFG-3 Develop locally adapted steelhead broodstock over 10-year period after analyses of hatchery and			

Component	Idaho Power	NMFS	ODFW	IDFG	AR/IRU	Nez Perce Tribe	Interior
				natural steelhead returning to hatchery is completed.			
Hatchery facilities	IPC-8, 9, 10, 11 Upgrade and improve efficiencies of hatchery facilities. Expand Oxbow hatchery to accommodate 1 million fall Chinook production goal.	NMFS-13 Screen all hatchery intake facilities to meet NMFS juvenile screen criteria.	ODFW-30 Upgrade hatchery facilities. Expand Oxbow hatchery to accommodate 1 million fall Chinook production goal.	IDFG-3 Supports Idaho Powers proposal to upgrade and improve to hatchery facilities and programs and expansion of Oxbow hatchery.			
Fish transport	IPC-8 Acquire fish transport vehicle.			IDFG-7 Acquire fish transport vehicle.			
Rapid River trapping/release site	IPC-11 Investigate development of new Rapid River hatchery trapping/release site near Stinky Springs.			IDFG-7 Supports Idaho Power proposal.			

Notes: FPRC – Fish Pass and Reintroduction Committee to be established
HGMP – Hatchery and Genetic Management Plan

[a] NMFS's recommendation letter stated it supported Idaho Power's proposed protection, mitigation, and enhancements for hatchery production. However its recommendation also states that Idaho Power should produce 200,000 steelhead smolts rather than 400,000 smolts, as was proposed by Idaho Power and was agreed to in the 1980 Hells Canyon Settlement Agreement. We therefore assume the 200,000 was a typographical error, and that NMFS intended to recommend production of 400,000 steelhead smolts.

Table 64. Additional hatchery/surplus fish recommendations. (Source: Staff)

Component	Shoshone-Bannock Tribes	NMFS	ODFW
Surplus/additional production	SBT-2 Construct, maintain, and operate two hatcheries at Yankee Fork and Panther Creek for sockeye, Chinook, and steelhead propagation.	NMFS-21 Shoshone-Bannock, Shoshone-Paiute, Burns Paiute Tribes, IDFG, NMFS, and ODFW participate, with FERC acting as mediator, if necessary, to establish an agreement to share excess spring Chinook or steelhead adults returning to Idaho Power hatcheries.	ODFW-27 Consult with ODFW to investigate and supply alternative fisheries in Oregon

Our Analysis

Hatchery Production

Production from Idaho Power-funded hatcheries contributes to commercial, tribal, and recreational fisheries for Chinook salmon and steelhead in the Pacific Ocean and Columbia River basin. In the mixed-stock coastal fisheries of the Pacific Ocean, the presence of hatchery fish allows for higher harvest levels than if there were no hatchery stocks in the fishery. Because wild fish are harvested along with hatchery fish in these coastal commercial and recreational fisheries, higher harvest levels may ultimately affect escapement of wild stocks. Marking hatchery fish with adipose fin clips, together with harvest restrictions on un-marked fish, would help reduce harvest mortality of wild fish.

Hatchery production could also help in the recovery of ESA-listed stocks. Fall Chinook salmon from the Oxbow hatchery facility and summer-run Chinook salmon produced at the Pahsimeroi hatchery are both components of ESA-listed ESUs. Successful hatchery production of these fish would aid in the recovery of these stocks.

Idaho Power's proposal and IDFG and NMFS's recommendation to continue to produce a defined number of fish from its four hatchery programs would provide fish to support commercial, recreational and tribal fisheries in the Columbia River basin and Pacific Ocean. Interior, ODFW, and AR/IRU recommend that Idaho Power hatchery production continue, but that smolt production goals be replaced with adult escapement goals or returns to sport and commercial fisheries, although they did not state specifically what those goals should be.

Measuring performance by escapement to the hatchery allows for evaluation of benefits of hatchery production in enhancing fish populations affected by the project and in meeting management goals of providing fish for harvest and population recovery purposes. However, replacing hatchery production goals with escapement goals would require Idaho Power to be more responsive to annual changes in factors that influence escapement such as ocean conditions, as well as, commercial and recreational harvest management, in addition to factors affecting the survival of hatchery fish they produce. These are factors Idaho Power has no control over. This would potentially require variable production in any given year to meet escapement goals. Such variable production would present challenges in management of production facilities, staffing, and budgeting. Additionally, such goals would be difficult to enforce given the external management and environmental factors that affect escapement success in any given year. However, there is merit to IDFG's recommendation that Idaho Power work with the agencies to develop broader goals on adult returns, which may be useful for developing refinements in broodstock selection and in production or release strategies to improve attainment of management goals and objectives. This recommendation would serve to guide hatchery operations, but would not replace the existing smolt production targets.

ODFW's recommendation to develop a hatchery production plan that complies with revised *United States v Oregon* production plans would help ensure that there are enough summer/spring Chinook salmon, fall Chinook salmon, and summer steelhead to support reintroduction programs and support any fish passage studies that may be included in a new license. This is similar to the AR/IRU and the Nez Perce Tribe's recommendation that they, along with ODFW, IDFG, and NMFS, develop a management agreement for hatchery production, management, and release protocols. Funding the development of a hatchery genetic management plan in consultation with state and federal resource management agencies and the Nez Perce Tribe, (which have management authority as prescribed in *United States v Oregon*), would help minimize conflicts among various agency actions and goals for use of hatchery fish.

Hatchery and Genetic Management Plans

To address the potential take of listed species, NMFS requires that IDFG, as the operator of Idaho Power's hatcheries, develop an HGMP for each of Idaho Power's hatcheries. The elements that are required to be included in an HGMP are defined in the final 4(d) rule issued by NMFS on July 10, 2000 (65 FR 42,425). The final 4(d) rule requires that:

- The HGMP has clearly stated goals, performance objectives, and performance indicators that indicate the purpose of the program, its intended results, and measurements of its performance in achieving those results.
- Listed salmonids are purposefully taken for broodstock purposes only if the donor population is currently at or above the viable threshold and the collection will not impair its function, if the sole objective of the current collection program is to enhance the propagation or survival of the listed ESU, or if the collection will not appreciably slow the attainment of viable status for that population.
- The HGMP takes into account health, abundance, and trends in the donor population, and broodstock collection programs reflect appropriate priorities, including reestablishing indigenous salmonid populations for conservation purposes. After the species' conservation needs are met and when consistent with survival and recovery of the ESU, broodstock collection programs may be authorized by NMFS for secondary purposes, such as to sustain tribal, recreational, and commercial fisheries.
- The HGMP includes protocols to address fish health, broodstock collection, broodstock spawning, rearing and release of juveniles, deposition of hatchery adults, and catastrophic risk management.
- The HGMP evaluates, minimizes, and accounts for the propagation program's genetic and ecological effects on natural populations, including disease transfer, competition, predation, and genetic introgression caused by the straying hatchery fish.
- The HGMP describes interrelationships and interdependencies with fisheries management, and artificial propagation programs and harvest management are designed to provide as many benefits and as few biological risks as possible for the listed species.
- Adequate artificial propagation facilities exist to properly rear progeny of naturally spawned broodstock, maintain population health and diversity, and avoid hatchery-influenced selection or domestication.
- Adequate monitoring and evaluation exist to detect and evaluate the success of the hatchery program and any risks that would potentially impair the recovery of the listed ESU.
- The HGMP provides for evaluating monitoring data and making any revisions of assumptions, management strategies, or objectives that the data indicate are needed.
- NMFS provides written concurrence with the HGMP and specifies the implementation and reporting requirements.
- The HGMP is consistent with plans and conditions set within any federal court proceeding with continuing jurisdiction over tribal harvest allocations.

Completion and implementation of an HGMP for each hatchery would ensure that Idaho Power's hatchery programs are managed in a manner that is in conformance with ESA recovery plans and would help to further efforts to increase populations of ESA-listed fish. Such plans would also ensure that any monitoring and evaluation efforts that are needed to measure effects on listed species are conducted and

that appropriate adjustments are made if objectives are not met or additional measures are needed to protect listed ESUs.

The developed HGMPs should reflect goals and objectives that are consistent with Idaho Power's mitigation requirements and *United States v Oregon* production plans, as well as address the management goals of the fisheries management agencies and tribes. To ensure that this happens, it would be beneficial for Idaho Power to consult with the fisheries management agencies and interested tribes to define the appropriate goals and objectives of its hatchery program. This initial planning effort would form the basis for each HGMP. As noted above, the HGMPs are required to include clearly stated goals, performance objectives, and performance indicators that outline the purpose of the program and its intended results, as well as a means to measure performance in achieving those results. This consultation would provide all parties, including Idaho Power, an opportunity to provide input into defining the goals and objectives for each hatchery.

Hatchery Facilities

Idaho Power's proposals and agency and tribal recommendations to upgrade, modify, and in some cases expand its hatchery facilities or operations would increase efficiencies, capacities, and staff safety to better meet current and future production goals, as well as monitoring and evaluation requirements. Updating facilities with current technology would likely decrease fish handling stress and mortality. We assess hatchery-specific measures and facility upgrades/modifications below.

Pahsimeroi Hatchery

Idaho Power's proposal to develop a pathogen-free source of water by constructing groundwater wells would decrease the possibility of whirling disease caused by *Myxobolus cerebralis* found in current source water from the Pahsimeroi River. Currently hatchery fish can become infected, resulting in decreased survival of hatchery fish and/or a potential for infecting wild fish with whirling disease.

Idaho Power's proposal and IDFG's recommendation to develop a locally adapted steelhead brood stock would likely result in a steelhead population that is better suited to survive conditions in the upper Salmon and Pahsimeroi rivers. Such a stock would likely exhibit lower straying rates, potentially reducing negative effects of straying on other populations, and would ultimately lead to an increase in returns and survival of native steelhead in the Upper Salmon and Pahsimeroi rivers.

Oxbow Hatchery

Idaho Power's proposal to upgrade existing facilities and expand the hatchery to provide adult holding and spawning facilities, and to accommodate rearing up to 1 million fall Chinook smolts, would aid in stock recovery efforts. This would enable the hatchery to contribute more fish to the population. ODFW and IDFG also recommend these actions, which would aid in the development of a fall Chinook broodstock at the hatchery. This would eventually reduce the reliance on the Lyons Ferry Hatchery for fall Chinook broodstock for the hatchery.

Idaho Power's proposal and ODFW's recommendation to distribute carcasses from Oxbow hatchery to tributaries within the project would reintroduce a source of marine-derived nutrients and carbon that was lost historically. The presence of these nutrients contributes to the biotic productivity of a freshwater stream by increasing nutrients that enhance the aquatic macroinvertebrate and zooplankton forage base, which would benefit native fishes such as bull trout.

Niagara Springs Hatchery

Idaho Power's proposal to acquire an additional smolt tanker to transport spring Chinook salmon, fall Chinook salmon, and steelhead to various release sites would decrease the amount of time it currently

takes to release fish from the hatchery (45 days) by increasing the transport capacity from two tanker-trailers to three. IDFG states that reducing transport time would help to optimize release timing for smolts, and help minimize residualism and maximize downstream survival (Dorman and Chapman, 2004).

All smolts currently released from Idaho Power's mitigation program are marked with an adipose fin clip, and some are also tagged with coded wire tags or passive integrated transponders (PIT tags). Acquiring a fish marking unit capable of clipping adipose fins and tagging fish with coded-wire tags would increase the efficiencies of this program, and allow for continued identification of hatchery fish from naturally-spawning fish. This would enable selective fishery management, as well as facilitate evaluations of interactions between hatchery and natural stocks.

Rapid River Hatchery

Distributing carcasses above and within known bull trout rearing areas in the Pine-Indian-Wildhorse core area would reintroduce a source of marine-derived nutrients and carbon that was lost historically. As noted above, the presence of these nutrients contributes to the biotic productivity of freshwater streams, which is expected to benefit native fishes such as bull trout.

Idaho Power proposes, and IDFG supports, constructing an offsite spring Chinook smolt acclimation/adult collection facility on the Little Salmon River near Stinky Springs (RM 18.6 to RM 21.1). Releasing fish at an additional site would help distribute adult returns to the Little Salmon River, potentially increasing harvest opportunities for recreational and tribal anglers who actively fish those areas. The collection site would also provide a contingency backup for the Rapid River hatchery for spring Chinook broodstock collection.

Additional/Surplus Fish

ODFW states that a disproportionate number of hatchery releases occur in Idaho, resulting in decreased opportunities for Oregon anglers. It recommends Idaho Power consult with ODFW to modify the hatchery program to address the loss of fishing opportunities for Oregon's anglers. Potential measures suggested by ODFW include developing a fall steelhead fishery in the Powder River below Mason dam or developing a rainbow trout supplementation program in Phillips and Brownlee reservoirs. Such programs would provide fish to increase opportunities for recreational harvest in Oregon.

IDFG and ODFW currently stock large numbers of fingerling and smaller numbers of catchable rainbow trout in project reservoirs, especially in Brownlee reservoir and several of the tributaries in the project area (table 30). Increased stocking of rainbow trout in Brownlee reservoir would adversely affect redband and bull trout through increased competition, introgression, and harvest. This could impede efforts to restore redband and bull trout populations through the tributary habitat improvement and fish passage measures that are proposed by Idaho Power.

NMFS recommends Idaho Power establish an agreement to share and distribute live adults that return to Idaho Power hatcheries and that are not needed to fulfill production or other obligations such as those stipulated in *United States v Oregon*. Also, during tribal consultation meetings held in March, 2007, the Burns Paiute and Shoshone-Paiute tribes expressed concerns that they had lost access to anadromous fish since the construction of the Hells Canyon Project. They stated concerns that restoration of anadromous fish to their historical fishing grounds may not take place for many years. The Burns Paiute Tribe expressed particular interest in anadromous fish restoration efforts on the Malheur River, and the Shoshone-Paiute Tribes expressed interest in restoration efforts (to establish subsistence and ceremonial fisheries) in the Owyhee River.

In the past, surplus adult spring Chinook salmon and steelhead returning to Idaho Power's hatchery system have been used to support tribal and recreational fisheries. Between 1985 and 1990, a

total of 6,617 surplus adult spring Chinook salmon were released into tributaries in the Salmon River basin including the Yankee Fork, Panther Creek, and the Lemhi River (Abbott and Stute, 2003). Between 1966 and 2000, IDFG released a total of 45,588 surplus adult steelhead to support recreational fisheries in Hells Canyon reservoir and in the Boise and Payette rivers (Abbott and Stute, 2003). We have found no information in the record that indicates whether these practices have continued since 2000, or whether Idaho Power has borne the cost of transporting and releasing surplus hatchery spring Chinook salmon and steelhead in the past.

Multiple benefits could be realized by distributing surplus salmon and steelhead. First, placing surplus fish in the project reservoirs and select tributaries within the project area would add a source of marine nutrients to the system and improve forage for bull trout. Second, planting spring Chinook salmon and steelhead in Pine Creek would provide Idaho Power, the resource agencies, and the tribes an opportunity to evaluate spawning success, egg viability and survival, and smolt outmigration and survival. Third, planting surplus fish into tributaries in the project area would help support recreational fishery opportunities in the project area. Finally, the use of surplus hatchery fish to provide fisheries for the aforementioned tribes would allow the tribes to resume subsistence and ceremonial fisheries that are clearly of substantial cultural importance.

Yankee Fork and Panther Creek

The Shoshone-Bannock Tribes recommend Idaho Power develop hatcheries on the Yankee Fork and at Panther Creek for the purpose of recovering wild stocks of sockeye salmon, Chinook salmon, and steelhead. The Yankee Fork, a tributary to the Salmon River near Sunbeam, Idaho, historically supported populations of spring/summer Chinook salmon. Panther Creek flows into the Salmon River east of the confluence of the Middle Fork Salmon River. Runs of Chinook salmon and steelhead in Panther Creek were largely eliminated as a result of mining activities in the drainage beginning in the 1940s (Reiser, 1986). The tribes report that ongoing restoration activities have resulted in near complete restoration of these tributaries, and that they could again support native fish populations.

Since 1995, the Shoshone-Bannock Tribes have implemented a project using streamside egg incubators to supplement and improve the viability of natural populations of steelhead and spring/summer Chinook salmon in Salmon River tributaries. The program includes several incubator sites on Yankee Fork. The tribes have typically obtained approximately 1,000,000 eyed steelhead eggs from the Sawtooth and Pahsimeroi fish hatcheries for this program (IDFG et al., 2007). In addition, smaller numbers of spring/summer Chinook salmon have been supplied to the program from a captive rearing project funded by BPA (IDFG, 2002).

Streamside incubators are a low-tech, low-cost method for hatching eggs that provides hatch rates comparable to hatcheries. Eggs are incubated and hatched in a more natural thermal environment, and the fry then emigrate from the boxes and rear in the stream where they are exposed to selective pressures that favor attributes that are favorable for survival in the wild. Although survival rates during the freshwater rearing phase are lower than a hatchery environment, the surviving smolts are likely to be more genetically and physiologically fit than hatchery fish. They also have more opportunity to develop predator avoidance skills, which increases survival during out-migration. These factors are expected to result in comparable adult production for a given number of broodstock or eggs (Galindo and Rinehart, 1998), but at a much lower cost than hatchery production. Natural selection during rearing in the stream environment is likely to produce fish that are more suitable for rebuilding natural stocks and for promoting recovery of listed ESUs.

During tribal consultation meetings held in March 2007, the Shoshone-Bannock Tribes indicated that they are especially interested in establishing a hatchery on the Yankee Fork, due to extensive habitat restoration work undertaken there. The tribes reported that their enhancement programs have relied on obtaining fish and eggs from state and federal hatcheries, but that these are provided only when there are

surplus eggs available. They indicated that recent requests for fish and eggs have been turned down. We also note that the 2005 HGMP for the Sawtooth/Hagerman summer steelhead A-run program indicates that the ability of these hatcheries to supply steelhead eggs to the streamside incubator program is uncertain. Developing facilities that would allow the Shoshone-Bannock Tribes to collect and spawn their own broodstock and incubate eggs to the eyed stage would increase the tribes' assurance of obtaining sufficient eggs to maintain their program, and contribute to rebuilding the Snake River steelhead and spring/summer Chinook salmon ESUs in Yankee Fork.[76]

Providing additional sources of fish in these tributaries would (1) contribute to restoration of the Snake River steelhead and spring/summer Chinook salmon ESUs, and (2) increase the potential for harvest opportunities for ceremonial, subsistence, and recreational purposes in this portion of the Salmon River drainage. Although habitat in the Yankee Fork and Panther Creek have not been directly affected by construction or operation of the Hells Canyon Project, the project does affect river flows and water quality conditions in the migratory corridor downstream of the confluence of the Salmon and Snake rivers, including elevated TDG levels during high spill periods and reduced flows during the smolt out-migration period caused by flood control operations at Brownlee reservoir.

3.6.2.13 Sturgeon Conservation Measures

Construction of the Hells Canyon Project and 10 other dams on the Snake River downstream from Shoshone Falls (figure 1, table 3) and other mainstem dams on the Columbia River eliminated upstream connectivity and gene flow among sturgeon populations over most of their historical range in the basin. Prior to development, this species could move freely between the ocean, estuaries, the Columbia River, and the Snake River upstream as far as Shoshone Falls (Idaho Power, 2003b). The loss of connectivity caused by dam construction contributed to a severe reduction in the abundance of white sturgeon in most river segments, many of which do not provide the type, quality and quantity of habitat required to maintain self-reproducing populations. Idaho Power's monitoring studies indicate that little or no recent recruitment has occurred in seven of the nine populations that are isolated by mainstem dams on the Snake River between Shoshone Falls and Lower Granite dam (Idaho Power, 2003b). Rebuilding sturgeon populations in these reaches would serve to restore recreational and tribal sturgeon fisheries, increase population resiliency, and conserve the genetic characteristics of Snake and Columbia River sturgeon. Rebuilding the Snake River populations would provide a source of broodstock that could be used to restore downstream populations if a catastrophic loss occurred in the lower Columbia River from factors such as disease, a chemical spill, or the long-term effects of contaminant accumulation.

Idaho Power established a technical committee to address sturgeon conservation issues associated with its mainstem hydroelectric projects within the historical range of the white sturgeon, which includes the Hells Canyon Project and five upstream developments (Upper Salmon Falls, Lower Salmon Falls, Bliss, C.J. Strike, and Swan Falls). In consultation with the technical committee, Idaho Power developed a conservation plan that identifies conservation measures to be implemented by Idaho Power in the reaches associated with each of these hydroelectric projects. The five sturgeon conservation measures proposed in the license application for the Hells Canyon Project are:

1. assessment of water quality-related impacts on early life stages of white sturgeon in the Swan Falls to Brownlee reach;
2. translocation of reproductive-sized white sturgeon to the Swan Falls to Brownlee reach;

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[76] Because of the extremely low number of sockeye salmon that currently return to the Salmon River Basin, we consider it unlikely that adult sockeye broodstock would be available for collection and spawning in the Yankee Fork.

3. development of an experimental conservation aquaculture program for the Swan Falls to Brownlee reach;
4. conducting population assessments and monitoring the genotypic frequencies of white sturgeon in Snake River reaches between Swan Falls and Lower Granite dams every 10 years; and
5. monitoring of genotypic frequencies..

Recommendations by agencies, tribes, and NGOs relating to sturgeon conservation are summarized in table 65, and are discussed below. Their recommendations focus on Idaho Power's proposed measures and several additional measures, including evaluating the need for passage or anti-entrainment measures, measures to improve water quality, and changes in operations to improve reproduction at Idaho Power's upstream projects.

Our Analysis

Conservation Plan Development

Idaho Power developed a White Sturgeon Conservation Plan that includes measures associated with each of its mainstem hydroelectric projects on the Snake River. The latest version of the plan (Idaho Power, 2005k) includes a proposed implementation schedule for measures proposed for each of the river segments delineated by Idaho Power's mainstem dams between Shoshone Falls and Lower Granite reservoir.

Regarding actions associated with the upstream Idaho Power projects, Article 407 of the licenses issued for the Upper Salmon Falls, Lower Salmon Falls and Bliss Projects and article 408 of the license issued for the C.J. Strike Project required Idaho Power to develop a white sturgeon conservation plan, including appropriate measures for the protection and enhancement of white sturgeon in the Snake River. Idaho Power filed the plan in compliance with these license articles in August 2005, and measures in the plan associated with the four upstream projects were approved by the Commission on May 31, 2006.

Several parties recommend that the conservation plan be updated to include their recommendations for the Hells Canyon Project. In addition, Interior recommends that Idaho Power develop an action plan to coordinate basin-wide implementation.

The existing White Sturgeon Conservation Plan provides a useful framework for evaluating measures associated with each of Idaho Power's projects located on the mainstem Snake River. We evaluate enhancement measures for the white sturgeon later in this section, including those proposed by Idaho Power in the conservation plan and the recommendations of other parties. Any new license issued for the project would include those measures deemed necessary by the Commission. The measures included in any license could include some or all of the measures that are proposed in the conservation plan for the project, and could also include other measures that have been recommended by stakeholders or developed by staff. The license articles would include any provisions that are needed to monitor the effectiveness of the adopted measures, to coordinate with measures that are associated with the upstream projects on the Snake River, and to facilitate adaptive management. Because these needs would be fulfilled through appropriate articles that would be included in the new license, we see little or no benefit in requiring Idaho Power to update the conservation plan.

Table 65. Recommended measures related to white sturgeon conservation. (Source: Staff)

Component	AR/IRU	IDFG	Interior	ODFW	Umatilla Tribes	Nez Perce Tribe
Conservation plan		IDFG-21. Use the White Sturgeon Conservation Plan to contribute to the long-term goal of restoring healthy white sturgeon populations.	Interior-51, 52. Promptly implement proposed conservation measures; implement a river-wide action plan, in consultation with FWS, state fish and wildlife agencies, and interested tribes.	ODFW-42. Update and implement measures identified in the White Sturgeon Conservation Plan.	CTUIR-13. Develop a plan that promotes rebuilding of white sturgeon populations within the area of potential effect.	NPT-18. Implement conservation measures to enhance population viability and persistence from Bliss dam to Lower Granite reservoir.
Conservation aquaculture	AR/IRU-12c. Develop conservation aquaculture program, examine genetic implications, consider expanding program to reaches other than Swan Falls after recruitment studies are completed	IDFG-24. Focus initial efforts on habitat restoration; evaluate genetic implications of hatchery supplementation on wild stocks before developing an experimental conservation aquaculture program.	Interior-53. Develop and implement a White Sturgeon Conservation Aquaculture Plan, including construction of an operational hatchery facility within 4 years.	ODFW-42. Focus initial efforts on habitat restoration; evaluate genetic implications of hatchery supplementation on wild stocks before developing an experimental conservation aquaculture program.	CTUIR-18. Supplement existing populations to rebuild them to pre-project levels and supply a harvestable surplus.	NPT-18. Begin to re-establish recruitment to populations where natural recruitment is severely limited; reestablish populations such that tribal harvest may occur.
Translocation	AR/IRU-12f. Do not translocate sturgeon until limiting factors have been determined and addressed, and effects on donor populations have been evaluated.	IDFG-23. Conduct feasibility studies prior to translocating reproductive-sized white sturgeon to the Swan Falls to Brownlee dam reach.		ODFW-47. Investigate opportunities for translocating sturgeon to the Swan Falls to Brownlee reach.		

Component	AR/IRU	IDFG	Interior	ODFW	Umatilla Tribes	Nez Perce Tribe
Passage and entrainment protection	AR/IRU-12d, 12e. Determine whether passage is a limiting factor; connect sturgeon populations; implement anti-entrainment and impingement measures at projects where sturgeon are at risk; reduce trash rack spacing at C.J. Strike.		Interior-50b, 55. Determine which Idaho Power dams need to have their trashracks replaced to protect juvenile sturgeon from entrainment; install protective trash racks at CJ Strike and Bliss dams.			
Water quality studies and improvements	AR/IRU-12b, 12g. Monitor success of sturgeon spawning and early life history stages; implement water quality improvement measures elsewhere in the basin to aid in sturgeon recovery.	IDFG-22. Assess effects of degraded water quality on early life stages and recruitment success in the Swan Falls to Brownlee reach as proposed by Idaho Power	Interior-50a. Implement water quality improvement measures elsewhere in the basin to aid in sturgeon recovery	ODFW-44, 46. Assess effects of degraded water quality on early life stages and recruitment success in the Swan Falls reach; implement water quality measures to aid in sturgeon recovery.		

Component	AR/IRU	IDFG	Interior	ODFW	Umatilla Tribes	Nez Perce Tribe
Operations at upstream dams, population monitoring	AR/IRU-12a. Implement run-of-river operations at Lower Salmon Falls Bliss, C.J. Strike projects during sturgeon spawning, incubation and early life stages.	IDFG-25, 26. Conduct long-term population assessments and genetic monitoring of white sturgeon as proposed by Idaho Power	Interior-50c. Determine the potential benefits of implementing a seasonal run-of-river operation at Lower Salmon Falls, Bliss, C.J. Strike and Hells Canyon dam to promote sturgeon spawning.	ODFW-45, 48. Conduct stock assessments and genetic monitoring between Swan Falls and Brownlee dams, in Oxbow and Hells Canyon reservoirs, and downstream of Hells Canyon dam		

Population Supplementation

Population sampling conducted by Idaho Power between Shoshone Falls and Lower Granite dam indicates that populations in seven out of the nine segments delineated by mainstem dams do not consistently support successful reproduction and thus are not self-sustaining. The results of Idaho Power's sampling program indicates that the sturgeon population is particularly depressed in the Swan Falls dam to Brownlee segment and in all three of the Hells Canyon Project reservoirs (figure 107).

Idaho Power proposes a phased approach to rebuilding the white sturgeon population in the Swan Falls to Brownlee reach, which would start with studies to evaluate the effects of water quality conditions on spawning success and survival of early life-stages. Based on the results of these studies, adult sturgeon would be translocated from a donor population, or, if current water quality conditions would not support natural reproduction, a conservation aquaculture program would be implemented to rebuild white sturgeon populations in the Swan Falls to Brownlee reach.

Idaho Power's proposal represents a logical stepwise approach to rebuilding white sturgeon populations in the Swan Falls to Brownlee reach. However, implementation of a conservation hatchery program could have several advantages as a means for rebuilding sturgeon populations. This approach would provide a much greater level of assurance that juveniles could be recruited to the recipient populations on a yearly basis. This would provide a much more rapid and certain path toward rebuilding sturgeon populations to levels that could support a tribal and non-tribal harvestable fishery, especially in shorter river segments such as the Brownlee to Oxbow dam reach and the Oxbow to Hells Canyon dam reach. These reaches do not include the full complement of habitats that are needed to support a self-reproducing population. Because sturgeon are a highly fecund species, collection and spawning of a small number of adult fish each year could provide sufficient juvenile production to simultaneously rebuild sturgeon populations in most, and perhaps all, of the interdam segments where population levels are depressed. The potential success for rapid population rebuilding is evident from results observed in the Shoshone Falls to Upper Salmon Falls reach, where IDFG stocked 1,588 juvenile sturgeon between 1989 and 2000, and the adult population has increased from very low levels to an estimated population of 777 sturgeon over 70 mm by 2001 (Idaho Power, 2005k). Only two out of the 251 sturgeon collected in Idaho Power's 2001 survey were of wild origin.

Although a conservation hatchery program would need to be carefully designed to ensure that it does not cause adverse genetic effects, several factors lead us to conclude that these risks can be addressed. First, a substantial amount of work has gone into designing the conservation aquaculture program that is being implemented to rebuild the ESA-listed sturgeon population on the Kootenai River (FWS, 1999). This work should provide a sound foundation for designing a conservation aquaculture program for the Snake River. Second, the population sizes of potential donor populations on the Snake River are substantially larger than the population on the Kootenai River. This means that a large number of reproductive adults and potential parental lines are available for incorporation into the program in any given year. Third, recent genetic work indicates that there is very little genetic differentiation between white sturgeon found in the Snake and Lower Columbia rivers (Idaho Power, 2003b). This suggests that a considerable degree of sturgeon movement occurred between the Snake and Columbia rivers prior to development.

Sturgeon are a very long-lived and late maturing species. Thus, it is unlikely that substantial selective adaptation has occurred in the time since the population was fragmented by dam construction. Because the smaller Snake River population was likely integral with the Columbia River population prior to development, using some brood stock from the robust sturgeon population in the lower Columbia River would help to restore gene flow and genetic variability in the white sturgeon populations that are now isolated in the interdam segments of the Snake River. However, we understand that IDFG and ODFW have concerns about potential genetic implications of stocking hatchery fish, and that the state agencies

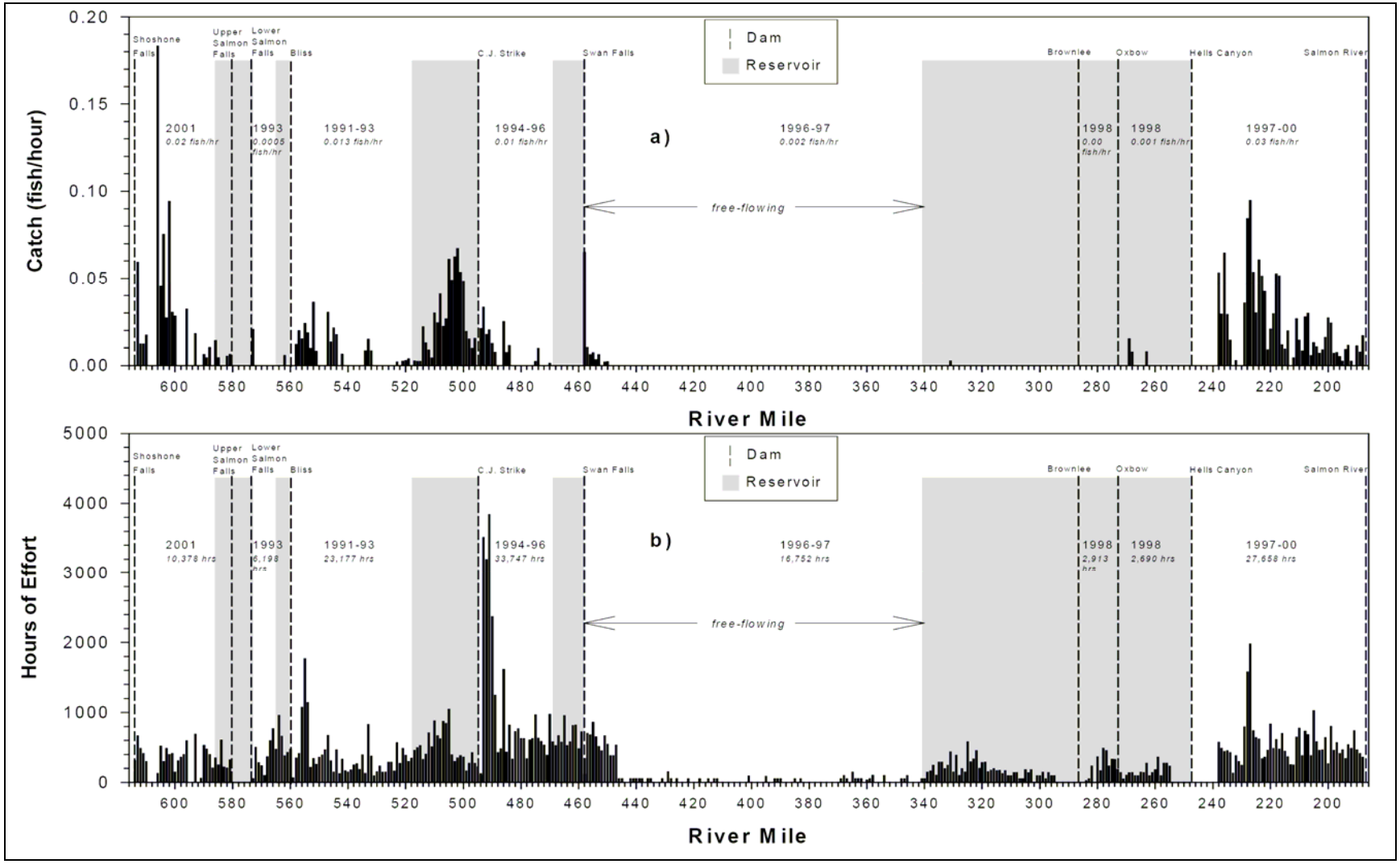

Figure 107. Catch rates and hours of effort expended sampling for white sturgeon with setlines in the Snake River between Shoshone Falls and the confluence with the Salmon River. (Source: Idaho Power, 2003b)

have the authority to regulate any stocking program that would occur. Developing a feasibility assessment that compares the risks and benefits of translocation versus a conservation aquaculture approach could assist with determining which approach may be appropriate and acceptable to the state management agencies in each reach.

Upstream Passage

Idaho Power conducted a review of passage alternatives, as well as constraints associated with passing white sturgeon upstream and downstream of the Hells Canyon Project (Wittmann-Todd et al. 2003). Idaho Power concludes that capture-and-transport represents the most reliable solution for providing upstream passage for sturgeon, and that all other options have biological uncertainties, particularly options that rely on volitional responses. Based on the uncertainty of effective upstream passage technologies, it does not appear that construction of upstream passage facilities is currently a viable means for restoring sturgeon populations or for maintaining the genetic variability of Snake River white sturgeon. Further, providing sturgeon passage, even if it were to become technically feasible, is not likely to be as effective as a conservation aquaculture program for rebuilding sturgeon populations to levels that would support viable recreational and tribal fisheries throughout the species' historical range in the Snake River.

At the 10(j) meeting, Idaho Power indicated that it intends to continue holding annual meetings of the White Sturgeon Technical Advisory Committee to report on the results of monitoring and studies, and to assist with guiding the implementation of measures contained in the White Sturgeon Conservation Plan. This provides an opportunity for discussion and consideration of any new information or approaches for restoring sturgeon passage that may be applicable to the Hells Canyon Project. If any potentially feasible measures are identified, their possible implementation could be addressed through a license amendment.

Entrainment Protection

The potential need for, and benefits of, implementing measures to protect sturgeon from entrainment and impingement, as recommended by AR/IRU and Interior, can be assessed by monitoring population responses after recruitment has been restored to the subject populations. Although Idaho Power's studies indicate that some sturgeon do move downstream and are vulnerable to mortality from injuries caused by turbine passage, the general health of populations in the Bliss and Hells Canyon reaches indicate that the number of fish that move downstream is not high enough to cause a substantial reduction in these populations. In addition, the radio telemetry studies conducted by Lepla et al. (2003) indicate that sturgeon in Brownlee reservoir tended to remain in the upstream third of the reservoir, suggesting that the entrainment potential at Brownlee reservoir may be quite limited. It is difficult to quantify the effects of downstream emigration and turbine mortality on population sizes in other reaches until recruitment to these populations has been restored. If recruitment were restored, periodic population monitoring could be conducted to determine the extent to which sturgeon populations in any specific reaches are affected by losses from entrainment or impingement. Only after the rate of loss at specific developments has been determined could an informed analysis be conducted of the potential benefits of implementing protective measures.

If reducing trash rack spacing were to be considered, the potential to increase mortality by impinging juvenile sturgeon on the trashracks would need to be addressed. Idaho Power reports that the clear opening between bars of the trashracks at the Brownlee, Oxbow and Hells Canyon intakes are 3.625 inches wide by 7.625 inches high, 4.75 inches wide by 20 inches high, and 5.5 inches wide by 17 inches high, respectively. Water velocities at the trash racks, as estimated by Idaho Power range from 3 feet per second at the Brownlee and Oxbow intakes, to 3.5 feet per second at the Hells Canyon intake. These

velocities may exceed the swimming capability of fairly large sturgeon when water temperatures are low and swimming capability is reduced.[77] Given the length-to-width ratio of 4:1 reported by Scott and Crossman (1973), the largest sturgeon that could pass through the racks at Brownlee, Oxbow and Hells Canyon intakes would be 14.5, 19 and 22 inches, respectively. Because of the sturgeon's limited swimming capability, reducing the trash rack spacing by replacing the existing racks would increase the potential for impingement of any sturgeon that do not have sufficient swimming capability to fight the current approaching the trashrack and are too large to pass through the trashracks. Impingement could result in higher mortality rates than turbine passage, and would reduce recruitment that would otherwise occur to the downstream population from fish that survive turbine passage. Expanding the size of the intake and trashrack structure could reduce approach velocities and the potential for impingement, but would involve substantial capital costs, given the engineering challenges of constructing a large structure in a deepwater forebay environment.

Water Quality Enhancement

Implementing measures to improve water quality conditions in the basin could benefit sturgeon by improving reproduction and preventing water-quality related fish kills, especially in the Swan Falls to Brownlee reach. We note, however, that no water quality-related kills of adult sturgeon have been reported since the 1990 kill of 28 adult sturgeon that occurred in the transition zone of Brownlee reservoir. Furthermore, water quality conditions are expected to slowly start to improve over the next license term as TMDL implementation proceeds, which should reduce the potential for adverse effects of poor water quality conditions in the Swan Falls to Brownlee reach.

Mid-Snake Project Operations

Any changes to operation of the upstream Idaho Power projects, including changes designed to benefit white sturgeon, would be evaluated and implemented through a license amendment or through the Commission's license re-opener process for these projects.

Population Assessments and Genetic Monitoring

Periodic population monitoring, as proposed by Idaho Power, would provide information on population responses to implemented measures and to changes in environmental conditions, including improvements in water quality that should start to occur over the next license term with TMDL implementation. As noted above, periodic monitoring would be useful for determining the effectiveness of a conservation aquaculture or translocation program, if implemented, and the potential benefits of implementing additional protective measures to reduce entrainment or impingement. Given the late maturation and long lifespan of the species, monitoring at 10 year intervals in each reach should be sufficient to document changes in population status and the need for altering management or implementing additional conservation measures.

Given the migratory nature of the species and the results of recent genetic surveys, we conclude that there is a clear basis supporting the benefits of re-establishing gene flow from the lower Columbia River into the currently isolated sturgeon populations in the Snake River. These benefits would include restoring genetic variability to the Snake River populations and development of a robust population that could serve as a donor stock in the event that at catastrophic loss of downstream populations were to occur. Because of its greater exposure to contaminants from upstream sources and from shipping traffic, we consider the population in the lower river to be vulnerable to such a catastrophic loss from the

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[77] Studies of the swimming ability of lake sturgeon conducted by Peake et al. (1997) indicate that sustained swimming speeds at 14°C were approximately 25 and 85 cm per second (0.8 and 2.8 feet per second) for sturgeon 45 and 120 cm (17.8 and 47.2 inches) in length, respectively.

potential influence of disease, chemical spills, or the long-term effects of contaminant exposure. In addition, genetic monitoring would be useful for selecting the appropriate donor stock for a translocation or aquaculture program, and for monitoring the effects of the program on both donor and recipient populations.

3.6.2.14 Sediment Augmentation

Project-related effects on sediment transport may affect fall Chinook habitat by reducing: (1) the availability of gently sloping shorelines that provide favorable conditions for fall Chinook rearing habitat; (2) the availability of suitable gravel for spawning; and (3) turbidity levels during smolt outmigration, which may increase vulnerability to predation. In section 3.4.2.2, *Sediment Augmentation and Monitoring*, we provided a general evaluation of measures recommended by stakeholders to monitor sediment transport processes and to address project effects on sediment supply and transport. In this section, we provide a more detailed evaluation of measures that relate to effects on fall Chinook spawning and rearing habitat.

Our Analysis

Although we conclude in section 3.4.1.2, *Beaches and Terraces*, that the number and volume of sandbars in the upper Hells Canyon reach has been reduced, it is likely that the gently-sloping shorelines that provide favorable fall Chinook salmon rearing habitat were never prevalent in this reach because of its relatively high gradient, confined channel, and powerful hydraulic forces. Therefore, due to the channel characteristics, even restoring sandbar numbers and volume to pre-impoundment conditions would only slightly increase rearing habitat.

Restoring the sandbars to pre-impoundment conditions would require replacing the total volume of fine sediment trapped by the project reservoirs. Even if this could be accomplished, it is not likely to substantially improve rearing habitat. Juvenile fall Chinook salmon produced upstream of the Salmon River would tend to move downstream to seek out and use the more suitable and abundant rearing habitat that is provided in downstream areas. We anticipate that addition of smaller amounts of fine sediment, such as specified by the Forest Service in FS-4, would provide negligible benefits to fall Chinook salmon rearing habitat.

To determine the potential benefits of gravel augmentation, we reviewed recent trends in the abundance and distribution of fall Chinook spawning activity in the Hells Canyon reach to evaluate whether there is a need for additional spawning habitat.

Spawning-size gravel likely comprises a small proportion (on the order of 10 percent of the combined coarse sand and gravel component, or 1 to 2 percent of the total sediment load) that is trapped in project reservoirs each year. In addition, any gravel that is added downstream of Hells Canyon dam is likely to be retained within the Hells Canyon reach for a longer duration than fine sediments. To determine the potential benefits of gravel augmentation, we reviewed recent trends in the abundance and distribution of fall Chinook spawning activity in the Hells Canyon reach to evaluate whether there is a need for additional spawning habitat.

As previously discussed in *Anadromous Fish Spawning*, the number of fall Chinook spawning in the Hells Canyon reach has increased 4- to 5-fold since 1999, and the population may be approaching the capacity of available spawning and rearing habitat. In addition, the proportion of fish that spawn upstream of the Salmon River has been increasing in recent years (table 66), increasing the potential for adverse effects on eggs that are damaged or dislodged due to redd superimposition.

Table 66. Percentage of fall Chinook redds observed in the mainstem Snake River, by reach, 1991 to 2000. (Source: Groves, 2001, as modified by staff)

	Percentage of Redds Observed by Reach		
Year	**Hells Canyon Dam to the Salmon River**	**Salmon River to Grande Ronde**	**Grande Ronde to Lower Granite Reservoir**
1991	37	0	63
1992	34	0	66
1993	15	9	76
1994	55	31	14
1995	46	45	9
1996	50	40	10
1997	42	9	49
1998	74	12	14
1999	78	14	8
2000	66	22	12

In the draft EIS, we recommended that a small-scale pilot gravel augmentation study be implemented to evaluate the potential benefits of gravel augmentation on the quantity of spawning habitat available to fall Chinook salmon. We recommended that the scale and duration of the gravel augmentation pilot study be determined in consultation with state and federal resource agencies and tribes. We indicated that because the operation of Brownlee reservoir for flood control reduces the incidence and magnitude of peak flood events, the addition of as little as 10 percent of the amount of gravel that is trapped in the project reservoirs each year could provide a substantial increase in the amount of spawning gravel that is available to spawning fall Chinook salmon in the upper Hells Canyon reach. We also indicated that the pilot gravel augmentation program would provide an opportunity to evaluate the effects of turbidity on predation losses of outmigrating juvenile fall Chinook salmon.

Most of the comments we received on our recommended pilot gravel augmentation program noted that the quantity of gravel we recommended to be added would not be sufficient to have a noticeable effect. Idaho Power commented that there is no evidence that spawning gravel below Hells Canyon dam is deficient or in need of augmentation, noting that during each year of spawning surveys new spawning areas are being used and some areas that were heavily used in past years see little or no use. In addition, Idaho Power reports that neither it nor the FWS has noted significant superimposition of redds during their weekly aerial and ground surveys of spawning sites. As an alternative, Idaho Power filed a Fall Chinook Spawning and Gravel Monitoring Plan with its draft EIS comments. Idaho Power asks that FERC adopt the Fall Chinook Spawning and Gravel Monitoring Plan. If monitoring indicates that gravel augmentation may be necessary or appropriate, Idaho Power indicates that FERC can then instruct it to develop a plan to address the issue. We discuss the details of Idaho Power's proposed gravel monitoring study in section 3.4.2.2, and we conclude that the Fall Chinook Spawning and Gravel Monitoring Plan proposed by Idaho Power would provide an effective means of determining whether project-related effects on the quantity or quality of fall Chinook spawning habitat are having any adverse effect on the spawning and incubation success of fall Chinook salmon. We note that Idaho Power's proposed Fall Chinook Spawning and Gravel Monitoring Plan would benefit from annual consultation with NMFS, Interior, IDFG, ODFW, and the treaty tribes to report on monitoring results to date, and to guide monitoring efforts in the coming year.

3.6.2.15 Benthic Community Monitoring

The invertebrate community downstream of Hells Canyon dam includes a number of special status mollusk species. In addition, the composition of the aquatic invertebrate, periphyton and macrophyte communities serves as an indicator of water quality conditions, as well as the food resources that are available to native species of fish, including juvenile fall Chinook salmon, bull trout, redband trout, and white sturgeon. Long-term monitoring can be useful for tracking ecological responses to changes in basin conditions and project operations, and the implementation of environmental measures. Idaho Power reported the results of extensive invertebrate surveys in its license application and in its response to AIR AR-2, but does not propose any future monitoring efforts.

AR/IRU and Interior provided several recommendations related to benthic community monitoring. Interior (Interior-70, -71, -72, and -73) recommends several monitoring programs associated with a proposal to evaluate a series of three operational modes that would be maintained for a period of several years or more. The three operational modes would consist of: (1) continued peak-loading operations with a ramping rate of 12-inches-per-hour, measured within 1 mile downstream from Hells Canyon dam; (2) the same operations combined with supplemental enhancement of DO; and (3) if warranted, studying continued DO enhancement with run-of-river operations. Monitoring activities recommended by Interior to assess biological responses to the three modes of operation include: (1) biannual monitoring of benthic invertebrates, with emphasis on the Ephemeroptera, Plecoptera, and Trichoptera (EPT) index and species indicative of poor water quality or frequent disturbance; (2) biannual monitoring of benthic macrophytes and algae, emphasizing taxonomic groups useful in determining water quality; (3) zonal distribution surveys of keystone and sensitive benthic species to evaluate the effects of exposure to repeated dewatering and inundation; and (4) monitoring of known colonies of the Hells Canyon rapids snail and the short-faced limpet.

Interior (Interior-74 and -75) also recommends that Idaho Power establish and monitor experimental populations of Hells Canyon rapids snail and short-faced limpet within 10 miles downstream of Hells Canyon dam, and of western ridged mussels in appropriate habitat. Under Interior's recommendation, monitoring of the experimental populations would be conducted during the three operational test periods and continued, if needed, for the term of the license.

AR/IRU (AR/IRU-14) recommend that Idaho Power employ an adaptive management approach to assess and mitigate project effects to the benthic community in the Snake River within, and downstream of, the project. AR/IRU also recommend that Idaho Power undertake studies, designed by a Technical Advisory Committee, to evaluate the effects of habitat alteration caused by the project on the benthic community. Based on these results, the Technical Advisory Committee would determine what mitigation Idaho Power should undertake. AR/IRU indicate that mitigation could include changes in operation, and alludes to other actions such as replacing fine sediment.

Our Analysis

Although it is clear that the existence of the project reservoirs and changes in the flow regime caused by project operations affect the downstream benthic community, it is difficult to assess the potential benefits of AR/IRU's adaptive management recommendation without knowing what specific measures would be implemented. Some of the measures that could be undertaken to compensate for project effects would have adverse effects on important aquatic species. For example, restoring the historical load of fine sediments to the reach would likely adversely affect the spawning and incubation environment for fall Chinook salmon.

Interior recommends several monitoring efforts in conjunction with a multi-year program to evaluate the effects of DO augmentation and the elimination of flow fluctuations associated with load-following operations. As noted by Interior, continuation of invertebrate monitoring downstream of Hells Canyon dam would be useful to monitor the effects of project operations and environmental measures on

invertebrate production and on populations of rare and sensitive mollusks, and for adaptive management of project operations based on monitoring results. We do not see the benefit, however, to Interior's proposal to establish specific study durations for baseline sampling and for sampling with DO enhancement measures in place and with run-of-river operations. We conclude that a well-designed study program with a year or more of baseline data should be sufficient to document changes in the invertebrate community prior to DO implementation, and we expect that the schedule for implementing DO enhancement measures will be established in the water quality certification. We also conclude that a well-designed monitoring program could assess the effects of load following operations without imposing a multi-year test period of run-of-river operations, by comparing and evaluating species composition and abundance in areas that have been dewatered at different frequencies over a range of hydrologic year-types.

In the draft EIS, we stated that we also saw little benefit in Interior's recommendation that Idaho Power establish experimental populations of Hells Canyon rapids snail, short-faced limpet, and western ridged mussel downstream of Hells Canyon dam because a wide range of variables could affect the success or failure of an experimental population. However, if water quality conditions improve to a point where habitat may support a species that is thought to have been extirpated, the monitoring program could include provision for attempts to re-establish the species in the rehabilitated habitat.

3.6.2.16 Effects of Other Measures on Aquatic Resources

Below, we discuss the effects that measures developed to address other resources would also have on aquatic resources.

Terrestrial Resource Measures

In sections 3.7.2.2 through 3.7.2.8, we discuss the effects that proposed and recommended terrestrial resource measures would have on plants and wildlife. As discussed in section 3.5.2.7, *Effects of Other Measures on Water Quality*, increasing the extent of woody plants and other riparian plants along the shoreline of the project reservoirs, Snake River, and islands in the Snake River would likely result in a slight reduction in water temperatures in and around shaded areas along the shoreline. This thermal effect is expected to be so small and localized that it would have negligible effects on fish and other aquatic organisms. However, restoring riparian vegetation would increase the available amount of cover in shoreline areas and, thereby, reduce predation on fish. Riparian enhancement measures would not involve any instream work, so no direct adverse effects on aquatic species are expected.

Recreation Measures

In section 3.10.2.3, *Recreation Site Improvements*, we discuss the effects that proposed and recommended recreation facility improvement measures (table 86) would have on recreation. As discussed in 3.5.2.7, *Effects of Other Measures on Water Quality*, improving boat launches and removing sediment buildup around docks and in-reservoir pumps would likely increase turbidity and resuspend sediments and any contaminants associated with them into the water column. Implementation of appropriate BMPs for these activities would limit the extent and duration of these adverse water quality effects, thereby limiting any adverse effects on fish, other aquatic organisms, and piscivorous wildlife to minimal levels.

3.6.3 Cumulative Effects

In this section we address cumulative effects on Pacific lamprey, redband trout, and white sturgeon. We address cumulative effects on listed anadromous salmonids and bull trout in section 3.8.3.

3.6.3.1 Pacific Lamprey

The distribution and abundance of juvenile Pacific lamprey in the Snake and Columbia River basins has been severely reduced due to impacts associated with hydropower development. The construction of numerous dams on tributaries has reduced the amount of habitat that is accessible for the freshwater spawning and rearing lifestages. Construction of the Hells Canyon Project blocked access to habitat upstream of Hells Canyon dam, contributing to a cumulative loss of accessible habitat. Although Pacific lamprey primarily spawn and rear in tributary streams, the project-related reduction in the delivery of fine sediments to the reach likely reduced the quantity and quality of potential habitat for Pacific lamprey in the mainstem Snake River downstream of Hells Canyon dam.

The number of lamprey that ascend above Lower Granite dam has declined to very low levels due to poor passage conditions at downstream dams on the Lower Columbia and Snake rivers. Pacific lamprey are poor swimmers, and adults tend to have difficulty migrating upstream through fish ladders; passage rates as low as 50 percent have been reported in recent studies at Bonneville dam (Close and Bronson, 2001, as cited in Groves et al., 2001). As a result of low numbers ascending past Lower Granite dam, it is unlikely that blocked access to habitat upstream of Hells Canyon dam affects the population size of lamprey because the tributaries to the Hells Canyon reach provide sufficient habitat to accommodate the current number of adult returns.

3.6.3.2 Redband Trout and White Sturgeon

The settlement and development of the Snake and Columbia River basins caused substantial adverse cumulative effects to resident fish species, including redband trout and white sturgeon. Habitat losses in the Snake River basin began primarily with placer mining, which took place throughout the basin, followed by development of the basin for agricultural production, timber harvest, and livestock production. Construction of numerous additional tributary dams and agricultural development of the basin reduced the recruitment of spawning gravel to historical redband trout habitats, altered river flows, and adversely affected water quality by increasing water temperatures and nutrient loads, reducing DO, and introducing pesticides. Construction of additional mainstem dams on the Snake and Columbia rivers, including eight mainstem dams downstream of Shoshone Falls that are owned by Idaho Power, substantially restricted the ability of white sturgeon and redband trout to migrate throughout the river system to access available habitats. Dam construction has also greatly reduced the availability of anadromous fish as a food source for white sturgeon downstream of Hells Canyon dam, and has eliminated this food source upstream of Hells Canyon dam. Thus, the population in many of the reaches between dams has been greatly diminished. Impediments to fish movement from project reservoirs and dams contribute to a cumulative loss of connectivity among populations of redband trout and white sturgeon in the project area.

Under Idaho Power's proposal, the sturgeon population in the Swan Falls to Brownlee reach would be increased by translocating sturgeon from a donor population, if water quality conditions are found to be suitable to allow reproduction. Alternatively, a conservation aquaculture program would be implemented if water quality conditions are found to limit reproduction. We also evaluate the concept of a conservation aquaculture program that would be used to augment sturgeon populations in the project reservoirs, as well as the Swan Falls reach. The conservation aquaculture program would be designed to ensure that population sizes are rebuilt to robust levels, that gene flow from downstream populations is restored, and that genetic variability is enhanced, thus, addressing the primary adverse effects associated with a loss of connectivity.

Under Idaho Power's proposal, upstream connectivity over Hells Canyon dam would be restored for redband trout. Also, installation of a permanent monitoring weir at Pine Creek would allow outmigrating trout to be transported past Hells Canyon dam without being exposed to the risk of turbine mortality. A second phase, which would occur at least 5 years later, would involve construction of a trap

at Oxbow dam to provide upstream passage into the Wildhorse River. Idaho Power's proposal, however, would not provide a safe means of downstream passage for redband trout that emigrate from the Wildhorse River or from Indian Creek. Under Interior's preliminary fishway prescription and Idaho Power's alternative prescription, downstream passage would be provided from each tributary when tributary traps are installed, although these would be contingent upon meeting trigger criteria that would be identified in a bull trout passage plan.

Under any of the action alternatives, TDG levels are expected to exceed state standards when spills at the project exceed approximately 30,000 cfs, which has the potential to cause injury to redband trout that migrate from tributaries into the Snake River downstream of Hells Canyon dam. However, installation of spillway flow deflectors at Hells Canyon dam as proposed by Idaho Power, and at Brownlee dam under the Staff Alternative, would reduce the project's contribution to high TDG levels under most spill conditions.

The Hells Canyon Project contributes to the occurrence of low DO levels and elevated water temperatures in the late summer and early fall, which may adversely affect habitat conditions for redband trout downstream of Hells Canyon dam, although many redband trout probably move into tributaries prior to the onset of project-related increases in water temperature and reductions in DO. Developing and implementing a DO supplementation plan would reduce adverse effects from low DO levels downstream of Hells Canyon dam. During the spring and summer months, delayed warming caused by the project likely improves habitat conditions for redband trout downstream of Hells Canyon dam.

Ramping of flows associated with load following operation of the project may adversely affect redband trout rearing in the mainstem of the Snake River by adversely affecting the availability of invertebrates and forage fish, and through direct mortality from stranding. A stranding and entrapment management plan and an invertebrate monitoring plan could be used to evaluate, and if needed, develop and implement, approaches to protect and enhance rearing conditions for aquatic species.

3.6.4 Unavoidable Adverse Effects

The project reservoirs would continue to block sturgeon and anadromous fish from migrating through the project reach of the Snake River, and would continue to cause mortality to some sturgeon and redband trout that are entrained through the project turbines. The suitability of fish habitat in Brownlee reservoir would continue to be adversely affected by low DO levels, and fish habitat downstream of Hells Canyon dam would continue to be affected by gas supersaturation when spills exceed approximately 30,000 cfs.

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3.7 TERRESTRIAL RESOURCES

3.7.1 Affected Environment

3.7.1.1 Terrestrial Habitat Conditions

Idaho Power conducted terrestrial resource studies along 163 miles of the Snake River from Weiser, Idaho, to the confluence of the Snake and Salmon rivers near Lewiston. The study area included five study reaches: from the Weiser Bridge to Brownlee reservoir (about 12 miles); Brownlee reservoir, including the Powder River arm (about 55 miles); Oxbow reservoir (about 12 miles); Hells Canyon reservoir (about 25 miles); and the Snake River downstream of Hells Canyon dam (about 59 miles). The width of the study area varied, depending on specific study goals and objectives. For the vegetation studies, Idaho Power delineated cover types within 0.5 mile of the river and reservoir shorelines above Hells Canyon dam, and within 0.25 mile of the shoreline downstream of Hells Canyon dam (Holmstead, 2003a). This study area encompasses land and water within the FERC project boundary, and provides a larger ecological context for terrestrial resources.

Idaho Power found that upland vegetation is prevalent in the study area, with grasslands comprising a little over 35 percent and shrub cover types comprising almost 29 percent of the area. Forest, open woodland, and herbaceous cover types dominated by forbs or by very sparse forbs and grasses account for less than 2 percent of the study area. Riparian vegetation is also limited, comprising less than 5 percent of the study area.

Idaho Power mapped lands that do not support vegetation, such as cliffs, talus slopes, barren land, lentic (open water), and lotic (flowing water) cover types, as natural features. These natural features, including the Snake River and project reservoirs, account for about 22 percent of the study area.

Lands that were not classified based on vegetation or other habitat characteristics were mapped according to their land use. These cover types (which represent about 7 percent of the study area) include lands managed for agriculture, grazing, orchards, parks and recreation, residences, and project facilities.

Below, we summarize the major characteristics of upland and riparian habitat found in each of the five project reaches. We also summarize the characteristics of habitat found along the Pine Creek-Hells Canyon transmission line (#945).

Weiser Reach

The topography upstream of Brownlee reservoir is relatively gentle, the river gradient is low, and several island complexes are present. Agriculture is the predominant land use, and grassland is the predominant upland vegetation cover type. Bluebunch wheatgrass is the prevalent species in grasslands, but introduced annual grasses, such as cheatgrass, are also common.

Riparian habitat is more abundant in this reach than farther downstream because of the wider floodplain, lower gradient, finer soils and sediments, and higher rainfall. Riparian vegetation is primarily scrub-shrub wetland, with patches of forested and emergent wetlands. The most common trees and shrubs in these areas are introduced species (e.g., box elder, silver maple, American elm, green ash, false indigo, and tamarisk), but some native shrubs, such as peachleaf willow, coyote willow, and Wood's rose, are also present.

Brownlee Reservoir Reach

The topography is steeper around Brownlee reservoir, with large rock outcrops. Land is used primarily for agriculture and grazing, and grasslands and shrub savanna are the most abundant cover types. The most common grassland species are bluebunch wheatgrass, cheatgrass, and medusahead.

Cheatgrass is abundant, and medusahead is prevalent along the main pool. Big sage and gray rabbitbrush are the most common shrubs.

The transition between uplands and the reservoir pool is abrupt along most of the shoreline, and there is little riparian vegetation except at the upper end of the reservoir and at the mouths of tributary streams. These patches of riparian habitat support willows, water birch, white alder, black cottonwood, and mock-orange.

Shore and bottomland wetlands account for most of the riparian vegetation in the Powder River arm of Brownlee reservoir. Weedy annual species, such as common cocklebur, purslane, pigweed, and barnyard grass, colonize extensive areas of the shoreline that are exposed during drawdown periods.

Oxbow Reservoir Reach

The topography around Oxbow reservoir is steeper than it is around Brownlee reservoir, with talus slopes and basalt outcrops dominating the shoreline. About 124 acres are developed as parks, project facilities, and residences, but no land is used for agriculture, and very little for grazing. Upland vegetation is about evenly divided between grasslands and shrub savanna. Grassland plant assemblages are similar to those found along Brownlee reservoir, but shrub savanna includes more netleaf hackberry and more bitterbrush. Other upland shrubs include serviceberry and bitter cherry. A few small forested stands are present, characterized by Douglas fir or ponderosa pine with an understory of snowberry, ninebark, or both.

The most common riparian vegetation cover type along Oxbow reservoir is scrub-shrub wetlands, which occur in a narrow, patchy band around the reservoir and at the mouths of tributary streams. The most common plants in these wetlands are water birch, white alder, mock-orange, poison ivy, netleaf hackberry and black hawthorn.

Hells Canyon Reservoir Reach

Talus slopes and basalt outcrops also dominate the shoreline of Hells Canyon reservoir. Topography is very steep. No land is used for agriculture or grazing. Parks and recreation facilities occupy about 55.6 acres, while project facilities and residences account for about 83.7 acres. Shrub savanna, shrubland, and grassland characterize most of the landscape. In the shrub cover types, the most abundant species are netleaf hackberry and bitterbrush. Bluebunch wheatgrass is most common in grassland cover types.

Riparian vegetation comprises scrub-shrub wetlands but also includes small areas of forested wetlands. Scrub-shrub wetlands include the same species found at Oxbow reservoir. In addition to its presence in many scrub-shrub wetlands, netleaf hackberry is an important component of forested wetland cover types at Hells Canyon reservoir.

Snake River Downstream of Hells Canyon Dam

Downstream of Hells Canyon dam, the Snake River flows through a deep, narrow canyon confined by bedrock walls and steep cliffs. Because of both topography and ownership patterns, very little of this reach (less than 1 percent) is developed or disturbed.

Upland habitats are mostly grasslands dominated by bluebunch wheatgrass, with occasional stands of ponderosa pine. The netleaf hackberry/poison ivy plant assemblage characterizes many of the forested and scrub-shrub riparian habitats. Water birch, white alder, and mock-orange are also common. Idaho Power documented coyote willow at a few sites.

Netleaf hackberry dominates areas that were cover typed as shore and bottomland wetlands, as well as being the dominant in scrub-shrub and forested wetlands. In these settings, netleaf hackberry

grows in cobbly substrate, with little, if any, herbaceous cover. Eaton's aster, a native forb, is prevalent at several other shore and bottomland wetland sites.

Transmission Line Right-of-Way

The 19-mile-long Pine Creek-Hells Canyon transmission line runs along a paved road from a substation at Oxbow dam to Hells Canyon dam. Most of the area occupied by the right-of-way is located on public land in either federal or state jurisdiction and is mapped as disturbed habitat (Dumas et al., 2003a). Where the right-of-way leaves the road, it passes through a mosaic of grasslands, big sage, riparian scrub-shrub, ponderosa pine forest, rock, and reservoir cover types. The right-of-way crosses several small drainages; the larger drainages include Allison, Eckels, and Kinney creeks. Small amounts of riparian forest are mapped at these crossings.

3.7.1.2 Special Status Plants and Plant Communities

Idaho Power conducted rare plant surveys within approximately 150 feet of the Snake River or each reservoir shoreline from Weiser to the confluence with the Salmon River (Krichbaum, 2000). Using a sub-sampling approach, botanists surveyed a 0.25-mile segment of each river mile in the study area, recording 47 occurrences of 6 rare plant species (Krichbaum, 2000). These include Oregon bolandra, Schweinitz flatsedge, porcupine sedge, Hazel's prickly phlox, stalk-leaved monkey flower, and American wood sage. Biologists observed three other rare plants (Back's sedge, shining flatsedge, and bartonberry) during general vegetation surveys, but these locations were upslope in tributary drainages, where project operations would not affect plants. Only one species—bartonberry—was documented during surveys of the transmission line and service roads (Dumas et al., 2003a). Dumas et al. (2003a) and Krichbaum (2000) indicate the species that were observed and their federal, state, and Natural Heritage Program status.

During each of the surveys, Idaho Power evaluated the occurrence of rare plant populations in relation to project features and project-related activities. Along the river corridor, Idaho Power recorded the elevation of the plant population above the mean high water mark (MHWM) in 6-inch increments, or height-classes.

Oregon bolandra is a perennial forb in the saxifrage family, producing small, purplish-brown flowers from May through June. Bolandra grows in wet, rocky habitats in the Snake River Canyon and the Columbia River Gorge, along the Imnaha-Snake Divide, and along the lower Willamette River in Oregon. Surveyors observed eight populations of bolandra in the study area. Four were observed downstream of Hells Canyon dam, one in the Hells Canyon reservoir reach, and three in the Oxbow reservoir reach. Two of the eight sites came to within seven and nine height-classes of the MHWM, but most began above the 20-height-class mark and all sites extended beyond this elevation. The lateral distance from the river varied. Six populations were located 80 feet or more from the MHWM. The other two were located within approximately 30 feet of the MHWM.

Porcupine sedge is a rhizomatous perennial sedge found in wet riparian habitats. Surveyors located 10 populations of porcupine sedge in the study area. Three were observed downstream of Hells Canyon dam, and seven were observed in the Oxbow reservoir reach. Generally, these species were found growing in wet, fine to cobbly silt loam soils on low to moderate slopes. Four populations were situated below the MHWM. The other six populations were located along tributary drainages, 90 feet or more in lateral distances above the MHWM, and well above the 20-height-class elevation. Two of the tributary populations extended onto steeper slopes, including one population that contained plants growing in bedrock at the base of a waterfall.

Schweinitz flatsedge is a rhizomatous perennial sedge. Surveyors observed 21 populations of this species growing in upland shrub savanna communities dominated by netleaf hackberry, mixed grasses,

and weedy forbs on gentle to moderate slopes. Soils at each site consisted of dry, coarse, sandy loam soils. At three sites, populations extended below the MHWM of the Snake River into the flow zone.

Hazel's prickly phlox is a dwarf perennial shrub that is endemic to dry rock outcrops and talus habitats along the Snake River and lower Salmon River. Surveyors located six populations on cliffs above the MHWM, where 75 to 90 percent of the surrounding area consisted of bare rock. At three of the six sites, plants were located at least two height-classes above the MHWM. At the other three sites, plants were located at least 20 height-classes above the MHWM.

Surveyors observed one population downstream of Hells Canyon dam at Pleasant Valley Rapids and five populations in the Hells Canyon reservoir reach, scattered over a distance of about 2 miles along both shores of the reservoir from just south of Thirty-two Point Creek to just south of Squaw Creek.

Stalk-leaved monkey-flower is an annual forb that produces small yellow flowers from May through August. This species grows in damp soils, wet cliffs, and road cuts from the east slope of the Cascades in Oregon to the Snake River Canyon in Idaho.

Surveyors observed one population of stalk-leaved monkey-flower in the Oxbow reservoir reach, in a road cut along State Route 71. Surveyors observed an estimated 50 individuals scattered within an area of about 100 square feet of gently sloping, damp rocky ground. Most of the site is bare soil and rocks, with scattered weedy grasses and forbs. About 3 miles north of this population, there are four previously known occurrences.

American wood sage is a rhizomatous perennial of the mint family. Spikes of purplish flowers bloom from June through August. One population of this plant was found on the Oregon side of the river downstream of Hells Canyon dam, about 1,000 feet south of Temperance Creek, where 14 individuals are scattered within an area of about 65 square feet. This occurrence was observed on a gently sloping, moist, rocky site along the shoreline. Plants spanned the MHWM, from one height-class above to five height-classes below.

Back's sedge is a small tufted sedge that grows from lowlands to mid-montane elevations. In the Wallowa Mountains, it is found in uplands, growing on steep southerly aspects in open ponderosa pine savanna. In the project area, surveyors observed Back's sedge in one shrubland site and in one scrub-shrub wetland.

Shining flatsedge species is a grass-like, tuft-forming annual that occurs in wet, often gravelly shores of rivers, lakes and ponds at relatively low elevations. Surveys in the 1990s along the Payette, Boise, and Snake rivers indicated the species was more common than previously thought. During the general vegetation surveys project, surveyors observed shining flatsedge at three different wetland sites, including one scrub-shrub wetland, one emergent wetland, and one shore and bottomland wetland type.

Bartonberry is endemic to Hells Canyon, known only from Adams and Idaho counties in Idaho and Wallowa County, Oregon. It occurs in riparian communities along small to moderate-sized streams, and in rockslides along lower canyon slopes (Moseley, 1989). Idaho Power surveyors observed this species growing in two forested wetlands and one scrub-shrub wetland.

Bartonberry was the only rare plant species documented during surveys of the transmission line and service road rights-of-way. Ten populations were observed within the Payette National Forest along the Pine Creek-Hells Canyon transmission line.

Based on information provided by FWS, three federally listed plant species (MacFarlane's four-o'clock, Howell's spectacular thelypody, and Spalding's catchfly) may occur in the project area (letter from J.L. Foss, Supervisor, Snake River Fish and Wildlife Office, Boise, ID, to the Commission, dated November 28, 2005). We discuss these three plants in section 3.8, *Threatened and Endangered Species*.

3.7.1.3 Plants of Cultural Importance

Many of the plants found in the project area are important to Native American tribes in the region (Reed-Jerofke, 1999; Whipple, 2001; Nez Perce, 2006; Burns Paiute, 2006; Shoshone-Bannock, 2006). Plants provided food, medicine, and materials for clothing, baskets, tools, decoration, and ceremony. Plants are still an important part of any traditional menu, and many elders continue to use plants, such as juniper and lomatium species, for their medicinal benefits. Examples of other important plants include upland species, such as sagebrush and rabbitbrush; riparian shrub species, such as red osier dogwood and coyote willow; and wetland plants, such as cattail, tule, and nettles. The Nez Perce gathered pine nuts, sunflower seeds, and black moss for food, as well as bitterroot, wild carrot, wild potato, other roots, chokecherries, currants, and a wide variety of berries. The Shoshone-Bannock Tribes used roots and berries extensively during the winter.

3.7.1.4 Noxious Weeds and Invasive Exotic Plants

Idaho Power conducted surveys for noxious weeds and invasive weedy plant species concurrently with surveys for rare plants, using the same sub-sampling approach to cover the study area (Krichbaum, 2000). Botanists observed 1,905 separate weed populations and found that 98 percent of the survey units contained at least one weed population. The number of weed species per unit varied from 0 to 14.

The most abundant upland weeds were medusahead, common St. John's wort, Scotch thistle, and whitetop. The most abundant riparian weeds were perennial pepperweed, poison hemlock, tamarisk, and reed canarygrass.

The survey results showed the highest densities of weeds are present in the Weiser reach, where 70 percent of the survey units contained weeds. In this reach, the most common species were associated with riparian habitats, and included poison hemlock, perennial pepperweed, Scotch thistle and Canada thistle.

Weeds were present in 45 percent of the survey units in the Brownlee reservoir reach. False indigo, Scotch thistle, field morning glory, and perennial pepperweed were most abundant.

Weeds were present in about 30 percent of the survey units in both the Oxbow and Hells Canyon reservoir reaches. In the Oxbow reservoir reach, the most common species were houndstongue, false indigo, medusahead, Scotch thistle, and perennial pepperweed. Results in the Hells Canyon reservoir reach were similar, although puncturevine was one of the most common species, while false indigo was not as abundant.

Downstream of Hells Canyon dam, surveyors found weeds in only 10 percent of the survey units. The most common species were common St. John's wort, houndstongue, Scotch thistle, and field morning glory. Surveyors observed very few riparian-associated weeds.

In addition to surveying the Snake River corridor, Idaho Power conducted weed surveys along the Pine Creek-Hells Canyon transmission line (Dumas et al., 2003a). Surveyors documented weeds in about 88 percent of the survey units. Surveyors documented a total of 144 occurrences of eight noxious weed species. The most common weed was puncturevine, which surveyors found in 72 percent of the survey units. Scotch thistle was found in over half the survey units, and Dalmatian toadflax, whitetop, poison hemlock, field morning glory, and diffuse knapweed were also common. Canada thistle was present, but in only two of the survey units.

3.7.1.5 Key Wildlife Species

Idaho Power conducted a number of studies to identify wildlife species in the project area and to evaluate their relative abundance, distribution, and habitat associations. Below, we briefly summarize the

findings of the studies to highlight species that are representative of habitats in the project area, or those that are especially important in terms of their ecological role or cultural or recreational values.

Mammals

Big Game

Idaho Power conducted detailed studies of mule deer and found that the project vicinity provides one of the most important winter ranges for mule deer in eastern Oregon and western Idaho (Christensen, 2003; Edelmann et al., 2003a; Edelmann, 2003). Most of the suitable winter habitat is located adjacent to Brownlee and Oxbow reservoirs. About 74 percent of the deer that occupy winter range in the project vicinity migrate to summer range in and around the Wallowa Mountains of Oregon and the Cuddy and Sturgill mountains in Idaho. Only about 25 percent of the deer are year-round inhabitants.

Idaho Power biologists counted a total of 10,864 mule deer in the survey area between Weiser and Hells Canyon dam in 1998, with even higher numbers in 2000 and 2001, when mule deer counts totaled 13,979 and 14,496, respectively (Edelmann et al., 2003a). Numbers of elk that winter in the project vicinity are difficult to estimate because data come from a variety of sources. Idaho Power reports that survey data for recent years indicate that elk populations on the Oregon side have been stable and that numbers of elk on the Idaho side are in the range of 1,400 to 2,329 animals. Like mule deer, elk numbers are expected to vary considerably from year to year, depending to a great extent on winter conditions (Edelmann, 2003).

The project area also supports mountain goats (Edelmann and Rocklage, 2003). Mountain goats are native to the Idaho side of Hells Canyon, and possibly to the Oregon side, as well. They were extirpated by the mid-1930s and reintroduced in the early 1960s into the Seven Devils Mountains in Idaho. Mountain goats are occasionally observed near the Hells Canyon reservoir and along the Snake River downstream of Hells Canyon dam during winter and spring, but surveyors observed most goats at high elevations, outside the project boundary. Based on recent habitat mapping, almost 100 percent of the currently occupied and potential habitat for this species is located on National Forest System lands. Idaho Power counted 117 goats during surveys in 1996 (Edelmann and Rocklage, 2003). Compared to numbers counted in 1993, Idaho Power suggests there may have been as much as a 30 percent decline in the 3-year period.

Bighorn sheep are also native to the region but were extirpated by about 1945 (Ratti and Lucia, 1998). The first reintroductions occurred in 1971, with several other transplants between 1971 and 1995. Fourteen herds now occupy the area around Hells Canyon, with an average herd size of 50 animals. Seven disease die-offs have been linked to transmission of disease from domestic sheep and feral goats.

Habitat for this species consists of steep slopes with good visibility, proximity to open water, and winter range relatively free of snow. About 68 percent of the suitable habitat for bighorn sheep in the project area is located on federal or other public lands.

Carnivores and Furbearers

Idaho Power conducted surveys for carnivores and furbearers along Brownlee, Oxbow, and Hells Canyon reservoirs (Edelmann and Pope, 2003). Using scent stations, it documented the occurrence of red fox, black bear, common raccoon, bobcat, weasel, and skunk. Surveyors observed coyote, bobcat, and raccoon throughout the study area. Idaho Power also observed red fox, black bear, long-tailed weasel, striped skunk, mountain lion, northern river otter, American badger, American beaver, and mink.

Small and Medium-sized Mammals

During focused surveys, Idaho Power trapped eight species of small mammals (Eshelman, 2003). The most common were deer mouse, montane vole, western harvest mouse, and vagrant shrew. Common medium-sized mammals in the project area are red squirrel and mountain cottontail. Small and medium-sized mammals are important as part of the prey base for larger mammals, raptors, and snakes (Holthuijzen, 2003a; Turley and Holthuijzen, 2003a).

Bats

Hells Canyon provides high-quality habitat for bats because of its low elevation; abundance of cliffs, caves, and mines; year-round open water in the river and reservoirs; and the variety of vegetation cover types (Anderson, 1998). Through a cooperative effort with the Forest Service, Idaho Power compiled the results of a number of surveys that had been conducted over the years, finding that 10 species of bats have been recorded from 46 sites in the vicinity and that 3 others have been recorded from nearby uplands. Based on their range and distribution, two other species may also be present.

Birds

During focused surveys and incidental to general field surveys, Idaho Power documented the occurrence of 223 bird species (Turley and Holthuijzen, 2003b). In summer, lazuli bunting, spotted towhee, black-capped chickadee, and western meadowlark were most common. In winter, dark-eyed junco, black-capped chickadee, and horned lark were most common. Neotropical migrants (e.g., yellow warbler and willow flycatcher) represented about half the total bird density in each cover type during spring and summer.

In addition to conducting point counts, Idaho Power conducted focused surveys to evaluate upland game birds, migrant shorebirds, waterfowl, colonial nesting waterbirds, and raptors. These species groups are described below.

Upland Game Birds

The upland game bird community includes both native and introduced species (Turley and Edelmann, 2003; Ratti and Guidice, 2003). The most common native is the mourning dove. California quail, chukar, gray partridge, wild turkey, and ring-necked pheasant were introduced to provide huntable populations, and surveyors frequently observed these species (except wild turkey) during field surveys (Turley and Edelmann, 2003). Surveyors also observed ruffed grouse and blue grouse. The most important species, in terms of recreation and economic value, is the chukar. Chukar and gray partridge are also important in providing a prey base for golden eagle, great horned owl and coyote.

Surveyors found no mountain quail in the study area, despite reports of its occurrence in the vicinity and the presence of habitat that appears suitable, based on GIS modeling (Rocklage and Edelmann, 2003a). The mountain quail is associated with open forests and woodlands where there is abundant brushy vegetation in the understory and in forest openings. It also occurs in riparian woodland, meadow edges, and brushy regeneration following fire and timber harvest.

Migrant Shorebirds

Seasonal drawdown of Brownlee reservoir exposes barren, sediment-rich mudflats that offer foraging opportunities for a variety of migrant shorebirds (Turley and Holthuijzen, 2003c). Killdeer were the most commonly observed species, followed by several species of sandpiper. The location of the project area outside any major flyway may explain the relatively low level of use the mudflats receive. Migration timing in relation to drawdown timing may also influence the level of use (i.e., the mudflats may not be exposed during peak migration periods).

Waterfowl

Seven species of waterfowl are known or suspected to nest in the area: Canada goose, mallard, northern pintail, American wigeon, green-winged teal, common merganser, and wood duck (Rocklage et al., 2003a). The Canada goose is by far the most common species, followed by mallard.

The most important areas for waterfowl production are located at the west end of the Powder River arm and between Weiser and Farewell Bend. Islands between Weiser and Farewell Bend are of particular importance. Lower Brownlee, Oxbow, and Hells Canyon reservoirs have steep slopes, rocky shorelines, and swift water that do not provide suitable habitat for breeding waterfowl.

The most important areas for wintering waterfowl are also located at the upper end of the project area, in the unimpounded reach above Farewell Bend and in the Powder River arm, with numbers per mile declining in a downstream direction (Holthuijzen, 2003b). During winter surveys, Idaho Power found that the most common species were mallard, goldeneye (both common and Barrow's goldeneye), common merganser, Canada goose, and bufflehead. Compared to other large reservoirs and wetland complexes to the southeast along the Snake River that are located within a mapped flyway, the project area receives very little use. In its comments on the draft EIS, Interior identified two more important habitats upstream from the Hells Canyon Project area: Deer Flat National Wildlife Refuge and Fort Boise Wildlife Management Area. The Deer Flat National Wildlife Refuge averages more than 5,000 shorebirds during migration (National Audubon Society, 2004), while surveys of Brownlee reservoir totaled less than 100 shorebirds per survey (Turley and Holthuijzen, 2003c). The Deer Flat National Wildlife Refuge also provides nesting habitat for several species of waterfowl, wading birds, and shorebirds during spring and summer. The Fort Boise Wildlife Management Area includes Gold Island, which was purchased by Idaho Power in 1959 and transferred to the State of Idaho as mitigation for the effects of Brownlee reservoir on goose nesting habitat. IDFG purchased adjacent lands, and the Wildlife Management Area now totals more than 1,600 acres, which provide nesting habitat for both waterfowl and upland birds (IDFG, 2007). The Fort Boise Wildlife Management Area also supports a very high diversity of waterfowl, wading birds and shorebirds during spring and fall migrations.

Colonial Nesting Waterbirds

Idaho Power conducted surveys to evaluate waterbird nesting colonies that might be present in the project area (Pope, 2003). Surveyors found three nesting species (great blue heron, double-crested cormorant, and black-crowned night-heron) at two colonies. Surveyors observed only great blue heron nesting at a colony along the upper Powder River arm. In 1998, this colony supported 16 nests. Peep Island, located above Brownlee reservoir, supported nesting by double-crested cormorant (43 nests) and black-crowned night-heron (5 nests), in addition to great blue heron (4 nests).

Raptors

Idaho Power conducted surveys to evaluate the raptor community in the project area, and found the golden eagle to be the most abundant nesting raptor, with 11 active territories (Pope and Holthuijzen, 2003). Biologists documented nesting territories of several other raptors, as well, including red-tailed hawk, prairie falcon, American kestrel, and peregrine falcon. Additionally, surveyors observed five territories occupied by common ravens, which are sometimes grouped along with raptors. Biologists observed Cooper's hawks, but did not confirm nesting by this species.

Idaho Power conducted a separate study to evaluate peregrine falcon occurrence in Hells Canyon (Akenson, 2000). Surveys documented one eyrie on a cliff in the Hells Canyon Creek drainage, almost 0.5 mile west of the Hells Canyon boat launch. The eyrie was located at about 3,900 feet in elevation (Akenson, 2000), more than 2,000 feet above the reservoir. The nest fledged one young in 1996. Occupancy behavior (copulation, prey delivery, patrolling the territory) was observed during surveys

between 1997 and 2000, indicating that the site was active in all four years, but biologists could not confirm nesting success.

Biologists documented five owl species in the project area: great horned owl, common barn owl, western screech-owl, long-eared owl, and burrowing owl. Biologists documented nesting by burrowing owls near Brownlee reservoir.

Reptiles and Amphibians

Idaho Power conducted trapping surveys for reptiles, capturing 10 species and documenting the presence of 4 others (Beck et al., 2003). The most common species it observed included racer, gopher snake, western whiptail, western rattlesnake, and night snake.

During amphibian surveys, biologists found western toads at 24 sites, long-toed salamanders at 22 sites, Pacific tree frogs at 21 sites, bullfrogs at 6 sites, spadefoot toads at 2 sites, and Columbia spotted frogs at 1 site (Beck et al., 2003). Western toads, long-toed salamanders, and Pacific tree frogs were common throughout project-area wetlands, but bullfrogs, spadefoot toads, and Columbia spotted frogs were observed only in the southern portion of Brownlee reservoir.

All of the wildlife species described above may be valuable cultural resources for Native American tribes in the region (refer to section 3.9.1.5, *Traditional Cultural Properties, Sacred Sites, and Rock Art*).

3.7.1.6 Special Status Wildlife Species

In consultation with the agencies and tribes, Idaho Power developed a list of more than 100 special status wildlife species that are known to occur or may be present in the project area (Turley and Holthuijzen, 2003d). The list includes species that federal or state agencies have listed as threatened, endangered, proposed or candidates for listing, and those that have been designated as sensitive, rare or in need of special management. FWS indicated that four federally listed wildlife species (gray wolf, Canada lynx, Northern Idaho ground squirrel and bald eagle) may occur in the project area and should be addressed (letter from J.L. Foss, Field Supervisor, Snake River Fish and Wildlife Office, Boise, ID, to the Commission, dated November 28, 2005). We present additional information about these species in section 3.8, *Threatened and Endangered Species*.

To focus Idaho Power's evaluation of potential project effects (table 67), the parties narrowed the initial list of special status species to 34 species during further consultation. In addition to listed, proposed, and candidate species, the species were grouped roughly according to guild or use of habitat. Table 67 summarizes their occurrence in the project area, based on Idaho Power's surveys, or the likelihood of occurrence, based on their range and habitat associations.

Table 67. Special status species and species groups used to focus evaluations of project effects. (Sources: Idaho Power, 2003a; Rocklage et al., 2003b; Turley et al., 2003; Anderson, 1998; Edelmann and Copeland, 1999; Turley and Holthuijzen, 2003d; Csuti et al., 1997; Hemker, 2004; DAI, 2005; FWS, 2005a,b,c; Reynolds and Hinckley, 2005; TNC, 1999; ONHIC, 2004; IDFG, 2005a,b,c, as modified by staff)

Species or Species Group	Likelihood of Occurrence in Project Area
Threatened, Endangered and Candidate Species	
Bald eagle (*Haliaeetus leucocephalus*)	Documented: Nests known near Hells Canyon and Oxbow reservoirs; wintering concentrations at Oxbow reservoir and Powder River arm.
Peregrine falcon (*Falco peregrinus*)	Documented: Eyrie near Hells Canyon dam active in 1996; pairs observed 1997–1999.

Species or Species Group	Likelihood of Occurrence in Project Area
Yellow-billed cuckoo (*Coccyzus americanus*)	Low: Associated with mature cottonwood stands and dense understory. In Idaho, most historical records and current observations are from upper Snake River basin, but recently documented in Malheur County, Oregon.
Gray wolf (*Canis lupus*)	Documented sightings east side of Hells Canyon reservoir and near headwaters of Wildhorse River, a tributary to Oxbow reservoir.
Canada lynx (*Lynx canadensis*)	Low: One unconfirmed sighting on Idaho side of Snake River downstream of confluence with Salmon River.
Northern Idaho ground squirrel (*Spermophilus brunneus brunneus*)	Documented near Barber Flat.
Southern Idaho ground squirrel (*Spermophilus brunneus endemicus*)	Documented at Cobb Rapids and Corral.
Columbia spotted frog (*Rana luteiventris*)	Documented in Powder River arm.
Upland Species	
Greater sage grouse (*Centrocercus urophasianus)*	Documented incidentally at several locations adjacent to south end of Brownlee reservoir and near Powder River arm.
Columbian sharp-tailed grouse (*Tympanuchus phasianellus*)	Documented: Rare observations in spring near Brownlee reservoir.
Loggerhead shrike (*Lanius ludovicianus*)	Documented at all three reservoirs during spring, summer, and fall; not observed above Brownlee or below Hells Canyon dam.
Sage sparrow (*Amphispiza belli*)	Moderate: Strongly associated with sagebrush and native grasslands; declines in Idaho and Oregon may be due to habitat fragmentation.
Brewer's sparrow (*Spizella breweri*)	Documented as uncommon at Brownlee, rare at Oxbow and Hells Canyon reservoirs; not observed above Brownlee or below Hells Canyon dam.
Open Water Species	
Trumpeter swan (*Cygnus buccinator*)	Low: No observations in project area; nests in eastern Idaho, introduced breeder in southeastern Oregon. Winters primarily along Pacific coast, but some may winter at Wallowa Lake.
Harlequin duck (*Histrionicus histrionicus*	Documented on Brownlee and Oxbow reservoirs, winter and spring.
Black tern (*Chlidonias niger*)	Moderate: No observations in project area. Migrates along Snake River corridor. Uncommon breeder in the Boise valley and south-central and southeastern Oregon, winters in South America and Africa.
Mountain quail (*Oreortyx pictus*)	High: None observed during surveys, but thought to exist in Hells Canyon.
Willow flycatcher (*Empidonax traillii*)	Documented: Rare throughout project area in spring, summer and fall.
Yellow warbler (*Dendroica petechia*)	Documented: Uncommon above Brownlee reservoir; common through the rest of the project area in spring, summer, fall.
MacGillivray's warbler (*Opopornis tolmiei*)	Documented: None above Brownlee; uncommon through the rest of the project area in spring, summer, fall.

Species or Species Group	Likelihood of Occurrence in Project Area
Townsend's warbler (*Dendroica townsendii*)	Documented: Rare along Brownlee, Oxbow and Hells Canyon reservoirs; absent above Brownlee reservoir and below Hells Canyon dam.
Wilson's warbler (*Wilsonia pusilla*)	Documented: None above Brownlee; uncommon through the rest of the project area in spring, summer, fall.
Solitary (plumbeus) vireo (*Vireo plumbeus*)	Documented: None above Brownlee reservoir; uncommon along Brownlee and Hells Canyon reservoirs and below Hells Canyon dam; common at Oxbow reservoir during spring, summer, and fall.
Yellow-headed blackbird (*Xanthocephalus xanthocephalus*)	Documented: Uncommon above Brownlee reservoir, rare along Brownlee, Oxbow, and Hells Canyon reservoirs, absent below Hells Canyon dam.
Northern river otter (*Lutra canadensis*)	Documented: Observed on each reservoir and below Hells Canyon dam.
Amphibians	
Northern leopard frog (*Rana pipiens*)	Low: No observations, but known to breed at wetlands in the Snake River plain. No recent observations in Oregon.
Inland tailed frog (*Ascaphus truei*)	Documented: Brownlee, Dukes, Deep, Granite and Sheep creeks.
Western toad (*Bufo boreas*)	Documented: Common in wetlands throughout project area.
Bats	
Pale big-eared bat (*Corynorhinus townsendii pallescens*)	Documented at 22 of 46 survey sites in Snake River corridor, including 4 maternity colonies and 2 hibernacula.
Spotted bat (*Euderma maculatum*)	Documented in project vicinity.
Fringed myotis (*Myotis thysanodes*)	Documented at 1 of 46 survey sites in Snake River corridor.
Western pipistrelle (*Pipistrellus hesperus*)	Documented at 2 of 46 survey sites in Snake River corridor.
Big Game	
California bighorn sheep (*Ovis canadensis californiana*)	Low: Nearest observations are from Burnt River, approximately 30 miles west of Brownlee reservoir.
Forest Carnivores	
Fisher (*Martes pennanti*)	Low: No suitable habitat in the project area, due to absence of mature, closed-canopy conifer forest.
Wolverine (*Gulo gulo luteus*)	Low: No suitable habitat in the project area, due to low elevations, but known from Seven Devils Mountains, about 10 miles northeast of Hells Canyon dam.
Insects	
Johnson's hairstreak (*Mitoura johnsoni*)	Low: Strongly associated with Douglas fir and western hemlock stands. Confirmed records from Baker County, Oregon; not reported from Hells Canyon.
Silver-bordered fritillary (*Boloria selene*)	Low: Typically found in wet meadows, bogs and marshes. Confirmed records from Baker County, Oregon; not reported from Hells Canyon.
Yuma skipper (*Ochlodes yuma*)	Possible: Associated with ponds, streams, springs, seeps. Confirmed from Wallowa County, Oregon and Twin Falls County, Idaho; not reported from Hells Canyon.

Species or Species Group	Likelihood of Occurrence in Project Area
Columbia River tiger beetle (*Cicindela columbica*)	Possible: Associated with sandy beaches along Snake and Columbia rivers. Recently observed along lower Salmon River, but not known from Hells Canyon.

3.7.1.7 Game Species of Cultural Importance

Several wildlife species that still occur in the project area are of special importance to Native American tribes in the vicinity. For example, the Nez Perce and Shoshone-Bannock tribes hunted elk, deer and bighorn sheep (Nez Perce, 2006; Shoshone-Bannock, 2006). The Nez Perce hunted bear and mountain goats, as well. Hunting was especially important during times of the year when salmon were unavailable for food. The Shoshone-Bannock Tribes used elk horns to sharpen knives and arrow points, and turned buffalo and bighorn sheep horns into tools, from spoons to bows and shields. Big game also provided hides for clothing, and their bones, teeth, and hooves were used for decoration. Skins of smaller animals (e.g., beaver, ermine) also provided decoration. The Nez Perce hunted rabbit, squirrel, badger, and marmot when needed, and a variety of birds, including ducks, geese, grouse, and sage hens.

3.7.1.8 Land Management Practices

Idaho Power owns about 3,450 acres of land in fee within the FERC project boundary. Most of the land use is related to hydroelectric project operation, but Idaho Power also manages it for secondary residential use, general public recreation, and activities authorized by specific leases and permits. These activities influence wildlife and botanical resources in the project area.

Project-related use includes normal O&M activities associated with the hydroelectric plants, transmission lines, residential areas, access roads, a landing strip, and several recreational facilities that are part of Idaho Power's existing project license. Idaho Power defines secondary residential use as land uses associated with housing on project lands. Some employees who live in the project area graze livestock on project lands. Idaho Power indicates that grazing in well-irrigated pastures generally did not adversely affect vegetation or soils, while steeper, drier sites were more vulnerable to erosion, especially when overstocked.

Idaho Power allows dispersed recreation throughout most of the project area. The most common activities are fishing, boating, lounging, sightseeing, and hiking. Of 169 dispersed recreation sites in the project area, 55 are reported to be completely or partially on Idaho Power land. Vehicle and foot traffic has caused soil compaction and trampling of vegetation at these sites, leading to increased soil erosion and weed infestation. Damage to trees is apparent (e.g., branches cut for firewood, carving on trunks) where trees exist. Idaho Power indicates that the greatest problems are trash and human waste.

Idaho Power grants permits and leases for specific uses, including livestock grazing and agriculture, parks owned and operated by other entities (e.g., local governments, concessionaires, private recreation organizations), and private boat docks, cabins, and associated landscaping. Some unauthorized land uses also occur, whether intentional or accidental. Idaho Power indicates that the most common unauthorized use is cattle grazing where private lands abut Idaho Power property.

Currently, Idaho Power manages three agriculture and grazing leases on the Powder River arm of Brownlee reservoir. Two of these are within the FERC project boundary. The 10-acre Myers lease allows 35 animal unit months of grazing, beginning about March 1 and continuing through September, to assure 10 to 12 inches of grass re-growth by October 1 to provide winter forage for wildlife. In addition to irrigated uplands, this parcel includes high-quality riparian habitat and supports a bald eagle roost. The riparian area is fenced off from the irrigated pasture, but Idaho Power notes that the fence is in disrepair. The parcel is not fenced from the reservoir shoreline, and Idaho Power observed evidence of trespass

grazing as cattle from nearby ownerships cross the Brownlee drawdown zone in early fall to access the Myers lease.

The 28-acre Wright lease also provides high-quality riparian habitat, and another bald eagle roost. This parcel has been used for cultivated crops (e.g., alfalfa). Like the Myers lease, the parcel is fenced from adjacent agricultural fields, but is not fenced along the reservoir, and trespass cattle grazing occurs.

Idaho Power has issued permits for four major parks. Hewitt Park's permit covers the boat ramp, docks, and the shoreline edge. The Holcomb Park permit covers day-use (parking and picnicking), the boat ramp, docks, and the shoreline edge. These two parks are heavily used for reservoir access and fishing, but do provide some habitat for wildlife.

At Steck Park, the permit covers the entire shoreline and a boat ramp and docks. The railroad separates the main park from the shoreline, so there is little recreation activity along the shoreline. This separation has provided some level of protection for riparian habitat at Steck Park. Limited access to a boat ramp and dock at Spring Recreation site (permitted to BLM) affords some protection for riparian habitat at this site, as well.

In addition to the leases and permits identified above, Idaho Power has issued a permit for gravel storage and crushing that covers an area of about 5 acres adjacent to the Huntington-Richland Road. Three permits cover communication lines and facilities, which are generally aligned within existing road rights-of-way. A commercial permit issued to Mountain Man Lodge and Marina, located at the mouth of Dennett Creek, has not been used for several years.

Most private residences, cabins, and accompanying docks permitted by Idaho Power are located at the upper end of Brownlee reservoir, outside crucial mule deer winter range and the migration corridor. Most of these structures are used in late spring, summer, and fall. They are vacant during the winter, when human activity could disturb wildlife.

The Powder River arm contains a number of floating house docks. These structures are also used primarily in late spring, summer, and fall, so although they are located within an area that is considered crucial winter range, Idaho Power reports that disturbance is unlikely. These structures may adversely affect terrestrial and aquatic resources, however, through their impacts on water quality; no sanitation standards are required by either Oregon or Idaho DEQ. Idaho Power's current policy is to permit no new floating house docks.

As mentioned above, the most common unauthorized land use in the project area is trespass grazing. This is of special concern along the north and west sides of the Powder River arm, where the receding reservoir allows animals to graze on project lands, where they damage riparian habitat. Trespass grazing is also a concern on the east side of Brownlee reservoir between Woodhead Park and Mountain Man Lodge, where damage to riparian habitat could also occur.

At the current time, Idaho Power's HCRMP provides guidance for management of Idaho Power's lands. The HCRMP contains 87 "common policies" aimed at protecting and improving environmental quality, recreation, aesthetics, and cultural resources, including 13 that specifically target botanical resources, and three that pertain specifically to wildlife resources. The HCRMP also contains three resource management classifications that designate areas where natural or cultural resources are of primary concern. These designations (special management, resource protection, and resource conservation areas) are intended to provide additional protection or management guidance to address specific concerns.

3.7.2 Environmental Effects

3.7.2.1 Effects of Project Operations on Terrestrial Resources

We describe Idaho Power's Proposed Operations in section 2.2.2, *Proposed Project Operations*, and we assess the effects of the proposed operation on reservoir levels and project outflows in section 3.3.2, *Effects of Project Operations on Water Quantity*. In section 3.3.2.2, we identify operation-related recommendations filed by agencies, tribes, and other parties (table 9), and we describe three alternative operational scenarios that we use to assess the effects of the various operation-related recommendations. At our request (AIR OP-1), Idaho Power simulated project operations for these representative scenarios under various hydrologic conditions. Refer to section 3.3.2.2 for additional discussion of the scenarios and the modeling process used for the simulations. We use the results of these simulations to assess the effects of the operation-related recommendations.

In the following sections, we evaluate the effects of Idaho Power's Proposed Operations and operation-related recommendations received from agencies, tribes, and other parties on the following resources: (1) special status plants; (2) noxious weeds and exotic non-native plants; (3) riparian habitat and associated wildlife; (4) island and beach habitat and associated wildlife; (5) fish-eating wildlife species; (6) big game winter range and migration routes; and (7) plants and game species of cultural importance.

Special Status Plants

Reservoir fluctuations and flow fluctuations can alter hydrologic support for rare plant populations that may occur within fluctuation zones and can cause erosion and soil disturbance. In this section, we evaluate the effects that proposed and alternative operations would have on special status plants, based on studies conducted by Holmstead (2003a), Krichbaum (2000), and Braatne et al. (2002) and on Idaho Power's responses to AIR OP-1.

Our Analysis

Idaho Power documented the occurrence of several populations of six rare plant species. Three of these—stalk-leaved monkeyflower, Hazel's prickly phlox, and Oregon bolandra—grow at elevations above the influence of water level fluctuations. They are not affected by current operations, and no changes would be expected under Proposed Operations or any of the flow alternatives.

Populations of three other species—porcupine sedge, Schweinitz flatsedge, and American wood sage—grow near or below the MHWM. Krichbaum (2000) noted hydrologic disturbance at some of the sites where these species occur. Braatne et al. indicated that the source of the disturbance is occasional peak flows.

Porcupine Sedge

As mentioned in section 3.7.1.2, *Special Status Plants and Plant Communities*, one population of porcupine sedge is located below the MHWM in the Oxbow reservoir reach. Modeling provided in response to AIR OP-1(g) indicates that none of the modeled flow alternatives would result in much change in the pattern of reservoir fluctuation at Oxbow reservoir. For this reason, disturbance effects on this porcupine sedge population would likely be the same under any alternative.

The three populations downstream of Hells Canyon dam are also located below the MHWM. Surveyors noted disturbance within the flow zone at these sites. None of the flow alternatives would alter spring peak flows, so none would increase disturbance to these populations. However, Proposed Operations would reduce flows during July and August, thus reducing the irrigation effect that now

provides hydrologic support to riparian vegetation growing along the shoreline. We discuss this effect in more detail in *Riparian Habitat and Associated Wildlife* below.

The Scenario 1a (Reregulating) would eliminate flow fluctuations due to load following and reduce ramping rates. This alternative would reduce hydrologic support for plants growing along the MHWM to a slightly greater extent than under Proposed Operations.

Under the Scenario 2 (Flow Augmentation Alternative), daily flow fluctuations would be reduced from March through May, but average flows and flow fluctuations during the summer would be about the same as under current conditions. Effects on existing porcupine sedge populations would likely be about the same as they are under current conditions.

The effects of the Scenario 3 (Navigation) would likely be about the same as Proposed Operations. Slight differences would occur in extremely low water years, when the Navigation Scenario would require less flow fluctuation in June and July, and more flow fluctuation in August.

Schweinitz Flatsedge

Three populations of Schweinitz flatsedge extend into the flow zone along the Snake River downstream of Hells Canyon dam. Under existing conditions, annual peak flows may disturb these three populations. Implementation of Proposed Operations or any of the other flow scenarios could adversely affect these three occurrences, as well, for the same reasons discussed above with regard to porcupine sedge. Implementation of the Flow Augmentation Scenario would have the least effect.

Surveyors observed 18 populations of Schweinitz flatsedge growing above the MHWM in upland shrub savanna communities, extending away from the river for 20 or more meters. Braatne et al. (2002) studied the distribution of six randomly selected populations of Schweinitz flatsedge and found they were located at the upper end of the facultative riparian zone, where they would be only rarely inundated by peak flows. Their occurrence primarily in upland shrub savanna communities also suggests that this species is tolerant of drier upland conditions, as well as moist riparian conditions. Proposed Operations or any of the flow scenarios would reduce the area of upland shrub savanna by reducing the irrigation effect associated with load following. Idaho Power predicts that with drier conditions, shrub savanna would convert to tree savanna. Changes under the Flow Augmentation Scenario would be very small (2.5 acres), with larger areas of conversion under the Reregulating Scenario (24.9 to 41.2 acres, depending on ramping rates) or the Navigation Scenario (18.2 acres).

American Wood Sage

Surveyors documented one population of American wood sage growing along the Snake River downstream of Hells Canyon dam. This population spans the MHWM, and some plants grow within the flow zone. Surveyors recorded heavy disturbance at this site because of its location in the flow zone. Implementation of Proposed Operations or any of the flow scenarios would be likely to adversely affect this occurrence of American wood sage, again, by reducing hydrologic support that now occurs as a result of load following.

Our evaluation indicates that annual peak flows cause some disturbance to several populations of rare plants growing near the MHWHM along the Snake River. None of the flow scenarios would modify the magnitude, timing or duration of peak flows, so this type of disturbance would be expected to continue.

All of the flow scenarios would slightly reduce the area of riparian vegetation and the area of shrub savanna because they would reduce the magnitude of stage fluctuations. For this reason, implementation of any of the flow scenarios would be likely to affect the rare plant populations described above.

In addition to hydrologic disturbance, Krichbaum (2000) recorded disturbance from recreation and livestock trampling or grazing at sites occupied by rare plants. This finding indicates that protective measures could be needed under any flow scenario that would be implemented. We discuss these measures in section 3.7.2.2, *Special Status Plant Protection*.

Noxious Weeds and Invasive Exotic Plants

Changes in project operation, including reservoir fluctuations and river flow fluctuations downstream of Hells Canyon dam, may disturb soil, creating conditions that promote the establishment and spread of noxious weeds and invasive exotic plants. Changes in Project Operations may also alter the hydrologic regime that supports plants growing along the reservoir and river margins. In this section, we evaluate the effects that proposed and alternative operations would have on existing weed populations and their potential to spread. Our evaluation is based on information provided in Holmstead (2003a), Krichbaum (2000), and Braatne et al. (2002), and on Idaho Power's response to AIR OP-1 items c (Navigation), f (Aquatic Resources), and g (Terrestrial Resources).

Our Analysis

A number of factors likely influence the pattern of weed distribution in the project area. Adjacent lands provide an abundant seed source and vehicle traffic, livestock grazing, road maintenance, and recreational activities can serve as vectors for weed introduction and spread. Riparian habitats are especially vulnerable because they are exposed to ground disturbance through flood events, scouring, and erosion. Roots, plant fragments, and seeds may be carried downstream, and readily establish in moist shoreline soils.

Some riparian weed species appear to be especially suited to establishing and thriving in reservoir and riverine fluctuation zones. Krichbaum (2000) identified seven species (purple loosestrife, salt cedar, false indigo, perennial pepperweed, reed canarygrass, yellow nut sedge, and common horsetail) as being positively associated with water level fluctuations, i.e., apparently benefiting from a variable moisture regime.

Braatne et al. (2002) modeled the effects of Proposed Operations and a run-of-river scenario (in which all three project reservoirs would be held at full pool) on proliferation and dispersal of 20 species, including most of seven plants identified by Krichbaum (2000) as benefiting from a variable moisture regime. The results of the study were inconclusive regarding the effects of project operation on purple loosestrife, and indicated that Proposed Operations would have little effect on dispersal of the other species, with the exception of salt cedar. Braatne et al. (2002) concluded that seasonal drawdown of Brownlee reservoir may be very important in preventing the downstream dispersal of salt cedar. Seedlings that might establish in the drawdown zone during mid-summer would not survive subsequent drought, followed by inundation. Braatne et al. (2002) also concluded that Proposed Operations would limit the proliferation and dispersal of at least three other perennial species (white top, leafy spurge, and possibly Russian olive). The same is likely true of many riparian weed species that were not included in the modeling study.

Braatne et al. (2002) did not find any correlation between reservoir operations and the dispersal of upland weeds, with the exception of puncture vine. The study results indicated that Proposed Operations would favor increased occurrence and expansion of this species.

Idaho Power's modeling in response to AIR OP-1(g) resulted in essentially the same findings for Proposed Operations, the Reregulating Scenario, the Flow Augmentation Scenario 2, and the Navigation Scenario. Few weed species would survive the seasonal pattern of inundation and desiccation to be transported downstream, and operations at Brownlee would continue to provide some protection for downstream reaches.

However, some increase in the area of weed coverage could occur under the Flow Augmentation Scenario because more area would be exposed from August through October or November than under any of the other scenarios. Weedy annuals (e.g., puncturevine) could establish at elevations between full pool and 2,050 feet msl as reservoir elevations fell during July. These plants could mature and set seed before the reservoir began to fill again in the fall.

Proposed Operations and all the flow scenarios would return Oxbow and Hells Canyon reservoirs to full pool on a daily or near-daily basis. For this reason, no changes would occur within the fluctuation zone or along the shorelines, compared to existing conditions.

None of the flow scenarios would be likely to result in measurable changes in the abundance or distribution of noxious weeds and exotic invasive plants along the Snake River downstream of Hells Canyon. However, reduced ramping rates that would occur under the Reregulating and Flow Augmentation scenarios could reduce erosion. Because weeds often colonize disturbed soils, any reductions in erosion could be of benefit in limiting the establishment and spread of weeds.

A review of Krichbaum (2000) indicates that several human activities and land uses are causing disturbance along the river corridor. These sources of disturbance have a greater potential to influence weed patterns than any of the flow regimes under consideration. We discuss the importance of weed monitoring and control measures in section 3.7.2.3, *Noxious Weed and Exotic Invasive Plant Management*.

Plants of Cultural Importance

Many of the plants that occur in the project area and that may be affected by project operations are important to Native American tribes in the region. In this section, we evaluate project effects on some of these, based on Idaho Power's technical studies (Reed-Jerofke, 1999; Whipple, 2001) and response to OP-1, as well as publicly available information about plants used by tribes in the vicinity.

Our Analysis

As described in section 3.7.1.3, *Plants of Cultural Importance*, vegetation in the project area includes a number of species that are important to Native American tribes for food and medicine. Plants also provide materials for clothing, basketry, decoration, and ceremonial purposes. Plants of importance are found in both upland and riparian habitats in the project area.

Shrub-steppe and grasslands dominate the landscape. In these cover types, important plants may include sagebrush, rabbitbrush, yarrow, desert parsley, and biscuit root. As discussed in section 3.7.2.5, *Upland and Riparian Habitat Acquisition*, project operations preclude the establishment of about 5,761 acres of upland vegetation within the fluctuation zones of Brownlee, Oxbow, and Hells Canyon reservoirs. A review of Idaho Power's response to OP-1 indicates that none of the modeled flow scenarios would affect upland vegetation associated with the project reservoirs, and there would be no change in habitat conditions.

Riparian habitats and wetlands are very limited in the project area because of the steep canyon walls, rocky soils, and dry climate. Culturally important species along the Snake River and its tributaries include coyote willow, serviceberry, and poison ivy. Wetland plants, such as tule and cattail, are uncommon. Project operations preclude the establishment of about 731 acres of riparian habitat within the fluctuation and shoreline zones of Brownlee, Oxbow, and Hells Canyon reservoirs (see section 3.7.2.5).

We discuss the effects of Proposed Operations and other flow scenarios on riparian and upland habitat along the Snake River downstream of Hells Canyon dam in *Riparian Habitat and Associated Wildlife*, below. Mitigation measures that protect or improve these habitats would similarly be expected to benefit culturally important plants, as well as more broadly classified riparian and upland plant

communities. Mitigation measures that address completion of ethnographic studies might also be useful in pin-pointing species of importance and identifying measures to protect or enhance them.

Game Species of Cultural Importance

As described in section 3.7.1.7, *Game Species of Cultural Importance*, several big game species, smaller mammals, waterfowl, and game birds were important sources of food, clothing, or decoration to Native Americans tribes in the area, and several continue to be important. In the following section, we evaluate project effects on some of these, based on Idaho Power's technical studies (Reed-Jerofke, 1999; Whipple, 2001) and response to AIR OP-1, as well as publicly available information about culturally important wildlife species.

Our Analysis

Animals of cultural importance include many of the wildlife species that occur in the project area. For this reason, negative or positive project effects on wildlife would in turn affect cultural resources. We discuss project effects on waterfowl and big game below, in *Island and Beach Habitat and Associated Wildlife* and *Big Game Winter Range and Migration Routes*. Project effects on smaller mammals (such as rabbits and squirrels) and game birds were not identified as a specific issue during scoping, but the loss of upland habitat within the fluctuation zone of Brownlee reservoir has reduced habitat availability for many species that were hunted by several Native American tribes when deer and elk were unavailable.

Mitigation measures that protect or improve habitat conditions for these species would benefit cultural resources, as well as wildlife in general. Mitigation measures that call for completion of ethnographic studies might also be useful; as in the case of culturally important plant species, additional information could help to identify species that are of particular interest, which could be enhanced through implementation of specific measures.

Riparian Habitat and Associated Wildlife

Current project operations prevent the development of riparian habitat within the fluctuation zones of Brownlee, Oxbow, and Hells Canyon reservoirs and limit the development of perennial riparian vegetation along the full pool shoreline of Brownlee reservoir. Load following operations downstream of Hells Canyon dam also affect riparian habitat. In addition to altering the amount of habitat available for wildlife, project operations may contribute to riparian habitat fragmentation. In this section, we evaluate the effects of Proposed Operations and alternative flow scenarios on riparian habitat and associated wildlife, based on Idaho Power's technical studies (Turley and Holthuijzen, 2003b; Rocklage and Edelmann, 2003a; Holthuijzen, 2003a; Eshelman, 2003; Turley and Holthuijzen, 2003a; Edelmann and Pope, 2003; Blair et al., 2003; Rocklage and Edelmann, 2003b; Holmstead, 2003a; Braatne et al., 2002) and Idaho Power's response to AIR OP-1.

Our Analysis

Many studies show the importance of riparian habitat in the arid west. More wildlife species use riparian habitats than any other vegetation type (Kauffman et al., 2001; Thomas et al., 1979; Knopf et al., 1988). Riparian habitat provides a wetter, cooler microclimate and supports higher levels of primary productivity than surrounding, drier shrub-steppe and grassland cover types. Riparian plant communities have higher levels of species and structural diversity, which in turn provide unique food resources, nesting opportunities, and hiding and thermal cover for wildlife. Riparian plant communities also function as travel corridors that allow for daily movements, seasonal migration, and juvenile dispersal.

In the Hells Canyon study area, Holmstead (2003a) found that riparian habitat accounts for less than 5 percent of the study area and occurs along less than 9 percent of the shoreline between Weiser and the Salmon River confluence. Several factors influence the extent of riparian vegetation. These include

the topography, soils and climate of the region, in addition to project operations. Because of these factors, riparian habitat may never have been extensive in the project vicinity and would not be likely to expand significantly under any project alternative.

With the exception of the Powder River arm, the shoreline of Brownlee reservoir is mostly steep, rocky, and bare of vegetation. Riparian habitat is restricted to small patches at the mouths of tributary drainages. Under existing conditions, seasonal drawdown of Brownlee reservoir precludes the establishment of 372 acres of riparian habitat within the fluctuation zone and 343 acres of riparian habitat along the shoreline.

The shorelines of Oxbow and Hells Canyon reservoirs are also steep, but without extensive seasonal drawdown, both reservoirs support a narrow band of riparian vegetation along the high water mark. Relatively small reservoir fluctuations prevent the establishment of 7 and 9 acres of riparian habitat, respectively.

Idaho Power estimates that the effects of project operations on riparian vegetation would be minor under any of the modeled flow scenarios. There would be no change in riparian habitat at Brownlee reservoir. Riparian habitat along the shoreline at Oxbow reservoir would be reduced by less than 1 acre under any of the flow scenarios, with a corresponding increase in upland habitat. At Hells Canyon reservoir, Proposed Operations would reduce riparian habitat along the shoreline by 0.82 acres. Losses under the Reregulating Scenario would range from 0.84 to 1.51, depending on ramping rate. The loss under the Flow Augmentation Scenario would be 1.57 acres, and under the Navigation Scenario 3, the loss would be 1.47 acres.

Proposed Operations and all the flow scenarios would result in larger changes in riparian and upland habitats along the Snake River downstream of Hells Canyon dam. This reach currently supports 242 acres of riparian vegetation. Under current conditions, load following results in average daily stage changes (as measured at the Hells Canyon gage) measuring from more than 1 foot to more than 4 feet. Stage fluctuations occur within the scour zone, where rocky substrate and annual peak flows prevent the establishment and long-term survival of a dense riparian plant community (Braatne et al., 2002). In its comments on the draft EIS, the Forest Service estimated that flow fluctuations combined with the loss of fine-grained sediments has prevented the establishment of native willows (primarily sandbar willows) on about 49 acres of shore and bottomland wetland. However, stage elevations influence soil moisture above the scour zone on the side slopes, providing daily or almost-daily irrigation to shoreline vegetation (Braatne et al., 2002).

Proposed Operations and all of the modeled flow scenarios would reduce the irrigation effect. With reduced hydrologic support, plant assemblages within the area influenced by project operations would transition to drier cover types, following a continuum related to soil moisture on the riverbanks.

Table 68 shows the existing acreage of riparian and upland cover types along the Snake River downstream of Hells Canyon dam, and the change in acreage that would occur as a result of implementing each of the flow scenarios. The table omits natural features (e.g., cliffs) and developed sites (e.g., campsites) because it is assumed they would not change as a result of Proposed Operations or other flow scenarios.

Table 68. Acres of existing upland and riparian cover types along the Snake River downstream of Hells Canyon dam, and the change in acreage that would result from implementation of various flow scenarios.

Cover Type	Existing Conditions	Proposed Operations	Scenario 1a (Regulating)	Scenario 1b (Year-round 2-Inches-Per-Hour Ramping Rate)	Scenario 1c (Year-round 6-Inches-Per-Hour Ramping Rate)	Scenario 2 (Flow Augmentation)	Scenario 3 (Navigation)
Uplands							
Other upland	30.5	11.30	22.50	20.20	13.6	1.30	9.90
Grassland	196.9	–10.40	–20.60	–18.50	–12.50	–1.20	–9.10
Tree savanna	16.9	22.8	45.30	40.60	27.40	2.70	20.00
Shrub savanna	412.0	–20.80	–41.20	–36.90	–24.90	–2.50	–18.20
Shrubland	52.9	12.00	23.70	21.30	14.40	1.40	10.50
Riparian Cover types							
Forested wetland	33.6	–2.00	–3.90	–3.50	–2.30	–0.30	–1.70
Scrub-shrub wetland	226.6	–13.00	–25.80	–23.10	–15.60	–1.50	–11.40
Emergent herbaceous wetland	1.7	–0.10	–0.20	–0.20	–0.10	0.00	–0.10
Shore/bottom-land wetland	329.1	56.20	111.40	99.80	67.40	6.80	49.30
Water	2,009.7	–56.20	–111.40	–99.80	–67.40	–6.80	–49.30
Total Change in Riparian Habitat (wetland and water)		–15.10	–29.90	–26.80	–18.00	–1.80	–13.2

Most changes would occur in scrub-shrub wetland, which grows closest to the existing MHWM and which accounts for most of the existing riparian vegetation. Scrub-shrub wetland would transition to shrubland. Some shrubland would convert to shrub savanna, but there would be a net loss in shrub savanna with some of this cover type becoming tree savanna. Netleaf hackberry would likely remain a dominant component of all these plant assemblages because it is tolerant of a variety of conditions. Coyote willow, which accounts for only about 17 percent of the scrub-shrub plant assemblages, is less tolerant of dry conditions, and would likely be reduced under all flow scenarios except Scenario 2 (Flow Augmentation).

Relatively large acreage changes would occur in water and shore and bottomland wetland cover types, also. Spring flooding would continue to scour rocky substrates within the flow zone. However, reduced load following would likely allow some perennial vegetation, such as netleaf hackberry, to colonize the newly exposed substrate. Coyote willow would likely be less successful, but Braatne et al. (2002) notes that interstitial sands and fine sediments required for its establishment remain trapped between larger rocks and underlying coarse layers. Idaho Power assumed that any perennial riparian vegetation that would establish in the larger area of shore and bottomland wetland would not provide significant habitat for wildlife.

Available information does not allow for specific predictions of how wildlife use patterns might change in response to changes in habitat availability. Idaho Power conducted numerous studies to evaluate the species-habitat associations of birds, mammals, amphibians, and reptiles and found that the characteristics of the canyon landscape complicate the interpretation of results. The size of habitat patches is relatively small and patches are well interspersed. For this reason, many wildlife observations may have been of animals moving between preferred habitats. In addition, many species that occupy Hells Canyon are generalists that use a variety of habitats, and others are associated with edge habitats.

In general, the changes shown in table 68 mean that less habitat would be available for species that use or rely on scrub-shrub wetland, forested wetland, emergent herbaceous wetland, shrub savanna, and grassland. More habitat would be available for species that use or rely on shore and bottomland wetland, shrubland, tree savanna, and desertic cover types.

The Terrestrial Resources Work Group (TRWG) identified several species and species groups as being associated with riparian shorelines, and potentially affected by project operations. These include mountain quail, neotropical migrants (e.g., willow flycatcher, yellow warbler, MacGillivray's warbler, Townsend's warbler, Wilson's warbler, plumbeous vireo, and yellow-headed blackbird), and the northern river otter. The TRWG did not identify inland tailed frog and western toad as being associated with riparian shorelines, but they are also of interest because of their association with riparian habitats. Based on species-habitat associations identified in the Draft Conservation Plan for Mountain Quail (Sands et al., 1998) for Idaho, mountain quail are strongly linked to riparian habitats characterized by tall shrub cover, medium canopy (25 to 50 percent coverage), and relatively sparse understory vegetation. Rocklage and Edelmann (2003a) used a landscape-level habitat model to calculate habitat suitability for mountain quail. They found that values were fairly high in scrub-shrub riparian habitat along the Snake River downstream of Hells Canyon dam (0.81 to 0.82 on a scale of 0 to 1.0). Suitability of shrubland and shrub savanna was much lower (0.02), while tree savanna was moderate (0.56 to 0.58). Based on the model, flow alternatives that would reduce scrub-shrub wetland may reduce the area of habitat available for mountain quail. Reductions in scrub-shrub wetland along the river would also reduce connectivity between tributaries.

All of the neotropical migrant bird species identified by the TRWG use a variety of habitats during spring migration, and changes between scrub-shrub wetland and shrubland would not be likely to affect their movement through the canyon. During the breeding season, the willow flycatcher, yellow warbler, Wilson's warbler, and MacGillivray's warbler usually nest in mesic to wet deciduous riparian habitats, usually dominated by willow, cottonwood, and alder shrub (Sedgwick, 2000; Lowther et al.,

1999; Ammon and Gilbert, 1999; Pitochelli, 1995). The loss of scrub-shrub wetland and forested wetland could reduce available nesting habitat for these species. However, all of these species are currently either uncommon or were not documented along the Snake River downstream of Hells Canyon dam (Turley and Holthuijzen, 2003b).

Changes in project operation would not likely affect nesting habitat for the plumbeous vireo, Townsend's warbler, or yellow-headed blackbird. The plumbeous vireo and Townsend's warbler are generally associated with conifer forest during the breeding season (Curson and Goguen, 1998; Wright et al., 1998). The yellow-headed blackbird typically nests in emergent herbaceous wetlands (Twedt and Crawford, 1995).

River otters are present throughout the project area. Although optimal habitat is sometimes described as slow-moving water with deep pools, dense riparian vegetation, and abundant prey, studies in the Payette and Clearwater River systems indicate that otters use a variety of habitats in Idaho (Mack and et al., 1994; Melquist and Hornocker, 1983). River otters in the Clearwater used rock cavities more than any other den type in areas that were either not vegetated or were characterized by a sparse shrub cover with a sparse herbaceous understory. Over half of the latrine sites were located in similar settings.

The Snake River downstream of Hells Canyon dam has a higher gradient, steeper slopes, and much less development than the study reach of the Clearwater River described above, but it is also dominated by rocky banks and relatively sparse riparian vegetation. Assuming otter use of Snake River habitats would be somewhat similar to use of the Clearwater River habitat, the change from scrub-shrub wetland to shrubland as a result of implementing Proposed Operations or any of the flow scenarios would not likely affect river otters. Reducing load following during the summer could increase the availability of suitable den sites, and any measures that would lead to more abundant fish populations would benefit otters in this reach.

It is important to note that the Clearwater study indicated that otters used sandy substrates more than would be expected, given its limited distribution. The authors suggested that a typical location for either a den or a latrine site would be a large rocky outcrop projecting into the river channel that would form an eddy with an associated sandy beach on the downstream side of the outcrop. Sand would continue to be limited in the Snake River downstream of Hells Canyon dam under any flow scenario.

Inland tailed frogs are typically associated with cold, clear, high-gradient streams (Leonard et al., 1993), and Beck et al. (2003) documented their occurrence in three tributaries to the Snake River downstream of Hells Canyon dam. Beck et al. (2003) also observed a tailed frog on the Snake River shoreline at the mouth of Granite Creek, noting that this was an unusual occurrence. Changes in project operation would not affect breeding habitat in tributary streams, but reductions in scrub-shrub wetland could interfere with dispersal. This species does not usually move far from streams, remaining in moist vegetation or debris along the banks, and drier conditions could reduce habitat connectivity along the Snake River between tributaries.

The western toad breeds in backwater ponds along the Snake River downstream of Hells Canyon dam. As described in section 3.7.2.8, *Special Status Wildlife*, surveyors noted that the availability of these ponds likely varies from year to year, depending on flows. In the Snake River Canyon, the western toad may breed as late as July in response to lower flows following annual peaks in May and June. There is no evidence that load following provides hydrologic support to these ponds, so reducing load following in July and August would not be likely to affect reproduction. The western toad is capable of long overland movements through dry forests and shrub (Leonard et al., 1993), so conversion of scrub-shrub wetland to shrubland would not likely interfere with dispersal.

Sections 3.7.2.5, *Upland and Riparian Habitat Acquisition*; 3.7.2.6, *Cooperative Wildlife Management Projects*; and 3.7.2.7, *Wildlife Management on Idaho Power Lands* describe several proposed or recommended measures that are intended to offset the adverse effects of ongoing project

operations on riparian habitat. Based on our evaluation of the various flow scenarios, additional measures could be useful in addressing the effects of implementing any new flow regime.

Island and Beach Habitat and Associated Wildlife

Construction of Brownlee dam inundated about 95 acres of islands (BLM, 2002), and reservoir fluctuations affect some remaining islands within the project boundary. Flow fluctuations may also affect sandbars and beaches along the Snake River downstream of Hells Canyon dam. In this section, we evaluate the effects of proposed and alternative operations on species that are often associated with islands and beaches, including waterfowl, colonial nesting waterbirds, and river otter, based on Idaho Power's technical studies (Rocklage et al., 2003a; Pope, 2003; Turley and Holthuijzen, 2003a; Edelmann and Pope, 2003) and on Idaho Power's response to OP-1.

Our Analysis

Riverine islands and beaches are important elements of the landscape for many wildlife species that use both terrestrial and aquatic habitats. Both are intermediate or transitional zones for species that nest or den on land and forage in water. Islands afford security from terrestrial predators; geese, ducks, terns, and other ground-nesting waterbirds may reach their highest densities on islands (Johnson, 2001). Tree-nesting waterbirds also reach high densities on islands, where nests can be located within clear view of foraging areas in the water. Islands may function as stepping stones during wildlife migration or dispersal. Typically clear of vegetation, riverine beaches have the potential to provide access both up and down the river corridor, and into shallows along the river margin.

To evaluate the potential effects of Proposed Operations or any of the flow scenarios on waterfowl, colonial nesting waterbirds, and river otters, we compared their current distribution and habitat use with the types of changes that would be expected in reservoir elevations or flow regimes downstream of Hells Canyon dam.

Waterfowl

Idaho Power conducted waterfowl surveys to evaluate project effects on nesting and brooding habitat. As described in section 3.7.1.5, *Key Wildlife Species,* the results indicated that in general, waterfowl use of the project waterbodies is low. Most use occurs along the shorelines and islands between Weiser and the headwaters of Brownlee reservoir, and in the Powder River arm. Surveyors observed very few waterfowl in the Oxbow and Hells Canyon reservoir reaches, and even fewer along the Snake River downstream of Hells Canyon dam. Idaho Power concludes that conditions at the upper end of the project area, including the low gradient of the river, more extensive floodplain, and wider riparian zone, are more compatible with waterfowl nesting and brooding requirements.

A comparison of seasonal reservoir elevations under current conditions, Proposed Operations, the Reregulating Scenario, the Flow Augmentation Scenario, and the Navigation Scenario indicates riparian habitat would not change within the Brownlee reservoir fluctuation zone or along the shoreline under any of the flow scenarios because extensive seasonal drawdowns would continue to occur during the spring and fall of medium and extremely wet years. The area of exposed substrate and the percent cover of vegetation within the drawdown zone would likely vary somewhat between flow alternatives, due to changes in the timing and extent of drawdown, but the only substantial changes would occur under the Flow Augmentation Scenario from August through October or November, when the reservoir would be fairly constant at a lower level from mid-summer through the fall than would be the case under the other flow scenarios. As described above in section 3.7.2.1.2, *Noxious Weeds and Exotic Invasive Plants*, weedy annual plants could establish between full pool and elevation 2,050 feet msl during this period. Cover would likely be sparse, and this late summer weed crop would not likely provide a significant source of forage for waterfowl.

Idaho Power's modeling indicates that very little change in operation of Oxbow or Hells Canyon reservoirs would occur, and we would anticipate no change in habitat availability or suitability for waterfowl. Waterfowl use of these reservoirs would likely continue to be very low. However, waterfowl could benefit from implementation of proposed habitat enhancements at Porter, Patch, Hoffman, and Gold Islands, as described in section 3.7.2.6, *Cooperative Wildlife Management Projects*.

Colonial Nesting Waterbirds

Several species of colonial nesting waterbirds occur in the project vicinity during spring and summer, including American white pelican, double-crested cormorant, great blue heron, black-crowned night-heron, great egret, western grebe, ring-billed gull, California gull, and Caspian tern. Several other colonial nesters (e.g., snowy egret, white-faced ibis, Franklin's gull, Bonaparte's gull, and mew gull) are present in spring or summer. Many of these species nest on 94 islands that are managed as part of the Deer Flat Wildlife Refuge, located on the Snake River about 70 miles upstream of Weiser.

Idaho Power conducted surveys for colonial nesting waterbirds between Weiser and Hells Canyon dam. Surveyors documented two previously unknown nesting colonies, both in unimpounded reaches of the Snake River. Peep Island is located upstream of Brownlee reservoir at approximately RM 348, outside the project boundary and outside the area of project influence. The Powder River site is located adjacent to the project boundary at the confluence of Eagle Creek and the Powder River with Brownlee reservoir, also outside the influence of reservoir fluctuations. Both colonies support nesting double-crested cormorants, great blue herons, and black-crowned night-heron. Biologists observed one adult great egret at the Powder River site but did not document any nesting.

Habitat for colonial nesting waterbirds would not be likely to change under Proposed Operations or any of the flow scenarios because no substantial changes would occur at Brownlee reservoir or upstream. Colonial waterbirds could benefit from habitat improvements at Patch, Porter, Hoffman, and Gold islands.

Not all colonial nesting waterbirds are piscivorous, but all depend on aquatic organisms as the mainstay of their diet. Any protection, mitigation, or enhancement measures that lead to increased fish populations would benefit many of the birds in this group, and any measures that are implemented to improve water quality would benefit all of them.

Northern River Otter

As described above, biologists observed northern river otters incidentally at several locations throughout the project area, including each of the reservoirs and along the Snake River downstream of Hells Canyon dam. Also as described above, river otters use a variety of habitats across their range, but a study in the Clearwater River suggests that a combination of rocky outcrops and sandy beaches would provide for secure den sites near open grooming and latrine areas and easy access to forage across gently sloping shorelines (Mack et al., 1994). Gently sloping shorelines also provide important habitat for slow-moving resident fish and rearing juvenile salmonids that serve as prey items for river otters.

Beaches and sandbars in river systems are not static habitat features but change in size and shape from year to year. The analysis presented in the *Beach and Terrace Erosion* section shows that implementation of the Reregulating Scenario would have the greatest effect in terms of reducing the risk of sandbar mobilization and erosion. This change would likely benefit river otters that use the Snake River downstream of Hells Canyon dam.

Measures that would increase fish populations would benefit river otters throughout the project area, and improvements in water quality would be especially important. As a top predator in the aquatic food chain, river otters are heavily exposed to contaminants. We discuss this concern in more detail in the *Fish-eating Wildlife Species* section below.

Fish-eating Wildlife Species

The Hells Canyon Project may affect fish-eating wildlife species in several ways: by affecting anadromous fish populations in the Snake River downstream of Hells Canyon dam, blocking anadromous fish from the Snake River upstream of the dam, and contributing to the accumulation of contaminated sediments in Brownlee reservoir. In this section, we evaluate the effects of Proposed Operations and other flow scenarios on fish-eating wildlife species, based primarily on Idaho Power's response to AIR OP-1 and a review of pertinent literature.

Our Analysis

Numerous studies over the past decade have investigated the relationship between salmon and terrestrial ecosystems (Bilby et al., 2003; Cedarholm et al., 2001; Naiman et al., 2002). In general, researchers are finding that salmon contribute substantially to terrestrial systems through several pathways (Gende et al., 2002). Studies in western Washington indicate that salmon directly or indirectly affect more than 100 wildlife species. At least 22 species of birds and mammals prey on salmon eggs or live salmon, or forage on salmon carcasses in freshwater systems. Salmon consumption may improve fitness (i.e., growth rate, litter size, reproductive success), suggesting that salmon play an important role in population dynamics of species, such as river otters, black bears and bald eagles.

Under current conditions, salmon provide a forage resource for fish-eating wildlife species along the Snake River downstream of Hells Canyon dam, but load following may limit their abundance. As discussed in section 3.6.2.1, *Effects of Project Operation on Aquatic Resources*, several changes in project operation could improve conditions for fall Chinook salmon, which would increase the forage base for fish-eating wildlife. There is no evidence that fall Chinook salmon populations affect otter, bear, or eagles in the Snake River System under current conditions, but no survey data are available to show population trends for fish-eating species other than for bald eagles. As described in section 3.8.1, *Threatened and Endangered Species*, bald eagle populations have increased substantially since 1998, with four new nests discovered between 2003 and 2004. In general, however, measures that would improve conditions for fish would also improve conditions for wildlife that prey on them. Indirect benefits to riparian plant and animal communities may also occur, as nutrients are transported to terrestrial habitats along the river corridor. Measures addressing a phased approach to restore anadromy upstream of Hells Canyon dam, improve fish habitat in project tributaries, and distribute salmon carcasses to increase bull trout forage measures to improve fish habitat in tributaries which would also benefit fish-eating wildlife, over time. We evaluate these measures prospective measures in sections 3.6.2.6, *Anadromous Fish Restoration*, 3.6.2.10, *Tributary Habitat Improvements*, and 3.6.2.11, *Marine-Derived Nutrients.*

Our analysis of project effects on anadromous fish rearing (in 3.6.2.1, *Effects of Project Operations on Aquatic Resources*) indicates that increasing habitat stability would benefit rearing fall Chinook salmon. Implementation of the Reregulating Scenario would result in the highest level of stability. Proposed Operations, the Navigation Scenario, and higher ramping rate scenarios (e.g., 6 inches per hour) would provide the least stable habitat conditions. Lower ramping rates would also result in less dewatering, which would result in higher production of aquatic macroinvertebrates that supply forage to rearing Chinook salmon. Finally, lower ramping rates would result in less stranding of juvenile Chinook salmon. Reducing stranding could improve survival for a number of other fish species, as well, that serve as prey for river otters and other animals. Stranding surveys identified substantial numbers of steelhead, smallmouth bass, carp, and Cyprinids in entrapment pools.

As discussed in section 3.6.2.1, *Effects of Project Operations on Aquatic Resources*, continuing to maintain a stable flow regime would be more protective of Chinook salmon redds than a variable flow regime. Stable flows between 8,000 cfs and 15,000 cfs would likely be optimal, based on the relationship between habitat capacity and flow.

Another issue related to project effects on fish-eating wildlife is the accumulation of contaminated sediments in Brownlee reservoir; these contaminated sediments are passed up the food chain to top predators, such as bald eagles, great blue heron, and river otters. Bioaccumulation of contaminants in birds and mammals that prey on fish may affect their behavior, impair reproduction, or cause death. To evaluate the potential effects of contaminants in Brownlee reservoir, Idaho Power reviewed a 1998 USGS study that focused on organochlorine compounds and trace metals found in bottom sediments and in tissues of fish captured in Brownlee reservoir (Dombrowsky et al., 2000). These authors compared the levels of contaminants found in these fish with national and regional findings, and modeled the potential exposure concentrations in great blue heron and river otter. Based on these comparisons, concentrations of DDT/DDE far exceeded ecologically based benchmarks (threshold concentrations below which adverse effects are considered unlikely to occur) for great blue heron and river otter.

A more recent study of bald eagle exposure to contaminants in southern Idaho indicates that nestlings in the Hells Canyon Project area are being exposed to relatively high levels of DDT, as the Snake River drains agricultural lands across southern Idaho (Bechard et al., 2006). However, the average level of 0.06727 ppm DDE in the blood of eagle nestlings was well below the 2.7 ppm DDE threshold considered to cause observable adverse effects.

The Bechard et al. (2006) analysis of adult bald eagle feathers from Hells Canyon showed high levels of mercury, as well, with levels exceeding 25 ppm. These levels are comparable to those found in eagles in other studies in other parts of the country (e.g., Georgia), but higher than the accepted level of concern of 7.5 ppm (Eisler, 1987). The significance of the higher levels is difficult to interpret, for example, Bechard et al. (2006) noted that all the eagles included in the southern Idaho study were breeding successfully.

Idaho Power monitored one bald eagle nest in 1998, which produced one young. Two nests were monitored between 1999 and 2001. Both nests produced one young in 1999, and two young in 2000 and 2001. Idaho Power monitored productivity at five of the six eagle nests in the project area in 2004 and 2005. It found the average number of young fledged was 2.4 in 2004 and 1.4 in 2005. Although productivity in each year of monitoring between 1998 and 2005 exceeds the recovery plan target of 1.0, the drop between 2004 and 2005 suggests that monitoring productivity, as well as occupancy, may be necessary to determine long-term trends. IDFG's 2006 report on annual bald eagle surveys recommends continued productivity monitoring on a state-wide basis, noting a downward trend in 2005 and 2006. In 2006, the percentage of nests failing to produce young was among the highest on record, and the number of young fledged per occupied nest fell below one, only the third time numbers have been below one since 1979 (Sallabanks, 2006).

Big Game Winter Range and Migration Routes

Because of its size, location, and the formation of ice in winter, Brownlee reservoir may function as a block to migrating mule deer, elk, and bighorn sheep, as well as reducing the availability of low-elevation winter range. In this section, we evaluate the effects of Proposed Operations and other flow scenarios on big game winter range and reservoir crossings, based on Idaho Power's technical studies (Ryel et al., 2003; Edelmann, 2003; Edelmann et al., 2003a, Ratti and Lucia, 1998; Edelmann et al., 2003b) and Idaho Power's response to OP-1.

Our Analysis

Idaho Power estimated populations of mule deer, elk, and bighorn sheep during surveys in 1998, 2000, and 2001 (Edelmann et al., 2003a). These authors observed mule deer throughout the rim-to-rim survey area, from the Weiser Bridge to Hells Canyon dam. Elk were present in about half the survey units, and bighorn sheep were reliably seen in very few of the survey units.

Densities for mule deer ranged from 1.6 to 20.1 deer per square kilometer. The highest densities occurred toward the north end of the reservoir, including the Powder River arm.

Elk densities were much lower, ranging from 0.02 to 8.2 elk per square kilometer. Elk tended to be scattered along the length of Brownlee reservoir, with slightly higher densities on the east side. Surveys did not identify important migration routes.

Bighorn sheep densities were also low, ranging from 0.01 to 1.2 sheep per square kilometer. The highest densities occurred just north of Brownlee dam in the Oxbow reservoir reach. Surveys did not identify any migration routes.

As discussed in section 3.7.1.5, *Key Wildlife Species*, the population surveys confirmed that the project area bisects some of the most important mule deer winter range in the region. For this reason, Idaho Power conducted several studies focusing on mule deer. The results of the studies indicated that Brownlee reservoir, in particular, limits winter habitat selection and increases winter mortality on about 86,408 acres of crucial winter range. Edelmann (2003) calculated that the project reduces habitat capability of winter range by 10 percent during average winters, and by an additional 9 percent during harsh winters.

Based on Idaho Power's modeling in response to AIR OP-1, none of the flow scenarios would alter habitat conditions for mule deer at Brownlee, Oxbow, or Hells Canyon reservoirs, and Brownlee reservoir, in particular, would continue to limit habitat capability. We discuss measures to offset project effects on habitat capability (e.g., acquisition, protection, and enhancement of land adjacent to the project, and implementation of specific habitat improvements on lands already in Idaho Power's ownership) in sections 3.7.2.5, *Upland and Riparian Habitat Acquisition,* and 3.7.2.7, *Wildlife Management on Idaho Power Lands*.

Results of the mule deer ecology study showed that the Powder River arm is an important migration corridor for deer that summer in the Wallowa Mountains and winter around Brownlee reservoir (Edelmann, 2003). Fall migrations occur into early January. Monitoring of radio-collared deer showed that migrating mule deer crossed the Powder River arm and the southern portion of the reservoir. Based on the number of deer that winter adjacent to Brownlee reservoir and the number of radio-collared deer that crossed, Edelmann (2003) estimated that from 1,000 to 1,500 deer likely move across the Powder River arm during fall migrations.

During 3 years of study, Edelmann (2003) reported 6 mortalities that likely were associated with reservoir crossings, either as a direct result of drowning or as a result of predation related either to water or ice crossings. Edelmann did not identify any significant correlation between the number of crossings and the elevation of Brownlee reservoir but did note a trend suggesting that more deer crossed the reservoir for short periods of time in the winter of 1999 when the reservoir was drawn down 80 feet than when the reservoir was kept at full pool during the winters of 2000 and 2001.

To further explore the effects of the project on mule deer migration and movement, Idaho Power conducted simulations of reservoir ice formation using the 2D CE-QUAL-W2 model (Ryel et al., 2003). The model simulated ice formation, thickness, persistence, and melting under Proposed Operations and a run-of-river scenario in dry, medium, and wet years (Ryel et al., 2003). The model compared icing patterns during December, January, and February, when ice is most likely to form, and then related icing patterns to the timing of big game migration.

Ryel et al. (2003) found that ice thickness and duration were about the same under Proposed Operations and the run-of-river scenario, suggesting that differences in lateral and vertical mixing of water within the reservoir would not be sufficient under either scenario to greatly alter the patterns of ice formation. Analyses described in section 3.5.2.1, *Effects of Project Operations on Water Quality*, indicate that none of the flow scenarios would involve greater mixing. For this reason, we do not anticipate that any of the flow scenarios would affect ice formation.

Ryel et al. (2003) found that ice is most likely to form in the Powder River arm and in the southern portion of Brownlee reservoir, both in the main channel and shallower, more protected embayments. Ice thickness and duration appeared to be greatest in the Powder River arm. Ice would be most likely to form in late December, with thawing and break-up in late February through early April. A comparison of the results of the icing study with deer movements indicates that about 25 percent of the reservoir crossings occurred during the winter (January and February) and 25 percent during green-up (late March-April). These periods coincide with times of the year when ice could be present, and some deer would encounter ice in crossing the Powder River arm or Brownlee reservoir.

In response to AIR OP-1(f), Idaho Power used CHEOPS to model reservoir elevations under Proposed Operations and three other scenarios (Reregulating, Flow Augmentation, and Navigation). The primary differences between these scenarios and actual conditions occur during spring, summer, and fall. Reservoir elevations during December, January, and February, when ice would be present, would be about the same under all scenarios. For this reason, we conclude that a small number of mortalities would continue to occur as a result of deer breaking through the ice and drowning as they attempt to cross the reservoir or because of increased vulnerability to predation as they cross the ice.

A review of Edelmann (2003) suggests that swimming across the reservoir also results in some mortalities for mule deer, as a result of drowning, exhaustion, and/or increased vulnerability to predation upon reaching the far shore. If there is a relationship between reservoir elevation and the number of crossings, the risk to mule deer may be highest during green-up (mid-March through mid-April), when most crossings occur.

A comparison of reservoir elevations in March and April shows that they would be about the same in dry and extremely wet years under existing conditions, Proposed Operations, and the three flow scenarios. In medium years, however, all of the flow scenarios would draw the reservoir down more slowly to a lower level than under existing conditions. Thus, any of the alternatives could result in a small benefit to mule deer, if they prefer to cross a narrower reservoir.

The major difference in elevations between the scenarios occurs during the summer and fall, under the Flow Augmentation Scenario. Under this scenario, the reservoir is drawn down more quickly and to a deeper level after the Fourth of July in all three water year types than it would be under Proposed Operations. However, Edelmann (2003) found that summertime reservoir crossings were less frequent than crossings in any other season, i.e., 0.21 per week, compared to 3.01 during green-up.

We conclude that Brownlee reservoir would continue to pose a risk to deer attempting to cross it, but that the risk of mortality related to either water or ice crossings is relatively small (i.e., less than 1 percent, assuming 6 mortalities in an estimated 1,000 to 1,500 crossings) and would not change under Proposed Operations or any of the modeled flow scenarios. The significance of this level of risk could increase in extremely harsh winters, or if predation increases as a result of growing cougar populations in the region. The significance could decrease if habitat improvements on adjacent lands are successful and hunting regulations result in lower predator populations.

3.7.2.2 Special Status Plant Protection

Idaho Power's survey documented the presence of several rare plant species in the project area. Project operations, project-related maintenance, management activities, and recreational activities have the potential to disturb rare plant populations or to disturb the habitat that supports them.

To address these issues, Idaho Power proposes to establish a rare plant advisory board that would coordinate the efforts of resource management agencies, local landowners and land managers, and other interested individuals and organizations (e.g., The Nature Conservancy) in protecting sensitive species within the river corridor between the headwaters of Brownlee reservoir and the Salmon River confluence. Idaho Power envisions that the advisory board's responsibilities would include establishing priorities and

specific objectives for protection and monitoring; identifying opportunities for cooperative uses of resources and manpower; creating management zones to aid in effective treatments; identifying common inventory and mapping protocols; determining meeting and reporting frequency; and evaluating feasibility for introducing new rare plant populations. Idaho Power would also consider the goals and objectives of federal, state, and private land managers. Idaho Power notes that the rare plant advisory board should coordinate closely with the noxious weed advisory board (discussed in section 3.7.2.3) because the spread of noxious weeds and invasive exotic plants is one of the primary threats to sensitive species.

Interior-34 recommends that Idaho Power develop and implement a plan to manage threatened, endangered, and special status species on BLM-administered lands within the project boundary and on BLM lands affected by the project. Interior-34 recommends Idaho Power include specific provisions for three rare plants—porcupine sedge, Schweinitz flatsedge, and American wood sage.[78] At a minimum, the plan would identify goals and objectives, describe existing conditions, identify data needs, and provide for additional baseline surveys and for monitoring surveys (initially at 1-year intervals, and then every 5 years) to be conducted throughout the term of any new license. The plan calls for Idaho Power to consult with BLM and prepare a biological evaluation for any actions proposed on BLM lands that could affect sensitive species.

Interior-78 recommends that Idaho Power consult with federal and state agencies and tribes to develop and implement a sensitive plant species management plan. Interior-78 states that the plan should place special emphasis on protection and enhancement and additional surveys for four sensitive species (Hazel's prickly phlox, bartonberry, spacious monkeyflower, and stalk-leaved monkeyflower) and the federally listed MacFarlane's four-o'clock and Spalding's catchfly. Like the Threatened and Endangered Species Plan recommended in Interior-34, the sensitive plant species plan would identify goals and objectives, describe existing conditions, identify data needs, and provide for additional baseline surveys and for monitoring throughout the term of any new license. The plan calls for implementation of weed prevention and control measures in sensitive plant sites/habitats, consistent with the Integrated Weed Management Plan covered under Interior-77.

The Forest Service (FS-9) specifies that Idaho Power should develop a plan to manage Forest Service sensitive species on National Forest System lands affected by the project. Under this condition, Idaho Power would conduct surveys when new species are designated, conduct bi-annual monitoring for sites where sensitive species are confirmed by these surveys for the first 6 years of any new license term and at 3-year intervals thereafter, and re-evaluate after the 6th year to determine whether continued monitoring is necessary. Under this condition, Idaho Power would protect or restore confirmed sites if monitoring indicates they are declining in condition, and would update the plan to address any revisions to species' status.

IDFG-33 supports Idaho Power's proposal to establish a rare plant advisory board. IDFG further recommends that cooperative projects be designed to restore native plant communities, rather than focusing on individual sites or species.

ODFW-65 recommends that Idaho Power consult with ODFW and the TRWG to develop a sensitive species management plan to address species that are listed as threatened or endangered federally or in Oregon. ODFW-65 states that the plan is intended to provide long-term protection and enhancement

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[78] Interior-34 recommends that the Threatened, Endangered, and Sensitive Species Management Plan also address seven wildlife species; we address this recommendation in section 3.7.2.8, *Special Status Wildlife*.

of sensitive plants and their habitats in and adjacent to the project area.[79] The plan would identify goals and objectives, describe existing conditions, provide for coordination with noxious weed management, include effectiveness monitoring and modification of measures, as needed, and identify additional measures for research, mitigation, or enhancement opportunities if any new species are listed.

Our Analysis

Idaho Power documented 47 occurrences of 6 plant species during surveys of the Snake River corridor, 9 occurrences of 3 other rare plants during general vegetation inventories, and 10 occurrences of 1 rare plant along the Pine Creek-Hells Canyon transmission line. Assessment of the plant locations in relation to project-related activities indicates that 22 occurrences are at a moderate, high, or very high risk of disturbance. Without management, ongoing project operations (such as road maintenance) and project-related activities (such as trail use and dispersed recreation) are likely to disturb some existing occurrences of rare plants, and reduce the quality of native plant communities that could support additional populations. Implementing Idaho Power's proposal would improve protection over existing levels and help to support biodiversity in the region.

Addressing federally listed species within the same plan as other special status species, as recommended by Interior, could result in a more coherent, comprehensive plan for rare plants, maximize the efficiency of field efforts, and minimize the need for consultation that might otherwise be duplicative.

Idaho Power suggests that the rare plant advisory board would determine the most appropriate sites for plant protection or monitoring projects, but anticipates that locations would be within a 1-mile corridor along the Snake River. With this approach, Idaho Power could participate in projects outside the project boundary. Implementation of projects outside the project boundary could have substantial ecological benefits and would assist other landowners in meeting their own regulatory requirements for rare plant protection. We note that a 1-mile corridor along the river would include lands outside Idaho Power's ownership and would not necessarily link management measures with project effects. The same is true of the area specified in Forest Service preliminary 4(e) condition no. 9, which would encompass National Forest System lands within one-fourth mile of the project boundary, as well as National Forest System lands within the project boundary.

Interior-34 describes a more general scope for Idaho Power's management plan as it relates to BLM, i.e., that it should cover BLM-administered lands within the project boundary and BLM lands affected by the project. Interior-34 would specifically address BLM's regulatory requirements through a recommendation that Idaho Power prepare a BE to address potential effects of any proposed actions on its lands.

Interior recommends (Interior-34 and -78) that Idaho Power conduct additional baseline surveys in areas that were not previously surveyed for rare plant occurrences. Pre-licensing surveys covered about one-fourth of the land along the river corridor between Weiser and the confluence of the Salmon River with the Snake River. While Idaho Power's sub-sampling approach provided a thorough landscape-level inventory, additional baseline surveys at sites where ground-disturbance regularly occurs (e.g., existing recreation facilities) or is planned (e.g., new recreation facilities) could provide information that would be more useful in planning and implementing projects during any new license period.

Idaho Power's initial proposal indicates that the rare plant advisory board would determine the frequency of monitoring. Interior-78, IDFG-33, and ODFW-65 do not recommend how often monitoring should be conducted. The Forest Service (FS-9) and Idaho Power's alternative condition would both establish a uniform frequency of monitoring for rare plant occurrences. An alternative that allows for

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[79] ODFW-65 recommends that the Threatened, Endangered, and Sensitive Species Management Plan also address wildlife species, as mentioned in section 3.7.2.8, *Special Status Wildlife*.

determining an appropriate schedule based on site-specific threats to rare plant populations could prove both more effective and more economical.

3.7.2.3 Noxious Weed and Exotic Invasive Plant Management

Reservoir fluctuations and flow fluctuations can cause soil disturbance that creates conditions that promote the establishment and spread of noxious weeds and invasive exotic plants. Project maintenance, management activities, and project-related recreation can also cause soil disturbance, and act as vectors for the spread of weeds. Idaho Power has proposed a plan to monitor and manage weeds.

Idaho Power proposes to develop an integrated management plan to coordinate priorities and actions for preventing, eradicating, containing, and controlling non-native invasive plants and noxious weeds along the Snake River corridor from Weiser to the Salmon River confluence, focusing on riparian species and habitats in particular. Idaho Power would establish a noxious weed advisory board as the primary mechanism for coordination and implementation of weed management measures. Idaho Power would consult with federal and state resource management agencies in developing and implementing the plan, but would focus on cooperative efforts with local CWMAs, landowners, land managers, and other interested individuals and organizations.

Interior-23 calls for Idaho Power to submit to BLM a plan for use or application of pesticides on project lands or non-project lands adjacent to BLM-administered lands. Interior recommends that Idaho Power prepare an annual report detailing the use of pesticides.

Interior-77 calls for Idaho Power to consult with the federal and state agencies to develop and implement an integrated weed management plan for the prevention, suppression, and containment of exotic and/or invasive plant species, including noxious weeds. The plan would be incorporated into the IWHP and WMMP. The plan would include a weed inventory of project-affected and Idaho Power-owned lands; identification of criteria for determining where control activities would be carried out each year; evaluation of a full array of control methods; implementation of weed control actions in cooperation with affected public and private landowners and counties; implementation and effectiveness monitoring; and implementation of BMPs for facilities and land management. Interior specifies that Idaho Power should also apply BMPs to actions such as shoreline erosion control, soil stabilization, land acquisition, habitat restoration, and recreation, to promote establishment of native plants and prevent or slow invasions of non-native, noxious plants.

The Forest Service (FS-7) specifies that Idaho Power consult with the appropriate agencies, including the Forest Service, to prepare and implement an integrated weed management plan to apply to invasive non-native plant species, including noxious weeds, in the project area and on National Forest System lands affected by the project. The Forest Service condition is generally consistent with Idaho Power's proposal, but also specifies that Idaho Power create a Hells Canyon CWMA, in addition to a Noxious Weed Advisory Board. The plan would be updated at 5-year intervals.

IDFG-32 supports Idaho Power's proposed weed management measures. IDFG would cooperate with Idaho Power and other stakeholders to implement the weed management plan.

ODFW-66 recommends that Idaho Power should provide 5-year updates to the plan, and that the plan should include communication and coordination protocols, defined roles and responsibilities, schedules for annual reports, work plans, meetings, review and updates, definition of the land area for cooperative efforts, goals and objectives, a description of existing conditions and identification of data gaps. In addition to developing the management plan and establishing a Noxious Weed Advisory Board, ODFW recommends that Idaho Power establish a Hells Canyon CWMA.

Our Analysis

Noxious weeds and invasive non-native plants are a growing threat throughout the west. During Idaho Power's surveys of the riparian corridor from Weiser to the confluence of the Salmon River with the Snake River, biologists observed 1,905 separate weed populations and found that virtually every survey unit contained at least one weed population. Surveys of the Pine Creek-Hells Canyon transmission line corridor and service roads provided further indication that weeds are widespread throughout the project area.

Without management, weeds would continue to spread in the project area because of their abundance on adjacent lands, tolerance of a variety of soil and moisture conditions, and ability to out compete native plants. Project operations and human activity, in addition to wind, water, and animal transport, would continue to serve as vectors for weeds. Weeds will likely continue to spread, even with an appropriate management plan in place, but ongoing, coordinated efforts would help to slow this process.

Since 1999, Idaho Power has participated in several weed control projects initiated by CWMAs or others in the project vicinity, and has worked with ODFW and IDFG to implement pilot projects at Patch and Gold islands. Idaho Power's proposal to establish a Noxious Weed Advisory Board would formalize these activities and provide a systematic approach to long-term management.

For the most part, the agency modified terms, conditions and recommendations outline management plans that would be similar to Idaho Power's description of the purpose and function of the Noxious Weed Advisory Board. However, the Forest Service specifies (FS-7) and ODFW-66 recommends that Idaho Power establish a CWMA, in addition to the Noxious Weed Advisory Board.

Idaho Power anticipates that most cooperative projects would be implemented within approximately 1 mile of the project boundary. With this approach, management measures may not be directly linked to project effects. However, this approach recognizes the fact that weeds spread across ownership boundaries, and that in some cases, control measures outside the project boundary may be even more effective in preventing the spread of weeds than treatment inside the project boundary would be.

3.7.2.4 Road, Transmission Line, and Right-of-Way Management

Road and transmission line rights-of-way must be managed to maintain safe and efficient operating conditions, but management activities (e.g., brushing, mowing, herbicide treatment, removal of hazard trees) may adversely affect native plant communities and the wildlife species that use them. Management activities may promote the establishment and spread of noxious weeds and exotic plants, which, in turn, also adversely affect native plant communities.

Management activities have the potential to disturb wildlife. Disturbance during the winter can cause physiological stress to big game and communally roosting bald eagles. Disturbance during the breeding season can impair reproductive success of many bird species.

Idaho Power proposes to develop a transmission line O&M plan to address the effects of right-of-way management on botanical and wildlife resources. The primary components of the plan would include: (1) scheduling the timing and location of O&M activities so that they would occur outside critical periods for plants, raptors, nesting neotropical migrant birds and wintering big game; (2) restoring and revegetating disturbed sites; and (3) managing noxious weeds and invasive exotic plants. Idaho Power proposes specific monitoring programs for botanical and wildlife resources.

The Forest Service (FS-11) specifies that Idaho Power should consult with the Forest Service to develop a transmission line O&M plan. The goal of the plan would be to provide for communication and coordination regarding monitoring and adaptively managing all resource specific restoration, protection and management actions associated with segments of transmission line that occupy National Forest

System lands to conform to Forest Service standards. Although not specified in the preliminary condition, the Forest Service (FS-7) indicates in its justification statement that the plan should address avian collision and raptor electrocution, in particular, and disturbance of mountain quail habitat near Blue Creek and Big Bar.

ODFW-67 recommends that Idaho Power consult with ODFW and the TRWG to develop and implement an integrated transmission line O&M Plan to adaptively manage O&M activities within the transmission line and service road rights-of-way. Under this recommendation, Idaho Power would restrict the timing and location of O&M activities to protect certain wildlife species and botanical resources, including big game wintering range, sage and sharp-tailed grouse leks, nest sites of riparian birds, raptor nests, and bald eagle perching and roosting areas. In addition, ODFW recommends that the plan provide for Idaho Power to enhance and restore shrub-steppe habitat to mitigate for unavoidable impacts to sage and sharp-tailed grouse, and participate with ODFW and other state and federal agencies to enhance and restore shrub-steppe habitats in the Hells Canyon area. To provide further protection for grouse, Idaho Power would monitor sage and sharp-tailed grouse lek sites within 3 km of project transmission lines, annually inventory raptors nests, and provide annual reports of these monitoring activities to ODFW and TRWG.

ODFW-68 recommends that Idaho Power consult with ODFW and the Forest Service to develop and implement a detailed plan for guiding riparian and riverine vegetation management along the Oxbow-Pallette Junction Line (junction line 907). The plan would include measures to repair damage caused by routine, emergency and major O&M activities, including actions to reduce erosion, minimize the spread of noxious weeds, and mitigate for unavoidable impacts to riparian vegetation snags, and large trees.

ODFW-69 recommends that Idaho Power consult with ODFW and the TRWG to develop and implement a detailed monitoring plan, conduct monitoring for electrocution mortalities, and modify transmission lines if any species are reported electrocuted.

ODFW-70 recommends that Idaho Power implement measures to minimize the risk of bird collisions with transmission lines at known collision sites, conduct effectiveness monitoring, and modify measures, as needed.

ODFW-72 calls for Idaho Power to schedule O&M activities that use project roads so as to avoid crucial winter range during the winter months, and should initiate appropriate temporary road closures if human disturbance begins to negatively affect wildlife.

Our Analysis

As a result of the Commission's orders dated March 31, 2005, and October 25, 2005, the only transmission line remaining within the Hells Canyon Project boundary is transmission line 945. Transmission line 945 is located entirely within Hells Canyon. It runs along the eastern shore of Hells Canyon reservoir from Oxbow dam to Hells Canyon dam, a distance of about 22 miles. The line runs parallel to a paved road (Hells Canyon Road). Several short spur roads lead off the Hells Canyon Road to provide maintenance access to transmission line 945. Idaho Power's vegetation cover type mapping shows that more than 90 percent of the habitat within the right-of-way is classified as disturbed, with small amounts of shrub-steppe, perennial grassland, and rock also present. The line crosses several small, unnamed drainages that may support some riparian vegetation.

Idaho Power's surveys identified 10 occurrences of bartonberry within the right-of-way of transmission line 945 where it traverses the Payette National Forest. FWS (Snake River Fish and Wildlife Service Office) identifies bartonberry as a species of concern, and the Forest Service and BLM identify it as sensitive.

Idaho Power's surveys documented 114 occurrences of eight noxious weed species within the transmission line right-of-way. Weeds were widespread, with at least one species found in 50 of 57

survey units. Although several weed species were present in the same survey units where bartonberry occurred, they were not growing in proximity to rare plants and did not appear to pose an immediate threat.

A variety of wildlife species occur along or near transmission line 945, including small mammals, reptiles, songbirds, and raptors. Bighorn sheep use the steep cliffs above the right-of-way, and at least one mountain quail occurrence is documented above the right-of-way near Big Bar.

Under current conditions, Idaho Power conducts annual pole and line inspections, makes replacements and repairs as needed, and clears vegetation every 5 to 10 years. Idaho Power has no formal plan to prevent or reduce adverse effects of O&M on botanical or wildlife resources. However, Idaho Power annually monitors bird electrocutions along transmission line 45, maintains a database of all reported mortalities, and has modified pole structures within 0.62 mile of an active bald eagle nesting territory to reduce the risk of electrocution.

Idaho Power's evaluation of the effects of their routine inspections and maintenance pointed out that O&M could disturb nesting bald eagles and other raptors, roosting bald eagles, and wintering bighorn sheep. Evaluations of the effects of O&M on botanical resources indicated potential disturbance of bartonberry, and a high risk of spreading noxious weeds along service roads and at tower locations.

To address these concerns, Idaho Power proposes to develop BMPs for O&M of the transmission line and service roads. BMPs would be developed based on consultation with the Forest Service because transmission line 945 and the service roads traverse National Forest System lands. Idaho Power proposes to implement timing restrictions on O&M activities, based on the type of activity and on wildlife requirements and plant phenology; and rehabilitate habitat after ground-disturbing O&M. Idaho Power would use the results of annual raptor nest surveys and ongoing electrocution monitoring to identify any need to modify measures.

Idaho Power's proposal would benefit terrestrial resources by providing a formal framework for identifying, monitoring, and addressing potential adverse effects of O&M. Terrestrial resource concerns would also be addressed by Idaho Power's proposals for establishing a rare plant advisory board and a noxious weed advisory board, as well as implementing the project-wide IWHP and WMMP.

Idaho Power's proposal would likely meet the objectives of each of the federal and state agencies that submitted preliminary terms, conditions, or recommendations regarding project transmission lines, with the exception of those that pertain to transmission lines that are outside the project boundary. Those lines are outside the scope of this proceeding.

3.7.2.5 Upland and Riparian Habitat Acquisition

Continued operation of the Hells Canyon Project would adversely affect more than 20,000 acres of wildlife habitat. Idaho Power's studies indicated that most impacts would be associated with reservoir fluctuations. Reservoir fluctuations reduce the abundance and connectivity of riparian habitat, limit waterfowl brooding habitat, decrease the suitability of shoreline areas for many wildlife species, and contribute to shoreline erosion. The presence and operation of the reservoirs also reduces the habitat capability of mule deer winter range and increases annual winter mortality.

To address these ongoing project effects, Idaho Power (2003a) indicated that it would acquire and manage 23,582 acres of habitat for wildlife. Idaho Power worked with the TRWG between 1996 and 2001 to develop a process for identifying and prioritizing potential parcels of land for acquisition, and followed up on this process in response to the Commission's AIR TR-1, dated May 4, 2004. Idaho Power and the TRWG assigned the highest priorities for acquisition to large, contiguous blocks of land near the Hells Canyon Project that would provide riparian and/or upland habitat for threatened, endangered, candidate, and sensitive species; waterfowl; big game; upland game birds; aquatic furbearers; amphibians; and neotropical migrant birds.

In its response to AIR TR-1, Idaho Power proposed to manage 2,990 acres of land in its ownership for wildlife, and if possible, to acquire the Daly Creek Ranch, Cottonwood Creek (or Lawrence) property, Sturgill Creek property, and Rocking M Ranch. Since filing the response to TR-1 in 2005, Idaho Power has completed the purchase of the Daly Creek Ranch (10,212 acres) in Oregon and the Cottonwood Creek property (1,971 acres) in Idaho. Idaho Power has signed an agreement to purchase the Sturgill Creek parcel (6,115 acres), also in Idaho. Together, the Idaho Power lands, the two parcels acquired to date, and the land to be purchased at Sturgill Creek total 21,288 acres. Acquisition of the Rocking M Ranch is expected to bring the total to 24,191 acres, which would exceed Idaho Power's initial proposal to acquire and manage 23,582 acres.

Several agencies and tribes submitted preliminary terms, conditions, or recommendations regarding acquisition of mitigation lands. While similar in some respects, the recommendations reflect different conclusions about the amount of land the project affects; whether studies to date have been adequate to establish the amount of land affected; the difficulty of replacing affected habitats; and the length of time it would take for replacement habitat to provide equivalent functions and values for wildlife. Table 69 shows Idaho Power's proposal and the minimum acreage that would be acquired under each agency or tribal recommendation.

Interior-35 states that BLM's priority is to mitigate for project effects on BLM lands on site and in kind; thus, priority sites include low elevation riparian and upland habitats contiguous to the project reservoirs. Interior recommends a compensation ratio of 2:1 for fluctuation effects on uplands; 3:1 for fluctuation effects on riparian habitat (including islands); and 10:1 for erosion effects on riparian habitat. BLM's recommendation for compensation for project effects on mule deer winter range uses the same formulas developed by Idaho Power (Edelmann, 2003).

Under Interior-35, Idaho Power would also fund a planting feasibility assessment to determine if riparian plantings can successfully address shoreline erosion around the project reservoirs. If revegetation efforts were unsuccessful, this recommendation would have Idaho Power acquire 224 acres of riparian habitat. If efforts were successful, the amount of riparian habitat acquired could be reduced.

Interior-76 would address project effects throughout the project area. The recommendation specifies that Idaho Power consult with the agencies to develop and implement a plan that would provide for no net loss of habitat units or value due to the construction or operation of the project, and seek to establish or protect the same resource abundance and habitat productivity as existed prior to construction of the project and inundation of the habitat. Priorities for acquisition would be low elevation riparian habitat contiguous to Hells Canyon reservoir and the Snake River downstream of Hells Canyon dam to the Salmon River confluence.

Interior-76 recommends a compensation ratio of 2:1 for fluctuation and inundation effects on upland habitat and 3:1 for fluctuation and inundation effects on riparian habitat, including 591 acres downstream of Hells Canyon dam. Interior-76 recommends a ratio of 10:1 for erosion effects on shoreline habitat and 1:1 for loss of habitat capability and higher mortality on mule deer winter range. As an alternative to fixed compensation ratios, Interior recommends Idaho Power use (Habitat Evaluation Procedure (HEP) to determine appropriate mitigation levels. Like Interior-35, Interior-76 also calls for a riparian planting feasibility assessment, but would not recommend reducing the acreage acquired if planting were successful. In comments on the draft EIS, Interior indicates that higher compensation ratios may be needed only if Idaho Power is unsuccessful in acquiring all four target parcels within a reasonable period of time following license issuance.

Table 69. Minimum acreage proposed or recommended for acquisition to address project effects on terrestrial resources. Proposed or recommended mitigation ratios are shown in parentheses. (Source: Staff)

Entity	Upland Acres (ratio)	Riparian Acres (ratio)	Riparian Acres Downstream of Hells Canyon Dam (ratio)	Shoreline Erosion (ratio)	Low Elevation Mule Deer Winter Range (ratio)	Total Acreage Proposed or Recommended for Acquisition
Idaho Power: Addresses operational effects	5,761 (1:1)	731 (1:1)	--	90 (1:1)	17,000 (1:1 x 0.19)	23,582
Interior-35: Addresses operational effects on BLM-administered lands	3,010 (2:1)	594[a] (3:1)	--	224 (10:1)	16,578 (1:1 x 0.19)	20,406
Interior-76: Addresses construction and operational effects	16,694 (2:1)	5,619[a] (3:1)	1,773 (3:1)	900 (10:1)	16,761 (1:1 x 0.19)	41,747
FS-6: Addresses operational effects on National Forest System lands	5,761(1:1)	731 (1:1)	56.3(1:1)	90 (1:1)	17,000 (1:1 x 0.19)	23,638
IDFG-28: Addresses operational effects	5,761 (1:1)	731 (1:1)	--	90 (1:1)	17,000 (1:1 x 0.19)	23,582
ODFW-61: Addresses construction and operational effects	9,182 (1:1)	3,085[a] (1.5:1)	296 (1.5:1)	122 (1:1)	23,054[b] (1:1 x 0.19)	35,739
Nez Perce Tribe: Addresses construction and operational effects						Not indicated
Burns Paiute Tribe: Addresses construction and operational effects						Not indicated
Shoshone-Paiute Tribes: Addresses loss of anadromous fishery						10,000

[a] Includes mitigation for 285 acres of islands inundated as a result of project construction.

[b] In its comments on the draft EIS, ODFW notes that the 23,054 acres of mule deer winter range should include 1,452 acres of riparian habitat and 21,602 acres of upland habitat to mitigate for mule deer mortality associated with project reservoirs and operations.

The Forest Service (FS-6) reflects Idaho Power's proposal for land acquisition, as outlined in its response to AIR TR-1, while providing additional mitigation for effects on 49 acres of shore and bottomland wetland and 7.3 acres of riparian habitat on National Forest System lands downstream of Hells Canyon dam. Following discussions regarding alternative 4(e) conditions, Idaho Power agreed to FS-6. Like Interior's recommendations, the Forest Service specifies a riparian planting feasibility assessment. Under this condition, Idaho Power would coordinate with the Forest Service within 2 years of license issuance to design and install control measures to correct active erosion problems around the project reservoirs and along the Snake River downstream of Hells Canyon dam. Idaho Power would acquire additional land to mitigate for the loss of riparian habitat at sites where erosion control is deemed infeasible. Under this preliminary condition, Idaho Power would survey for new erosion sites at 5-year intervals.

IDFG-28 supports Idaho Power's proposal for acquisition and management. IDFG recommends that the newly acquired lands should be located adjacent to or contiguous with the project area, and should replace or create the same habitat types that have been adversely affected. IDFG indicates that the lands should be equitably distributed between Oregon and Idaho, and should remain available in perpetuity for public use. However, in its comments on the 10(j) meeting, IDFG suggested that the highest priority should remain high value lands, whether in Idaho or Oregon (letter from IDFG dated January 27, 2007).

IDFG-29 points out that more than 16,000 acres of public lands are attached as grazing allotments to the proposed private property acquisitions. IDFG suggests that improving grazing management on these allotments could substantially expand the benefits of acquiring the base properties alone.

IDFG-29 recommends that if lands are not available that would meet the criteria outlined in IDFG-28, Idaho Power should develop an alternate mitigation strategy that would allow for acquiring additional acreage. IDFG indicates that an appropriate compensation ratio would be at least 2:1, if acquired lands are off site or out-of-kind.

ODFW-61 recommends that Idaho Power consult with ODFW and the TRWG to develop and implement a land acquisition and management program. Under this recommendation, Idaho Power would employ mitigation ratios of 1:1 for the effects of reservoir inundation and fluctuation on upland habitat and 1.5:1 for effects on riparian habitat (including 197 acres below Hells Canyon dam), if lands are located within the 2,100 feet elevation contour. Under ODFW's recommendation, if lands could not be acquired at low elevations, but were still located around the reservoirs, the amount of upland habitat Idaho Power should acquire would remain the same, but additional riparian habitat would be acquired, to meet a mitigation ratio of 3:1. If lands could not be acquired around the reservoirs, mitigation ratios would be 3:1 for uplands and 5:1 for riparian habitat.

ODFW-61 calls for Idaho Power to consider parcels located around Brownlee reservoir, the Powder River arm, and the Lookout Mountain and Pine Creek Management Units for acquisition or easements. In setting priorities for acquisition, ODFW indicates that criteria should include numbers of species positively affected, habitat connectivity, habitat values, and public access for hunting, fishing, and observation, and proximity to other public lands or high value lands. Under this recommendation, properties that would benefit both aquatic and terrestrial species (e.g., riparian habitats) would be given a higher priority than would be assigned to those that benefit single species or species types.

ODFW-71 recommends that Idaho Power study the effects of a harsh winter and reservoir icing on mule deer. The study results would be used to determine whether the habitat coefficient Idaho Power has applied is adequate to account for reduced habitat capability and higher winter mortality, or whether additional mitigation would be needed.

The Nez Perce Tribe recommends that Idaho Power purchase lands to fully mitigate for impacts to wildlife habitat caused by the filling and operation of the project reservoirs. Under this

recommendation, the acquired lands would closely resemble the types of habitat lost, focusing on low-elevation riparian habitat in particular. The tribe states that Idaho Power should give the highest priority for acquisition to lands that are already developed or are under threat of development, to allow for a net gain in habitat value. Under this recommendation, Idaho Power would give the second priority to in-holdings within the HCNRA, and third priority to other lands, spatially distributed between the northern and southern reaches of Hells Canyon.

The Burns Paiute Tribe recommends that Idaho Power establish a terrestrial resource task force. The role of the task force would be to assist in developing an initial, quantifiable assessment of wildlife losses associated with the construction, inundation, and operation of the project; identifying criteria for land acquisition; and annually reviewing Idaho Power's progress in mitigating wildlife losses. The tribe recommends use of HEP as a tool for assessing wildlife losses.

The Shoshone-Paiute Tribes also calls for establishment of a terrestrial resource task force. The tribe's recommendations specify that Idaho Power should use HEP to determine suitable habitat units for mitigation and that about 10,000 acres of lands acquired for mitigation should be located adjacent to or near the Duck Valley Indian Reservation, and should be held in fee title by the Shoshone-Paiute Tribes.

Our Analysis

Proposed and Recommended Acreage of Acquired Lands

Idaho Power's proposal would bring 20,592 acres[80] of land into the project boundary for management as wildlife habitat through any new license period, together with 2,990 acres already in Idaho Power's ownership. Idaho Power's proposal is based on the results of numerous studies to quantify ongoing project effects on botanical and wildlife resources. The proposal would replace acreages and habitat values that have been reduced as a result of reservoir operation with roughly the same amounts and types of habitats. Table 70 shows the acreage of various project effects, as identified in Idaho Power's terrestrial resource studies. Table 71 shows the acreage of project effects that may occur during any new license period, based on staff analysis.

Table 70. Acreage of current project effects, by habitat type. (Source: Edelmann et al., 2003b; USFS, 2006, modified by staff)

Location of Affected Acres	Riparian Acreage	Upland Acreage	Total Acreage
Brownlee reservoir fluctuation zone	372	5,448	5,820
Brownlee reservoir shoreline riparian	343	--	343
Brownlee reservoir shoreline erosion	79.07	--	79
Oxbow reservoir fluctuation zone	7	82	89
Oxbow reservoir shoreline riparian	--	--	--
Oxbow reservoir shoreline erosion	1.34	--	1.34
Hells Canyon reservoir fluctuation zone	9	231	240
Hells Canyon reservoir shoreline riparian	--	--	--

[80] For consistency, we continue to refer to Idaho Power's proposal as including 20,592 acres that would be acquired, plus 2,990 acres of land already in their ownership that will be dedicated to wildlife. However, as mentioned above, the actual acreage of the four parcels acquired, plus the 2,990 acres already owned, will likely total 24,191.

Location of Affected Acres	Riparian Acreage	Upland Acreage	Total Acreage
Hells Canyon reservoir shoreline erosion	3.45	--	3.45
Shore and bottomland wetland downstream of Hells Canyon dam[a]	49		49
Shoreline erosion downstream of Hells Canyon dam	6.34	--	6.34
Mule deer winter range[b]	--	--	17,000
Total	869.7	5,761	23,630.7

[a] The Forest Service estimates that the combined project effects of load following and limited sediment supply prevent the establishment of about 49 acres of sandbar willows that could otherwise establish within the scour zone (shore and bottomland wetland) below Hells Canyon dam.

[b] Includes habitat coefficient of 0.19 applied to 86,408 acres of crucial mule deer winter range around Brownlee reservoir, plus habitat coefficient of 0.10 applied to 5,820 acres in the Brownlee reservoir fluctuation zone.

Table 71. Acreage of anticipated project effects resulting from change in flow regime and shoreline erosion). (Source: Edelmann and Huck, 2005; staff)

Location of Affected Acres	Riparian Acreage	Upland Acreage	Total Acreage
Brownlee reservoir shoreline erosion	59.3	0	59.3
Oxbow reservoir shoreline erosion	1.1	0	1.1
Hells Canyon reservoir shoreline erosion	3.3	0	3.3
Riparian/wetland habitat downstream of Hells Canyon dam[a]	13.2	0	13.2
Shoreline erosion downstream of Hells Canyon dam	6.1	0	6.1
Upland acreage associated with riparian habitat acquisitions	0	0	0
Total	83	0	83

[a] Acreage would depend on flow alternative; maximum area of effect would be 29.8 acres (see section 3.7.2.1).

Under its proposal, Idaho Power would acquire (and at this time, has acquired) parcels of private land that are located adjacent to or near the project reservoirs, at relatively low elevations. These parcels would provide on-site, in-kind habitat, similar to uplands and riparian areas affected by project operation, and would benefit the species identified by the TRWG as having high priority (e.g., big game, raptors, and threatened, endangered, candidate, and sensitive species).

Implementation of FS-6 would have the same effects as Idaho Power's proposal, with an additional 49 acres to compensate for ongoing effects of project operation on shore and bottomland wetland along the Snake River downstream of Hells Canyon dam that can no longer support native willows. In addition, FS-6 specifies that Idaho Power acquire 7.3 acres of riparian habitat to mitigate for predicted effects of implementing Idaho Power's proposed flow regime, as evaluated in the final license application. Idaho Power notes that about 25 acres of upland must be acquired for each acre of riparian habitat, which would bring the total acreage for these elements of the acquisition package to 1,408 acres.

Implementation of IDFG-28 would have the same effects as Idaho Power's proposal, assuming all acreage targets could be met near the project. Implementation of IDFG-29 would expand the area that could be improved beyond simple fee acquisition, by coordinating management on federal or state grazing allotments. Idaho Power's response to AIR TR-1 indicates it would consult with BLM to

investigate the possibility of coordinated management of the Ruth Gulch and Daly Creek allotments, which are attached to the Daly Creek base property. IDFG-29 also calls for Idaho Power to acquire land at a 2:1 ratio, if target parcels are not available.

Interior (Interior-35 and -76) recommends that Idaho Power use a 3:1 ratio to compensate for project effects on riparian habitat and 2:1 for uplands. In its justification statement, Interior states that BLM has limited formal guidance regarding replacement ratios, but that precedents on various districts depend on the resource, the suitability of the replacement habitat, the distance from the project, and the acquisition of lands that serve a similar or suitable functional component, regardless of the size or dollar value of the land. More recently, in Interior's comments on the draft EIS, Interior indicates its objectives would be met if Idaho Power can acquire all four target parcels within a reasonable amount of time following license issuance. Interior recommends a higher mitigation ratio for lands not yet acquired, if Idaho Power is unsuccessful in purchasing all four parcels.

ODFW recommends ratios ranging from 1.5:1 to 5:1 for riparian habitat, and from 1:1 to 3:1 for uplands, depending on elevation and proximity to the reservoirs. ODFW states its mitigation policies are value-based, requiring no net loss of habitat quantity or quality for uplands, and net benefits of habitat quantity or quality for riparian habitat. Additionally, Interior and ODFW reference guidelines developed by several state and federal agencies to address wetland mitigation projects across the U.S. Wetland mitigation ratios are generally higher than 1:1, reflecting the technical difficulties and low rate of success in creating or re-establishing wetland functions and values under new soil and hydrologic conditions, and the length of time it takes to achieve the functions and values that were lost.

We find that acreage ratios based on typical wetland mitigation requirements would not apply to this project because Idaho Power's proposal and the agency recommendations target the acquisition and enhancement of uplands (including shrub-steppe and native grasslands) and riparian habitats (which may include wetlands), rather than wetland creation or re-establishment.

The mitigation value of the parcels within Idaho Power's proposal is based on several factors. These include: (1) locations contiguous with the reservoirs, with Idaho Power's existing ownership, and/or with large blocks of wildlife habitat on public lands; (2) large size; (3) existing and potential high-priority habitats (e.g., shrub-steppe, grasslands, wetlands, seeps and springs, cottonwood and willow stands); and (4) the documented presence of high-priority wildlife species. Idaho Power's response to AIR TR-1 indicates that all four parcels in its proposal provide important winter range for big game. Among the four parcels, they also support western toads, nesting raptors, neotropical migrant birds, upland game birds, burrowing owls, nesting and breeding waterfowl, migrating shorebirds, aquatic furbearers, and the southern Idaho ground squirrel.

To ensure that these parcels provide wildlife benefits that would offset project effects, Idaho Power proposes to develop and implement site-specific management plans.[81] Working with the IWHP workgroup (which would have functions similar to the TRWG), Idaho Power would measure baseline conditions, identify desired conditions, and implement treatments to improve conditions (e.g., grazing management, fencing to exclude livestock from riparian areas, weed control, riparian plantings, shrub-steppe seeding, and recreation restrictions).

Currently, grazing is the primary land use on each of the four parcels. Grazing and associated weed invasion have affected habitat quality on uplands and riparian habitats throughout the Snake River basin, and likely have affected habitat quality on the parcels included in Idaho Power's proposal.

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[81] Site-specific management plans would be developed as part of a project-wide Wildlife Mitigation and Management Plan (WMMP). The WMMP would apply to lands already in Idaho Power's ownership and to lands acquired for mitigation. Section 3.7.2.7 provides a more detailed description of this plan, and how it relates to Idaho Power's proposed IWHP.

Riparian habitat responds positively and rapidly to livestock management and weed control (NRC, 2002; Mosley et al., 1999). Upland habitats also respond positively, but more slowly, depending on site-specific conditions, and often require aggressive enhancement measures to maximize benefits (Bunting et al., 2002). Expected improvements in habitat quality over time, together with the physical location of the parcels and the fact that they are contiguous to other lands that are being or will be managed for wildlife, should result in net benefits for both riparian and upland habitats.

Under Idaho Power's proposal, Idaho Power would monitor the effectiveness of treatments over time. Management plans would be adapted and updated at intervals through any new license period, based on the results of monitoring, availability of new management techniques, or changes in resource needs.

Under ODFW-61, Idaho Power would acquire a minimum of 35,739 acres; however, it is unlikely that all or even most parcels would lie at elevations meeting ODFW objectives, and additional land would have to be purchased to make up the difference. The Nez Perce Tribe does not specify a mitigation acreage, but under their recommendation, Idaho Power would acquire land to mitigate for original project inundation. The Shoshone-Paiutes Tribes recommends Idaho Power acquire at least 10,000 acres. The benefits of Idaho Power's acquisition of larger acreages under these agency or tribal recommendations would be that more land in the project vicinity would be protected and managed for wildlife than under Idaho Power's proposal.

As an alternative to fixed compensation ratios, Interior recommends that Idaho Power conduct a HEP to quantify project effects and determine the amount of habitat needed for compensation. The Burns Paiute and Shoshone-Paiute Tribes also recommend using HEP to quantify habitat losses and mitigation needs. The effect of conducting a HEP would be to provide additional, more detailed information about pre-project conditions in areas now occupied by project reservoirs and associated facilities. However, a review of Idaho Power's studies to date indicates that adequate information is already available regarding the effects of ongoing project operation, and the amounts and types of habitat needed for mitigation. As mentioned above, Idaho Power would work with the IWHP workgroup to conduct additional, detailed assessments of habitat quality on lands acquired for mitigation; identify habitat goals and objectives; implement appropriate enhancement methods; and monitor changes over time to measure progress toward desired conditions.

Geographic Distribution of Acquired Lands

In addition to low elevation, the TRWG identified proximity to project effects as being one of the highest priorities for selecting parcels of land for acquisition. This approach is consistent with most federal and state mitigation policies, which specify on-site, in-kind compensation as having the highest value for habitat replacement. Idaho Power's response to AIR TR-1 reflects this prioritization. All four of the major land parcels included in Idaho Power's proposal are located adjacent to Brownlee reservoir, where project effects are most evident. Proposed parcels are about evenly divided between the west and east sides of the reservoir, with adjustments to take advantage of specific opportunities (e.g., presence of high priority habitats, extending habitat connectivity).

Implementation of Idaho Power's proposal would not provide any enhancement for terrestrial resources downstream of Hells Canyon dam, where Idaho Power estimates that project operation has caused about 6 acres of erosion between the dam and the Salmon River confluence. Alternatives to address this issue include on-site stabilization and revegetation of 6 acres of existing erosion sites, plus purchase of 6 acres of riparian habitat on private land within the boundaries of HCNRA to mitigate for continued erosion effects during any new license period. Idaho Power identified, mapped, and evaluated several private in-holdings. These parcels ranked low, primarily because of their distance from the project. Idaho Power would have no effective means of managing lands located at about RM 208, about 40 miles downstream from any other Idaho Power ownership.

Implementation of Idaho Power's proposal would not provide any enhancement for terrestrial resources near the Duck Valley Indian Reservation, located approximately 170 miles south of upper Brownlee reservoir. Studies did not indicate any project effects on terrestrial resources in the vicinity of the reservation.

Mule Deer Winter Range

Review of pre-project aerial and oblique photographs, General Land Office records, and interviews with agency biologists indicated that land uses (primarily unrestricted grazing since the turn of the last century) had severely affected range conditions and virtually eliminated riparian vegetation by the time the Hells Canyon Project was built (Blair et al., 2003b). While conditions downstream of Hells Canyon dam have improved dramatically in response to changes in land management practices within the HCNRA and conditions along the Hells Canyon and Oxbow reservoirs are now stable, invasive non-native weeds and grazing on public and private lands continue to affect habitat around Brownlee reservoir.

The project affects mule deer primarily by reducing the availability of high-quality winter range at low elevations around Brownlee reservoir. Mule deer that winter at higher elevations experience higher rates of mortality. Mule deer have a special importance in the region because of their ecological role, cultural significance, and the recreation opportunity they provide. They also are an important economic resource. ODFW and IDFG estimate economic benefits ranging from $1.43 to $2.9 million annually in Oregon and $335,645 to $1,512,632 annually in Idaho (letter from ODFW dated February 21, 2007; letter from IDFG dated January 27, 2007). For these reasons, mitigation for mule deer is a high priority both in Idaho Power's proposal and as part of agency terms, conditions, and recommendations.

Based on a combination of field studies and modeling of mule deer use of winter range in the vicinity (Edelmann, 2003), Idaho Power found that mule deer concentrated around Brownlee reservoir, and that most mortalities occurred along the shoreline. Idaho Power estimated that a habitat coefficient of 0.10 would reflect reduced habitat capability and an additional factor of 0.09 would account for increased mortality in harsh winters (Edelmann et al., 2003b). Idaho Power proposes to acquire 17,000 acres to address ongoing project effects that contribute to mortality and decrease habitat capability of 86,408 acres of crucial mule winter range near Brownlee reservoir between full pool and 2,700 feet, and on 5,820 acres of low-elevation winter range that is precluded from establishing within the reservoir drawdown zone.

Interior-34 states that BLM agrees with Idaho Power's proposal. However, Interior-34 applies the habitat coefficient of 0.1 to high elevation winter range, as well as low elevation winter range, and calculates that Idaho Power should acquire an additional 160 acres to mitigate for effects on BLM-administered lands.

Interior-76 and IDFG-28 are based on the same calculations Idaho Power used to estimate project effects on mule deer winter range. Implementation of these recommendations would have the same effects as Idaho Power's proposal, in terms of mitigating project effects on winter range.

ODFW concludes that the Hells Canyon Project affects 121,337 acres of crucial winter range for mule deer around Brownlee, Oxbow, and the southern half of Hells Canyon reservoir, at elevations between full pool and 3,200 feet. Although ODFW states that the project may be responsible for 10 to 30 percent of annual winter mortality, application of the 0.19 habitat coefficient used by Idaho Power indicates that Idaho Power should acquire and manage 23,054 acres to mitigate for direct and indirect mortality caused by project operations and reservoirs. ODFW-61 recommends that the 23,054-acre total include 1,452 acres of riparian habitat and 21,602 acres of upland habitat to reflect the proportion of each habitat type that is prevented from establishing in the Brownlee fluctuation zone.

With implementation of ODFW-61, Idaho Power would acquire 6,054 more acres specifically to mitigate for project effects on mule deer than Idaho Power proposes. However, all four parcels of land

within Idaho Power's 23,582-acre proposal provide winter range for mule deer. While Idaho Power's proposal contains less riparian habitat than ODFW recommends for acquisition, the mule deer studies indicated that deer concentrated in low elevation grasslands and shrublands during the winter, rather than in riparian habitat. For this reason, Idaho Power's proposal includes several measures intended to enhance uplands, as well as riparian habitat.

Implementation of some proposed and recommended aquatic resource measures would also help to support riparian habitat. Although designed to improve fish habitat, tributary enhancements in Pine, Indian, and Wildhorse creeks and several smaller tributaries and in the Powder and Burnt river basins would benefit wildlife, including mule deer.

ODFW-71 recommends additional field studies to verify that a habitat coefficient of 0.19 would accurately represent the project's direct and indirect contribution to mule deer mortality during a very harsh winter. Although Idaho Power's studies indicated that winter mortality since the filling of Brownlee reservoir does not appear to be reducing mule deer population viability, ODFW notes that predator-prey relationships have changed in recent years, as cougar numbers have increased. ODFW anticipates that the additional pressure of high predation rates during harsh winters could prevent mule deer populations from recovering, even during mild winters.

This situation points out the importance of managing predators, as well as improving habitat. ODFW has recently completed a draft Cougar Management Plan for the state (ODFW, 2006). In management units where mule deer herds have declined by 20 percent over the past 5 years or are 60 percent below the management objective for 3 years, ODFW would aim for more intensive cougar harvest. At the same time, implementation of Idaho Power's proposal would improve habitat capability for wintering mule deer through weed control, shrub-steppe and riparian plantings, and grazing management. Both of these approaches—predator management and habitat enhancement—would likely affect habitat coefficients under any winter conditions, but especially during harsh winters.

Riverine Riparian Habitat Downstream of Hells Canyon Dam

As described in section 3.7.2.1, *Riparian Habitat and Associated Wildlife*, load following operations downstream of Hells Canyon dam result in daily stage changes that influence soil moisture along the riverbanks above the scour zone and provide hydrologic support for riparian vegetation, while rocky substrates and annual peak flows prevent the development of significant perennial riparian vegetation within the scour zone itself (Braatne et al., 2002). Based on the results of modeling in response to the Commission's AIR OP-1(g), Idaho Power estimates that changes in the flow regime would result in the loss of 2 to 30 acres (approximately) of riparian habitat, depending on what flow regime is adopted because reductions in load following would reduce the irrigation effect on riparian habitat above the scour zone. Changes in the flow regime would also reduce the area of water, with corresponding increases in the area of shore and bottomland wetland within the scour zone. Changes would range from an increase of about 7 acres under the Flow Augmentation Scenario to about 111 acres under the Regulating Scenario (table 68). Idaho Power's acquisition proposal does not address changes in downstream riparian habitat that might occur during any new license period.

The basis for Interior-76 and ODFW-61 regarding mitigation for effects on riparian habitat is not entirely clear because each assumes a different area of impact. Interior-76 indicates 591 acres of riparian habitat are affected, attributing this estimate to the Forest Service, while the Forest Service states that 507.23 acres of shore and bottomland wetland are affected, based on Holmstead (2003a). ODFW indicates Idaho Power should mitigate for operational effects on 197 acres of riparian habitat downstream of Hells Canyon dam, also citing Holmstead (2003a). More recently, Forest Service comments on the draft EIS reflect their calculations that the current flow regime prevents the establishment of sandbar willow on 49 acres of the 329-acre shore and bottomland wetland zone (see table 70) (Braatne et al., 2002). The Forest Service estimates that Idaho Power's proposed project operations would affect 7.3

acres of a total 892 acres of forested, scrub-shrub, and emergent wetland above the scour zone. This estimate is based on assumptions described in the final license application regarding Idaho Power's proposed flow regime.

Implementation of Interior or ODFW recommendations would result in Idaho Power acquiring additional acreage as mitigation beyond the number of acres that Idaho Power has proposed. Acquisition and long-term protection of larger areas of land would provide incremental benefits to wildlife over Idaho Power's proposal, but such a program would not be clearly linked to project effects. Implementation of FS-6 would also result in Idaho Power acquiring additional acreage, but mitigation (49 acres) would be specifically linked to existing project effects on sandbar willows. As mentioned above, the Forest Service recommendation for 7.3 acres of land to mitigate for predicted effects on riparian habitat above the scour zone is based on information provided in the final license application. More recently, Idaho Power's response to AIR OP-1(g) indicated that implementation of Idaho Power's proposed flow regime would reduce riparian habitat by about 15.1 acres, rather than 7.3 acres. Implementation of other flow scenarios would reduce riparian habitat above the scour zone to varying degrees, ranging from approximately 2 acres to 30 acres.

Riparian Planting Feasibility Assessment

Idaho Power's shoreline erosion survey indicates that several factors contribute to erosion around project reservoirs and along the Snake River downstream of Hells Canyon dam (Holmstead, 2003b). In addition to reservoir fluctuations, these include wind and wave action, groundwater seeps, grazing, roads, and dispersed recreation activities. Reservoir operations do not have a strong influence on erosion processes that occur along the Oxbow or Hells Canyon reservoir shorelines because surface elevations are relatively stable. Idaho Power estimates a total of 1.34 acres of erosion at Oxbow reservoir and a total of 3.45 acres of erosion at Hells Canyon reservoir. By contrast, water level fluctuations at Brownlee reservoir are substantial, and Idaho Power estimates a total of 79.07 acres of erosion along the shoreline.

Idaho Power estimates a total of 6.34 acres of erosion along the river banks downstream of Hells Canyon dam. Idaho Power notes that most erosion sites are located upslope of the typical fluctuation zone, where they would be affected by boat-generated waves and dispersed recreation, as well as high flows.

Idaho Power's proposal would provide 1:1 mitigation for the acreage of erosion that has been documented to date along reservoir shorelines and the Snake River downstream of Hells Canyon dam (Holmstead, 2003b). In its license application, Idaho Power (2003a) concludes that the reservoirs are relatively recent features, and predicts that banks will continue to erode until shorelines reach equilibrium. Idaho Power concludes it may not be feasible to stabilize and revegetate most of the erosion sites because of the steep topography and remoteness of Hells Canyon. Idaho Power notes that managing human-caused factors that contribute to erosion (such as power boating, shoreline camping and hiking, vehicle access, and grazing) may be a more effective approach to erosion control.

Idaho Power's proposal does not take into account the acreage of erosion that is likely to occur during any new license period. Based on the age of each reservoir, the acreage of existing erosion, and an assumed constant rate of erosion, another 70 acres could be affected during the next 30 years.

Implementation of Interior-35, Interior-76, and FS-6 would provide a mechanism for systematically investigating the immediate causes of erosion at each existing site; evaluating soil and vegetation conditions; and designing site-specific treatments based on findings. The results could range from a confirmation of Idaho Power's earlier conclusions that on-site treatment would not be feasible at any of the sites to a finding that there would be a reasonable chance of success at all sites. If no treatments are successful, Interior specifies that mitigation should occur at a ratio of 10:1 for reservoir erosion. Interior-35 provides for reducing the amount of acquisition in proportion to the acreage of successful restoration. Interior-76 does not provide for any reduction. For sites where control measures

are not feasible, FS-6 specifies that Idaho Power should add to its riparian acquisition program. Like Idaho Power's proposal, Interior and Forest Service measures would not address erosion likely to occur in the future.

ODFW does not recommend stabilizing and replanting erosion sites. ODFW-61 recommends a mitigation ratio of 1:1 for 84 acres of erosion around the project reservoirs, and 38 acres along the river downstream of Hells Canyon dam that ODFW indicates the Forest Service has documented. The effects of ODFW's recommendation would be that Idaho Power would not address erosion sites where they are occurring and would not address 70 additional acres of erosion that could occur during any new license period.

3.7.2.6 Cooperative Wildlife Management Projects

Reservoir fluctuations at Brownlee reservoir adversely affect riparian habitats along the shoreline and on several small islands at the upper end of Brownlee reservoir, reducing their ability to support nesting and brooding waterfowl. Reservoir fluctuations also contribute to riparian habitat fragmentation along the shoreline, reducing its suitability for mountain quail. Idaho Power proposes to implement cooperative projects with state or federal agencies, or both, to address project effects on these species.

Island Habitat Enhancement Projects

Idaho Power proposes to provide funding ($26,000 annually through any new license period), equipment, personnel, logistical support, and expertise to IDFG and ODFW to support habitat enhancement projects on four Snake River islands. Idaho Power purchased the islands as mitigation for the effects of project construction on waterfowl and then conveyed title to the states to manage them. IDFG owns and manages Gold Island (331 acres), while ODFW owns and manages Patch (about 100 acres), Porter (about 70 acres), and Hoffman (60 acres) islands. The states have managed the islands primarily to provide waterfowl and upland game bird habitat, but lack of funding for management activities has resulted in a gradual decline of habitat values. Currently, non-native invasive weeds are the dominant vegetation on all four islands.

In IDFG-31, IDFG recommends that Idaho Power provide one-time funding for installation of a center pivot irrigation system on Gold Island at a cost not to exceed $100,000, and a higher level of annual O&M funding. IDFG-31 recommends Idaho Power provide $32,000 annually for O&M for the four islands, including $8,000 for projects undertaken on Gold Island. IDFG also recommends that Idaho Power cooperate with IDFG to develop a monitoring program to ensure that mitigation goals for this measure are met.

ODFW-62 recommends that Idaho Power establish a dedicated fund for cooperative management and maintenance of habitat values on the four Snake River islands through the term of any new license, and work with ODFW and IDFG to develop an Island Management Plan. ODFW-62 recommends that Idaho Power provide capital improvements funding totaling $198,800 for islands in Oregon, and annual operation and maintenance funding of $32,000 for the four islands. More recently, ODFW recommended Idaho Power participate in projects such as installing nest platforms and boxes, seeding grain to provide forage for waterfowl, enhancement of willows and other shrubs, and weed control (letter from ODFW dated February 21, 2007).

Our Analysis

Idaho Power's studies of vegetation, shoreline erosion, riparian habitat fragmentation, and waterfowl habitat use indicate that the potential for improving waterfowl habitat in the project area would be limited by ongoing reservoir fluctuations. Some benefits could be achieved on lands Idaho Power has proposed to acquire adjacent to the project, along the Powder River arm for example, where reservoir fluctuations have less effect. However, island habitat is unique in its connectivity with flowing water and

often provides safety for nesting birds from land-based predators. Neither of these characteristics can be replaced along reservoir shorelines. For this reason, it would be beneficial to implement cooperative projects on islands.

IDFG and ODFW have identified several projects that could be implemented on Hoffman, Porter, Patch and Gold islands to improve wildlife habitat. These include weed control, establishment of wildlife food plots, and planting of native riparian and upland trees, shrubs, and herbaceous vegetation. Idaho Power's participation in these projects could provide benefits to a variety of species, including waterfowl, colonial nesting waterbirds, raptors, neotropical migrant songbirds, and aquatic furbearers.

Idaho Power filed no information about the cost basis for its proposed level of funding at $26,000 per year (about $46 per acre for all four islands). IDFG did not indicate the basis for its recommendation of $8,000 per year ($24 per acre) for operation and maintenance on Gold Island, although IDFG mentions that it allocates $109 per acre for island management. ODFW did not indicate the basis for its recommendation of $32,000 per year for all four islands (about $57 per acre). However, IDFG and ODFW did provide itemized costs for capital improvements and equipment needed to initiate and continue enhancement projects.

As an alternative to Idaho Power's support for and participation in enhancement projects on the four state-owned islands, staff evaluated on-site options for island protection and enhancement. We found that reservoir fluctuations limit habitat suitability on islands within the project boundary. Staff also reviewed off-site options near the project, including Idaho Power's evaluation of two privately-owned islands upstream of Brownlee reservoir (Edelmann and Huck, 2005). Both islands (Westlake, 139 acres; and McCrea, 41 acres) support riparian habitat, but mitigation values were ranked as medium, based on the absence of high-value wildlife resources and low habitat diversity. Idaho Power's most recent estimate of $650 as an average per-acre acquisition cost indicates that purchasing these two islands would be relatively economical, but no information is currently available about existing conditions or the need for improvements, and consequently, about the cost of establishing or maintaining high quality wildlife habitat. Also, focusing Idaho Power's enhancement efforts on new acquisitions would represent a lost opportunity for enhancement of larger acreages, with known habitat concerns and known improvement costs, at the four islands that are already associated with Idaho Power's original license for the project. For these reasons, we conclude that Idaho Power's participation in enhancements at Porter, Hoffman, Patch and Gold islands, including annual operation and maintenance funding for equipment needed to initiate and maintain enhancement projects, would be a reasonable approach to providing mitigation for waterfowl.

Mountain Quail Habitat Enhancement

Project operation affects potential habitat for the mountain quail by preventing establishment of riparian vegetation along the Brownlee reservoir shoreline and limiting its extent along the shorelines of Oxbow and Hells Canyon reservoirs. Grazing on Idaho Power lands could reduce the cover of woody shrubs that provide important cover and forage for mountain quail, and project-related maintenance activities and recreation may cause some disturbance to this reclusive bird.

Idaho Power proposes to cooperate with state and federal wildlife management agencies to develop and implement a mountain quail restoration project by participating in enhancing low-elevation riparian habitat and reintroducing a mountain quail population. Idaho Power anticipates that state and federal wildlife management agencies would take the lead in identifying projects, and Idaho Power would provide funding, equipment, personnel, logistical support, and expertise to support them. Idaho Power would begin its participation within 1 year of license issuance, assuming a project or projects have been identified, and would continue participating through the next 5 years. If no projects have been specified at the time of license issuance, Idaho Power would participate as opportunities occur.

Forest Service (FS-10) supports Idaho Power's proposal. The Forest Service notes that any measures implemented on National Forest System lands would be subject to FS-1, which specifies that Idaho Power would notify the Forest Service prior to implementation of any habitat or ground-disturbing activities.

Under Interior-80, Interior recommended that Idaho Power develop a mountain quail management plan. Interior's comments on the draft EIS indicate that Interior's objectives would be met through Idaho Power's participation in mountain quail habitat enhancement and/or re-introduction projects led by the agencies. During the 10(j) meeting, Interior indicated that the Powder and Burnt River basins could provide important translocation sites.

ODFW-63 supports Idaho Power's proposal, as outlined by Idaho Power (2003a). ODFW recommends that Idaho Power should cooperate with an ODFW reintroduction study by providing personnel to assist with tagging, release, and monitoring of radio-marked quail in Hells Canyon. More recently, ODFW identified Spring, McGraw, and Fox creeks as potential sites for translocation projects (letter from ODFW dated February 21, 2007).

IDFG-30 supports Idaho Power's proposal for mountain quail habitat enhancement, as outlined in Idaho Power (2003a), but recommends that funding be directed toward assisting ODFW and IDFG with reintroduction efforts because other land acquisition and riparian habitat enhancement activities on new and currently owned lands should benefit future mountain quail population expansion and reintroduction. IDFG identifies several aspects of habitat enhancement that would be of particular benefit to mountain quail. These include increasing the extent and diversity of native woody plant species and the interconnectedness of riparian habitat, focusing on the use of plant species known to provide cover or food for mountain quail; evaluating the benefits of enhancing vegetation along the shorelines of Oxbow and Hells Canyon reservoirs, rather than Brownlee, where soil conditions and seasonal drawdown would prevent the establishment of suitable mountain quail habitat; and decreasing disturbance associated with recreation, roads, and project O&M activities. In comments on the 10(j) meeting (letter from IDFG dated January 27, 2007), IDFG indicates that several locations downstream of Oxbow dam, including Indian, Eckels, Allison and Deep creeks, should be considered high-priority sites.

Our Analysis

As summarized in the Habitat Conservation Assessment for Mountain Quail (Vogel and Reese, 1995), biologists noted declines in mountain quail populations in the intermountain west beginning in the early 1900s and the species has been nearly extirpated from eastern Washington, Oregon, Idaho and Nevada. The Conservation Assessment does not provide historical or current population numbers for populations, and Gutierrez and Delehanty (1999) and FWS (68 FR 14) note that lack of data about the historical distribution of the species makes it difficult to interpret population trends. The large number of translocation, reintroduction, and supplementation projects that have been implemented since the late 1800s further complicates this task.

Idaho Power biologists did not observe mountain quail during spring surveys for upland game birds, but did observe them incidentally at two locations downstream of Hells Canyon dam (Turley and Edelmann, 2003). Based on Idaho CDC records, Idaho Power also mapped one occurrence near Oxbow dam, one near Hells Canyon reservoir, and two near the Snake River downstream of Hells Canyon dam.

Idaho Power used GIS and a habitat suitability model for the mountain quail to assess habitat potential within one-half mile of reservoir shorelines and within one-fourth mile of the Snake River from Hells Canyon dam to the confluence with the Salmon River (Rocklage and Edelmann, 2003a). The assessment identified 2,500 acres of scrub-shrub wetland and forested wetland within this corridor that could likely provide high-quality habitat. Most of this is located along steep tributaries to Oxbow reservoir. Enhancement of existing riparian vegetation in the lower reaches of tributaries and along the reservoir shoreline could improve habitat quality and allow for secure movement of quail, if present,

between tributaries. Habitat enhancement projects could also be implemented as part of Idaho Power's IWHP/WMMP to benefit a wide variety of riparian-associated wildlife species, including mountain quail.

Interior, ODFW and IDFG recommend several sites to be considered for possible translocation projects. Idaho Power's participation in translocation projects could provide specific benefits to mountain quail recovery.

Implementation of Idaho Power's proposal would direct $100,000 in funding over a 5-year period, plus contribution of equipment and personnel, to specific projects developed by federal or state agencies. Benefits during this time could include on-the-ground habitat improvements; collection of new information about quail habitat requirements and behavior; and/or establishment of new populations in the project area. We conclude that this approach would be a useful means of addressing project effects that are difficult to quantify because of the imprecise historical record and the number of factors that may have contributed to the decline of this species.

3.7.2.7 Wildlife Management on Idaho Power Lands

In addition to project-related O&M, Idaho Power manages a variety of other land uses, including residential areas for employees, recreation sites, and specific leases and permits for agriculture and livestock grazing. These activities influence the abundance, distribution, and quality of wildlife habitat. Livestock grazing, in particular, has the potential to damage soils and native plant communities, promote the establishment and spread of invasive weeds, and increase competition with native ungulates for forage.[82]

To address these project effects, Idaho Power proposes to consult with agencies, tribes, NGOs, and other entities (which together would function as a work group, similar to the TRWG) to develop and implement an IWHP. The IWHP would provide guidelines for general stewardship, including restrictions on grazing, recreation, and maintenance activities that would help protect habitat and minimize disturbance to wildlife.

The IWHP would tier to the HCRMP (see section 3.12, *Land Management and Use*). The IWHP would be the mechanism for administering Idaho Power's wildlife management policies, environmental measures, and stewardship activities. Idaho Power also proposes to develop a WMMP to implement the programmatic goals and objectives and BMPs outlined in the IWHP, and to develop site-specific management plans and cooperative projects.

Idaho Power would designate wildlife lands as special management areas (SMAs) or wildlife management areas (WMAs). Currently, SMAs are small and focused on protecting a specific resource. As new wildlife lands are acquired, Idaho Power would assemble parcels that are geographically close, with common management issues and settings, into larger SMAs. Idaho Power would designate lands as WMAs to provide a broader emphasis on more diverse wildlife resources on larger parcels of land.

Interior-35 recommends that Idaho Power fund development and implementation of a Habitat Mitigation and Management Program (HMMP) and incorporate it into the IWHP and WMMP. The HMMP would be the principal instrument for acquisition, management, implementation, and monitoring of mitigation lands. The program would include criteria for acquiring parcels and conservation easements and a schedule for land acquisition and habitat improvement, as well as outlining goals, objectives, and management and monitoring procedures.

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[82] Participants in scoping identified a concern about the role of domestic sheep and goats on Idaho Power lands in transmitting disease to wild bighorn sheep. Idaho Power has eliminated sheep and goat grazing from lands in its ownership, and indicates it would do the same on any lands that are acquired for wildlife in the future.

Interior-76 recommends that Idaho Power develop a plan outlining a comprehensive strategy for terrestrial mitigation. The plan would be developed in cooperation with the agencies and tribes.

Interior-79 recommends that Idaho Power consult and coordinate with the agencies and tribes to develop and implement the HCRMP, IWHP, and WMMP. The recommendation specifies that the plan should incorporate an adaptive management element to implement environmental measures based on results from monitoring and evaluation. The recommendation further specifies annual reporting and work plans, updating the plan every 5 years (at a minimum), establishing monitoring protocols and schedules, and review cycles before reports are filed with the Commission.

Prior to implementing site-specific monitoring actions, Interior-79 recommends that Idaho Power establish baseline biological conditions for the resources that will be managed and monitoring, including estimates of pre-construction habitat conditions, as a means of ensuring that the amount of mitigation will offset project impacts. Interior states that HEP is the preferred procedure.

Forest Service (FS-5) supports Idaho Power's proposal, as outlined in its response to AIR TR-1, for preparation of an IWHP and WMMP to apply to lands within the project boundary and National Forest System lands adjacent to the project boundary that are affected by the project. The Forest Service specifies that Idaho Power should coordinate with the Forest Service in developing the plans. Under this condition, Idaho Power would develop and implement: (1) a monitoring program, including a process to establish baseline biological conditions for the resources that will be managed and monitored; and (2) an adaptive management process, including protocols and schedules, tailored to specific mitigation or management actions.

Forest Service (FS-6) specifies that Idaho Power finalize and implement the HCRMP, IWHP, and WMMP as outlined in Idaho Power's response to the Commission's AIR TR-1.

IDFG-28 recommends that Idaho Power implement its proposals for land acquisition and management as described in Idaho Power's response to the Commission's AIR TR-1. IDFG points out that acquisition alone does not necessarily mitigate for adverse impacts on wildlife habitat, and provides a number of specific recommendations regarding wildlife management and enhancement measures. IDFG also highlights the importance of protecting any acquired lands to ensure that they are protected in perpetuity, and that they remain available for public use.

ODFW-59 recommends that Idaho Power consult with ODFW and the TRWG, described below in ODFW-60, to develop and implement a comprehensive Terrestrial Resources Management and Mitigation Plan. The Terrestrial Resources Management and Mitigation Plan would address implementation, monitoring, and adaptive management of all restoration, protection, and management strategies. Under this recommendation, Idaho Power would consult with ODFW and the TRWG to review and evaluate monitoring results and develop the next year's proposals; complete required monitoring, and prepare an annual report summarizing the results. In consultation with ODFW and the TRWG, Idaho Power would update the Terrestrial Resources Management and Mitigation Plan every 5 years.

ODFW-60 recommends that Idaho Power establish a TRWG for the purpose of consulting in development of the Terrestrial Resources Management and Mitigation Plan; design of restoration, protection, management, and monitoring plans; and development of adaptive management or other recommendations. Under this recommendation, Idaho Power would be responsible for maintaining records of TRWG consultation and making them public. The TRWG would comprise representatives of federal and state agencies, tribes, NGOs, and other stakeholders. ODFW provides several specific recommendations about the role of the TRWG.

As mentioned in section 3.7.2.6, the Burns Paiute Tribe also recommends establishment of a terrestrial resources task force. Under the tribe's recommendation, the task force would annually review Idaho Power's progress in meeting the terms and conditions developed to mitigate wildlife losses.

The Shoshone-Paiute Tribes recommends that Idaho Power convene a terrestrial resource task force to ensure that the requirements of all projects and implementation of the new license provide protection, mitigation and enhancement measures for acquired land. Under this recommendation, Idaho Power would fund Tribal participation in the task force.

The Shoshone-Paiute Tribes also recommends that Idaho Power fund the development and implementation of wildlife management strategies for appropriate species on acquired lands (i.e., bald eagle and mountain quail) in consultation with appropriate federal agencies and tribes.

Our Analysis

Idaho Power's proposal to implement an HCRMP, IWHP, and WMMP would benefit wildlife and botanical resources on lands in its ownership and lands the company would acquire as mitigation for project effects. Idaho Power's proposal would help support biodiversity; restore and enhance native shrub-steppe, grassland, and riparian habitat; improve riparian habitat connectivity; and reduce traffic and noise disturbance at sensitive sites. The geographic arrangement of the SMAs and WMAs (i.e., those already in Idaho Power's ownership and those Idaho Power would acquire) in relation to large habitat blocks in public ownership would further expand the area of benefits. Cooperative management of grazing allotments that may be attached to acquired lands would add to this network. However, public land management responsibilities and methods may not parallel IWHP/WMMP priorities. With conflicting goals and objectives for management, there would be no assurance that cooperative management would result in benefits to wildlife.

The effects of the management recommendations outlined in Interior-35 and -76, FS-5 and -6, IDFG-28, ODFW-59 and -60 would be generally similar to those that would occur under Idaho Power's proposal. Despite the variety of names for wildlife management plans, all of the measures contain similar goals and objectives for protection, management and enhancement; recognize the need for effectiveness monitoring; and propose to use the results of monitoring to adaptively manage habitat. All of the measures specify that schedules for work planning, implementation, and reporting should be included in the management plan. All of the measures provide for establishment of a cooperative work group, but they differ in defining specific roles and responsibilities.

The effects of most aspects of Interior-79 would be similar to Idaho Power's proposals for wildlife management and several of the other agency and tribal recommendations, including the recommendation to establish baseline biological conditions for resources that would be managed and monitored. However, Interior-79 also recommends that Idaho Power establish pre-project baseline conditions. Interior recommends using HEP to accomplish both these objectives.

Using HEP to establish baseline conditions on lands that would be managed for wildlife might or might not provide the type of information that would be needed for later monitoring. While HEP is a useful tool for estimating large changes in habitat area or value, it is generally not as useful for measuring incremental effects of specific habitat management applications. Tailoring Idaho Power's monitoring protocols to adaptive management proposals would be more likely to provide the specific information needed to evaluate and adjust restoration and enhancement efforts.

Conducting a HEP to establish pre-project baseline conditions would provide additional detail and quantification about the impacts of inundation on wildlife habitat. The information would have limited use, however, because the results of Idaho Power's terrestrial resource studies already provide the level of detail needed to determine the acreage of upland and riparian habitats that should be acquired to help offset ongoing project effects; the existing review of habitat conditions in the basin clearly indicates resource needs; and the TRWG has already identified priorities for acquisition, management, and enhancement.

3.7.2.8 Special Status Wildlife

Idaho Power identified 68 special status species in the project vicinity (Turley and Holthuijzen, 2003d), and evaluated potential project effects on sites where these species occur (Dumas et al., 2003b). Idaho Power concluded that activities associated with roads, recreation, and transmission line O&M could cause disturbance to some species. Idaho Power does not propose to develop focused management plans for any special status species, but proposes to implement cooperative measures for mountain quail and waterfowl, and has identified several specific projects needed to protect wintering big game, bald eagle nests and roosts, bat hibernacula, neotropical migrant songbirds, and colonial nesting waterbirds. Proposals to acquire and manage lands for wildlife would afford other opportunities for Idaho Power to manage special status species where they are present.

Two agencies—BLM and ODFW—recommend development of overall management plans for threatened, endangered, and sensitive species. The Forest Service recommends development of a plan to address threatened and endangered species, and a separate plan to address Forest Service sensitive species. FWS recommends that Idaho Power develop specific plans to protect the southern Idaho ground squirrel, bats, amphibians, and reptiles. We discuss these recommendations below.

Threatened, Endangered and Sensitive Species Management Plan

Under Interior-34, Idaho Power would need to develop and implement a Threatened, Endangered, and Sensitive Species Management Plan for BLM-administered lands within the project boundary and on other BLM lands affected by the project.[83] The plan would include specific provisions for osprey, peregrine falcon, great blue heron, Columbia spotted frog, Townsend's big-eared bat, spotted bat, and Idaho ground squirrel.

According to Interior-34, within 2 years of license issuance Idaho Power would need to conduct additional surveys in potential habitat that was not previously surveyed to evaluate project effects on special status species on BLM-administered lands. Idaho Power would annually monitor selected sites and habitats for 5 years following plan implementation, and every 2 years thereafter. Idaho Power would evaluate the effectiveness of management and enhancement actions, and would update surveys, monitoring and adaptive management, as needed. Finally, Interior 10(a) recommendation no. 34 calls for preparation of a biological evaluation if Idaho Power proposes any actions that would affect threatened, endangered, and sensitive species on BLM-administered lands. In commenting on the draft EIS, Interior recommended establishment of an advisory board to guide implementation of the Threatened, Endangered and Sensitive Species Management Plan, similar to Idaho Power's proposed rare plant advisory board.

The Forest Service (FS-9) specifies that Idaho Power consult with the Forest Service to develop a Sensitive Species Management Plan that would be incorporated into Idaho Power's WMMP. The purpose of the plan would be to protect, manage, enhance and monitor sensitive species and their habitat on National Forest System lands affected by the project. Under this condition, Idaho Power would conduct additional sensitive species surveys when new species are listed, if project-related activities could affect them. Idaho Power would monitor confirmed sites every 2 years for 6 years following issuance of any new license, and then every 3 years thereafter. The need for continued monitoring would be re-assessed after year 6 of any new license term. Idaho Power would protect and/or restore sensitive sites or habitats that are declining in condition, as determined through monitoring. Finally, Idaho Power would update the plan to address revisions to designations by the Regional Forester.

Under ODFW-65, Idaho Power would develop and implement a plan to protect and monitor threatened, endangered and sensitive species on project lands and within a one-fourth- to one-half-mile

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[83] Interior-34 also identifies several special status plant species. We discuss this aspect of Interior's recommendation in section 3.7.2.2, above).

zone along the project reservoirs and the Snake River downstream of Hells Canyon dam. ODFW specifically recommends monitoring peregrine falcon, osprey, and great blue heron nest sites.

Our Analysis

Idaho Power's proposals for cooperative management projects, specific projects to be implemented on lands currently within its ownership, and long-term management of SMAs and WMAs as newly acquired lands are brought into the project boundary, would help protect and improve habitat that may support threatened, endangered, and sensitive species. Idaho Power proposes to develop monitoring, reporting, and review mechanisms to track the effectiveness of its measures, but does not propose specific plans or actions targeting threatened, endangered, and sensitive species.

The effect of implementing Interior-34 and FS-9 would be to provide a more structured framework for managing special status species and coordinating with BLM and the Forest Service. This would assist the agencies in meeting their internal management responsibilities. FWS recommends three additional plans, as discussed below, that would target protection for southern Idaho ground squirrel, bats, and amphibians and reptiles. Implementation of Interior, Forest Service, FWS, and ODFW recommendations would bring the total number of plans for special status wildlife to six, not including three other plans addressed in section 3.8.2,*Threatened and Endangered Species*.

Because of different agency authorities and responsibilities, each recommendation differs slightly in its focus of concern. However, developing a single, over-arching plan to address threatened, endangered and sensitive species could have several resource benefits. It would likely reduce the need for duplicative consultation, planning and reporting efforts, increase the efficiency of field efforts, and provide a consistent approach to developing and implementing agreed-upon protection, management and enhancement measures.

The plan could be applied to special status species at any sites where project operations or project-related activities could affect them, rather than prescribing a fixed distance for monitoring and management (such as a one-fourth or one-half-mile corridor). Exactly which species should be monitored could be determined as part of plan development, rather than pre-determining survey requirements for species such as peregrine falcon, which studies indicate are not affected by the project.

The plan could also incorporate a variable monitoring schedule, based on site-specific threats to special status species, rather than prescribing defined survey intervals (such as described in Interior 10(a) recommendation no. 34 and Forest Service preliminary condition no. 9). Intensive monitoring at sites with a high risk of disturbance and less frequent visits to remote sites would maximize protection where it is needed and minimize less productive efforts.

Southern Idaho Ground Squirrel

Project operations and project-related activities that affect shrub-steppe soils or vegetation (e.g., road maintenance, dispersed recreation, and recreation traffic associated with Steck Park), may adversely affect habitat for the southern Idaho ground squirrel. Interior-83 recommends that Idaho Power develop and implement a Southern Idaho Ground Squirrel Management Plan. The plan would provide for habitat enhancement and reintroduction of southern Idaho ground squirrels at two sites located along upper Brownlee reservoir (Cobb Rapids and Corral). The plan would be incorporated into Idaho Power's IWHP and WMMP.

Our Analysis

The southern Idaho ground squirrel is a candidate for federal listing under the ESA. It is endemic to southwestern Idaho, and currently occupies 294 known sites on rolling hills and flats at elevations ranging from about 2,200 to 3,200 feet in the Weiser River basin (FWS, 2004). Idaho Power's surveys in

1998 documented the occurrence of southern Idaho ground squirrels at Cobb Rapids and Corral near upper Brownlee reservoir, within the project boundary. In their response to AIR TR-1, Idaho Power indicates that southern Idaho ground squirrels also are present on the Rocking M Ranch parcel, which could be acquired as part of Idaho Power's terrestrial resource habitat package.

Given the lower limit of this squirrel's likely occurrence, Brownlee reservoir fluctuations would not affect its habitat, but land use and management activities that cause ground disturbance (e.g., road construction or maintenance) or affect vegetation (e.g., grazing, herbicide treatment) could in turn affect the southern Idaho ground squirrel. Enhancement of native shrub-steppe plant communities, translocations to reduce genetic isolation, predator (badger) control, and protection of occupied sites under conservation easements could benefit this species. Approximately 85 percent of occupied sites are located on private lands, so without implementation of such measures on private land, populations may continue to decline.

Bats

Project O&M could cause disturbance to bats where bats use project facilities such as dams, tunnels, houses, storage buildings, bridges, or other man-made structures. Project-related recreation could cause disturbance to bats that use caves, crevices, or mines. Interior preliminary 10(j) recommendation no. 82 recommends that Idaho Power incorporate three bat-related measures into its IWHP and WMMP: (1) monitor sites occupied by Townsend's big-eared bats, (2) protect maternity sites that are not already gated to prevent human access, and (3) protect and preserve Townsend's big-eared bat hibernacula within the project boundary.

Our Analysis

The Townsend's big-eared bat (also known as the pale western big-eared bat) is one of several special status bat species that occupy the Snake River corridor, including Hells Canyon. Anderson's (1998) compilation of bat survey results for the Snake River corridor reports that Townsend's big-eared bats were documented at 22 of 46 surveys sites, including four maternity colonies and two hibernacula.

In the justification for Interior-82, Interior notes that Hells Canyon provides abundant and secure habitat for bats, and a macroinvertebrate prey base that supports a bat community at "near historic or prehistoric levels." Anderson (1998) supports this conclusion, also noting that bats appear to use virtually every mine with a surface opening, and virtually every existing building in the canyon except those that have been sealed to prevent their access.

Ongoing project operations do not appear to affect bat habitat, but Idaho Power has not conducted focused surveys of the project facilities (e.g., dams, powerhouses, storage buildings, restrooms) to determine bat use of these structures. Unintended disturbance may occur as a result of project-related construction (e.g., new recreation facilities) or maintenance (e.g., dam, tunnel, or bridge inspections and repairs), or as visitors explore cliffs, caves, and mines. Disturbance during the winter can cause death because bats may leave hibernacula and use up energy stores that cannot be replaced because of the low availability of insect prey during colder months. Disturbance during the breeding season can cause abandonment of nurseries and loss of the year's young. Systematic surveys of project-related facilities or natural sites that could be disturbed by project-related maintenance or recreation would be useful in identifying sites that should be protected.

Human attitudes also pose a risk to bats. Anderson (1998) reported evidence of intentional shooting and "bat bashing" in the Snake River corridor. While relatively rare, such incidents also indicate a need for bat protection and visitor education.

Amphibians and Reptiles

Project-related recreation may affect special status amphibians as a result of traffic on roads that bisect wetland habitats, where passing vehicles can run over dispersing frogs and toads. Dispersed recreation along streams also has the potential to disturb amphibians and their habitat. Project-related recreation may affect special status reptiles. Recreation users may intentionally kill snakes or may unintentionally harm or kill them by chasing, capturing, or handling them. Idaho Power proposes no measures specifically intended to protect or manage amphibians or reptiles. Idaho Power documented the occurrence of four special status amphibians in the project vicinity, including the Columbia spotted frog, tailed frog, western toad, and Woodhouse's toad. The project vicinity contains suitable habitat for the northern leopard frog near Farewell Bend, but surveys did not reveal the presence of this species and it may be extirpated in Oregon. Surveyors observed only one special status reptile, the sagebrush lizard, although the project area contains abundant habitat and several special status species may be present.

For amphibians, Interior-85 calls for Idaho Power to maintain high spring flows downstream of Hells Canyon dam to maintain breeding habitat for western toads; locate, protect and enhance natural springs and seeps within the project boundary; and protect and acquire wetlands and springs outside the project boundary. Interior recommends Idaho Power map the northward progression of bullfrogs and develop and implement a plan to remove them from sites within the project boundary.

To protect reptiles, Interior recommends Idaho Power map all snake dens encountered within the study area. Interior-85 also recommends that Idaho Power discourage or restrict activities that affect known den sites.

Our Analysis

Surveyors found that western toads breed in backwater ponds along the Snake River downstream of Hells Canyon dam at sites where changes in project operation could affect them. Surveyors note that the availability of these ponds likely varies from year to year, depending on flows. In high-water years, some ponds may not be exposed until after the breeding season, while in low-water years, some ponds may dry up early in the season. This pattern would likely continue under all operating scenarios, somewhat modified by reduced ramping rates (see section 3.7.2.1).

Idaho Power has mapped wetlands and riparian habitats within the project area, and as described in the HCRMP, one of the objectives for terrestrial resource management is to protect these areas. Wetlands and riparian habitats are also a high priority in terms of ranking potential land acquisitions. Idaho Power proposes to consult with the TRWG to develop site-specific management plans for each parcel. Presumably, these plans would emphasize protection and enhancement of wetlands and riparian habitats.

Implementation of Interior's recommendation to map bullfrog occurrences throughout the project area would provide information that could be useful to federal and state agencies for planning and management at a regional level. However, implementation of control measures on a site-by-site basis, as part of the management plan for each SMA or wildlife management area, would focus Idaho Power's efforts where they would be most effective in protecting native amphibian populations, i.e., at known breeding sites for western toads. Bullfrogs are prolific, and readily repopulate ponds where even 90 percent of the individuals and egg masses have been removed. Draining ponds is temporarily effective in eradicating bullfrog populations, but bullfrogs are capable of moving long distances over land, and removal programs to date have not been effective where nearby source populations exist.

Idaho Power's license application (2003a) does not contain any information about snake dens, but given the abundance of reptile habitat, it is likely that they are present. Mapping and protecting any that are encountered would be effective as a general conservation measure, and could be included in the

IWHP and WMMP, as well as in any site-specific management plans that are developed for newly acquired lands.

3.7.2.9 Effects of Other Measures on Terrestrial Resources

Sediment Transport Measures

Under FS-4 (Sandbar Restoration), Idaho Power would establish a funding mechanism to support Forest Service restoration of 14 acres of sandbars on or adjacent to National Forest System lands downstream of Hells Canyon dam. Beach replenishment would increase habitat area for species such as river otters, black bears, mink, and raccoons. These species use sandy shorelines for travel, resting, and grooming, and use gently-sloped banks to access aquatic foraging areas. These species would also benefit from additional foraging opportunities if beach replenishment results in larger fish populations. However, one of the purposes of beach replenishment is to enhance recreation opportunities. Concentrated use of beaches for recreation would likely limit wildlife use during the summer.

Recreation Measures

Idaho Power's study of the influences of human disturbance on terrestrial resources (Dumas et al., 2003b) identified several sites where recreational access may currently disturb wildlife habitat, wildlife, and rare plants. Areas of special importance include habitat for Columbia spotted frogs and nesting waterfowl near Hewitt Park and Holcomb parks and at dispersed recreation sites nearby; tailed frogs at Kinney Creek, riparian-associated songbirds near Holcomb and McCormick parks, Carters Landing, Kinney Creek and Big Bar; bats at Big Bar, and bald eagles at Woodhead and McCormick parks, Bob Creek, Hells Canyon dam, and Big Bar. Wintering habitat for elk is present at Steck, Woodland, McCormick and Hells Canyon parks, and at Big Bar, Deep Creek, and Hells Canyon dam.

Dumas et al. (2003b) estimated a high or very high risk of disturbance to mule deer at McCormick, Woodland, Copperfield and Hells Canyon parks, and Carters Landing. The study found disturbance to be moderate at Holcomb and Hewitt parks and the Steck site. Holcomb and Hewitt parks and the Swedes Landing site are located within a mule deer spring migration corridor, but most recreation activity would occur after Memorial Day and would generally not conflict with deer use, which tapers off by early May (Edelmann, 2003).

Expansion and improvement of existing recreation facilities would remove small amounts of wildlife habitat and cause short-term disturbance during construction at each site. Over the long term, increases in recreational activity throughout the project area would cause increasing disturbance to wildlife, especially in the most confined reaches of Hells Canyon, and increasing competition for the limited amount of riparian habitat.

Several measures could be implemented to help minimize adverse effects. These include using the results of the Dumas et al. risk analysis to design recreation sites around wildlife habitat needs; reducing the footprint of recreation facilities planned for especially sensitive sites (e.g., Big Bar); and implementation of a program to educate visitors about ways they can minimize their impact on wildlife and wildlife habitat.

Dumas et al. (2003b) did not identify any rare plant occurrences associated with formal recreation facilities, but use of dispersed recreation sites (including trails) would have a moderate to very high risk of adversely affecting 14 populations. Species that could be affected include porcupine sedge, shining flatsedge, Schweinitz flatsedge, Hazel's prickly phlox, and bartonberry. To determine whether protective measures are needed at various sites, Idaho Power could use the results of the risk analysis to overlay proposed recreation measures onto known rare plant sites, using the GIS atlas developed for the project, to determine whether protective measures should be implemented at any sites.

3.7.3 Cumulative Effects

3.7.3.1 Riparian and Wetland Habitats

A variety of land uses and human activities, such as ranching, irrigation, mining, and hydropower development, have dramatically affected riparian habitat along the Snake River since the early 1900s. Together, these factors have reduced the extent and quality of riparian habitat in a region where climate and soils already limit the distribution of this important natural resource, including Hells Canyon. In addition to inundating riparian habitat and associated wetlands, construction of the Hells Canyon Project converted almost 90 miles of free-flowing riverine habitat to reservoir, accounting for almost half of the reservoir length that now exists between the Shoshone Falls and Ice Harbor dams. The primary effects of ongoing hydropower operation on riparian habitat and wetlands in Hells Canyon occur as a result of: (1) reservoir fluctuation; (2) trapping of sediments in project reservoirs; and (3) alteration of the natural flow regime in the Snake River downstream of Hells Canyon dam.

Under any of the action alternatives, effects on riparian habitat around project reservoirs would be minor. Oxbow and Hells Canyon reservoirs would continue to support narrow bands of riparian vegetation, and seasonal drawdowns at Brownlee reservoir would continue to prevent riparian habitat from establishing in the fluctuation zone and along the shoreline.

Under any of the action alternatives, changes in the flow regime would reduce the amount of riparian and wetland habitat along the Snake River downstream of Hells Canyon dam. Changes would range from about 2 acres under Scenario 3 (Flow Augmentation), to about 30 acres under Scenario 1 (Reregulating). The Brownlee impoundment would continue to trap large volumes of sediment, which would continue to limit the establishment of willows in this reach. Although they may never have been dense along the Snake River, willows are an important component of riparian plant communities, and their absence may reduce habitat quality for wildlife species that typically use willows for foraging, nesting, or cover.

These findings suggest that the Hells Canyon Project would continue to contribute to cumulative adverse effects that result from the operation of over 20 other hydropower facilities on the Snake River, including Shoshone Falls, Lower Salmon Falls, Bliss, and C.J. Strike. However, Idaho Power proposes to improve management of natural resources at Hells Canyon by implementing both project-wide BMPs and specific measures to protect and enhance riparian and wetland habitat within the project boundary. Idaho Power would also acquire, protect, and manage more than 800 acres of riparian habitat on lands adjacent to the project reservoirs to help mitigate operational effects and would support cooperative projects to protect rare plants, control invasive weeds, improve low-elevation riparian habitat for mountain quail, and enhance habitat on several Snake River islands for waterfowl and other riparian-associated species. These actions would complement similar measures that Idaho Power is implementing at the mid-Snake hydroelectric projects and contribute to the positive regional trends described in section 3.2.1.6, *Riparian/Wetland Habitat*.

3.7.3.2 Native Grasslands and Shrublands

Development and land uses in the Snake River basin since the early 1900s have adversely affected upland habitat, as well as riparian and wetland habitat. Of particular concern is the loss of large areas of low-elevation big game winter range as a result of inundation behind numerous dams; conversion to urban, residential, and agricultural uses; fragmentation; overgrazing; fire suppression; and the invasion of non-native weeds. Construction of the Hells Canyon Project inundated more than 10,000 acres of low-elevation winter range, and although inundation precludes restoration of this habitat, Hells Canyon continues to provide some of the most important winter range in the region (Christensen, 2003). Idaho Power's proposal to acquire and manage 23,582 acres would help mitigate the adverse effects on winter range. Parcels acquired for mitigation are located within areas mapped by Christensen (2003) as crucial

winter range, and include the Daly Ranch, which borders the primary migration route for deer moving between summer range in Oregon and winter range near Brownlee reservoir.

To offset project effects on uplands, Idaho Power proposes to improve management of natural resources at Hells Canyon by implementing both project-wide BMPs and specific measures (e.g., fencing to exclude trespass grazing) to improve the condition of uplands within the project boundary. Idaho Power would also acquire, protect, and manage more than 20,000 acres of upland habitat on lands adjacent to the project reservoirs to help mitigate for operational effects and would support cooperative projects to protect rare plants and manage invasive weeds. These actions would complement similar measures that Idaho Power is employing at the mid-Snake hydro projects and contribute to the positive regional trends resulting from better management of public grazing lands and more emphasis on weed control in the region.

3.7.3.3 Noxious Weeds and Invasive Exotic Plants

Project operation and project-related activities that cause soil and vegetation disturbance (e.g., reservoir fluctuations, transmission line maintenance, dispersed recreation) create conditions that promote the establishment of weeds and invasive exotic plants. Although these factors contribute to cumulative impacts, the project's role is very small in comparison to the effects of 100 years of overgrazing in the project vicinity. Weeds are abundant and widespread, and the combined efforts of all landowners would be needed to provide even a moderate level of control.

Under current conditions, Brownlee reservoir impedes the downstream spread of weeds because weeds within the fluctuation zone cannot survive the alternating inundation and desiccation of seasonal drawdowns. Seasonal drawdowns would continue under any of the flow alternatives. None of the proposed flow alternatives would be likely to affect the abundance or distribution of weeds.

Idaho Power proposes to develop and implement an Integrated Weed Management Plan, which would include cooperative weed control projects on adjacent lands. Other proposed measures, including implementation of a transmission line O&M plan and project-wide BMPs would also address this issue. These actions would complement similar measures that Idaho Power is undertaking at the mid-Snake hydroelectric projects and contribute to positive regional trends that are anticipated to result from better management of public grazing lands and a stronger emphasis on weed control in the region.

3.7.3.4 Peregrine Falcons

Peregrine falcon surveys conducted in the project vicinity between 1997 and 2000 documented one eyrie near Hells Canyon dam. The eyrie is located about 2,000 feet west of the Hells Canyon boat launch, at about 3,900 feet. The elevation of the reservoir at full pool is 1,687 feet. At this distance from and height above the reservoir, the eyrie is remote from project operations and potential disturbance. We conclude that the project does not affect peregrine falcons, and would not contribute either positively or negatively to cumulative impacts on this species.

3.7.4 Unavoidable Adverse Effects

As mentioned above, operation of Brownlee reservoir would continue to prevent the establishment of riparian vegetation within the fluctuation zone and along the shoreline. Trapping of sediments within Brownlee reservoir would continue to starve the Snake River downstream of Hells Canyon dam of sands and sediments which, if present, would likely support colonization by willows. Brownlee reservoir would continue to accumulate organochlorine compounds and mercury from non-project sources, which may pose a risk to fish-eating wildlife (such as river otters, great blue herons, and bald eagles). Long-term increases in recreational activity would cause increasing disturbance to wildlife, especially in the most confined reaches of the canyon.

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3.8 THREATENED AND ENDANGERED SPECIES

3.8.1 Affected Environment

Five federally listed threatened or endangered fish species are known to occur in the project area. These include two evolutionarily significant units (ESU) of Chinook salmon (the Snake River fall-run Chinook salmon and the Snake River spring/summer-run Chinook salmon), the Snake River sockeye salmon ESU, the Snake River basin *O. mykiss* (steelhead) ESU, and bull trout. We provided information on the biology of these species in section 3.6.1.3, *Anadromous Fish Species*, and in section 3.6.1.4, *Native Resident Salmonids*, and we describe the status and critical habitat of these species below. According to the FWS, two federally listed threatened aquatic mollusks (the Bliss Rapids snail and Idaho springsnail), three federally listed plant species (MacFarlane's four-o'clock, Howell's spectacular thelypody, and Spalding's catchfly) and four federally listed wildlife species (gray wolf, Canada lynx, Northern Idaho ground squirrel, and bald eagle) may occur in the vicinity of the project area (letter from Jeffery L. Foss, Supervisor, Snake River Fish and Wildlife Office, Boise, ID, to the Commission, dated November 28, 2005).

We provide additional information on the rangewide distribution and status of bull trout from FWS (2005d) in appendix F, and we provide additional information on the rangewide distribution and status of all Columbia River salmon and steelhead ESUs from NMFS (2005) in appendix G.

3.8.1.1 Fall Chinook Salmon

The Snake River fall-run Chinook salmon (*Oncorhynchus tshawytscha*) ESU was listed as threatened on April 22, 1992, and its status was reaffirmed on June 28, 2005. The ESU includes all natural populations of fall Chinook salmon in the mainstem Snake River and in the Tucannon, Grande Ronde, Imnaha, Salmon, and Clearwater rivers. NMFS considers the Lyons Ferry hatchery stock to be part of the listed ESU, including fish reared by Idaho Power at the Oxbow Hatchery and those released from acclimation sites by the Nez Perce Tribe (discussed below). Critical habitat for the listed ESU includes river reaches currently or historically accessible in the Columbia River upstream to the confluence of the Columbia and Snake rivers; the Snake River from its confluence upstream to Hells Canyon dam; the Palouse River from its confluence upstream to Palouse Falls, the Clearwater River from its confluence upstream to its confluence with Lolo Creek, and the North Fork Clearwater River from its confluence upstream to Dworshak dam. Critical habitat also includes river reaches currently or historically accessible (except reaches above impassable waterfalls or above Dworshak and Hells Canyon dams) to Snake River fall-run Chinook salmon in the following hydrologic units (drainages): Clearwater, Hells Canyon, Imnaha, Lower Grande Ronde, Lower North Fork Clearwater, Lower Salmon, Lower Snake, Lower Snake-Asotin, Tucannon, and Palouse.

Since 1996, the Nez Perce Tribe has undertaken a program funded by BPA to increase the natural spawning population of Snake River fall Chinook salmon upstream of Hells Canyon dam. Yearling and subyearling fall Chinook salmon are acclimated at two sites on the mainstem Snake River (Captain John Rapids and Pittsburg Landing) and at one site on the Clearwater River (Big Canyon). Records of the number of hatchery fall Chinook smolts released into the Snake River from the Lyons Ferry hatchery (located between Little Goose and Lower Monumental dams) and from acclimation sites upstream of Lower Granite dam from 1985 to 2001 are shown in table 72. The total number of fall Chinook salmon released from acclimation sites upstream of Lower Granite dam has averaged 443,814 yearlings and 1,812,209 subyearlings per year from 2002 to 2004 (McLeod, 2006).

Table 72. Releases of fall Chinook hatchery smolts into the Snake River basin. (Source: NMFS, 2003)

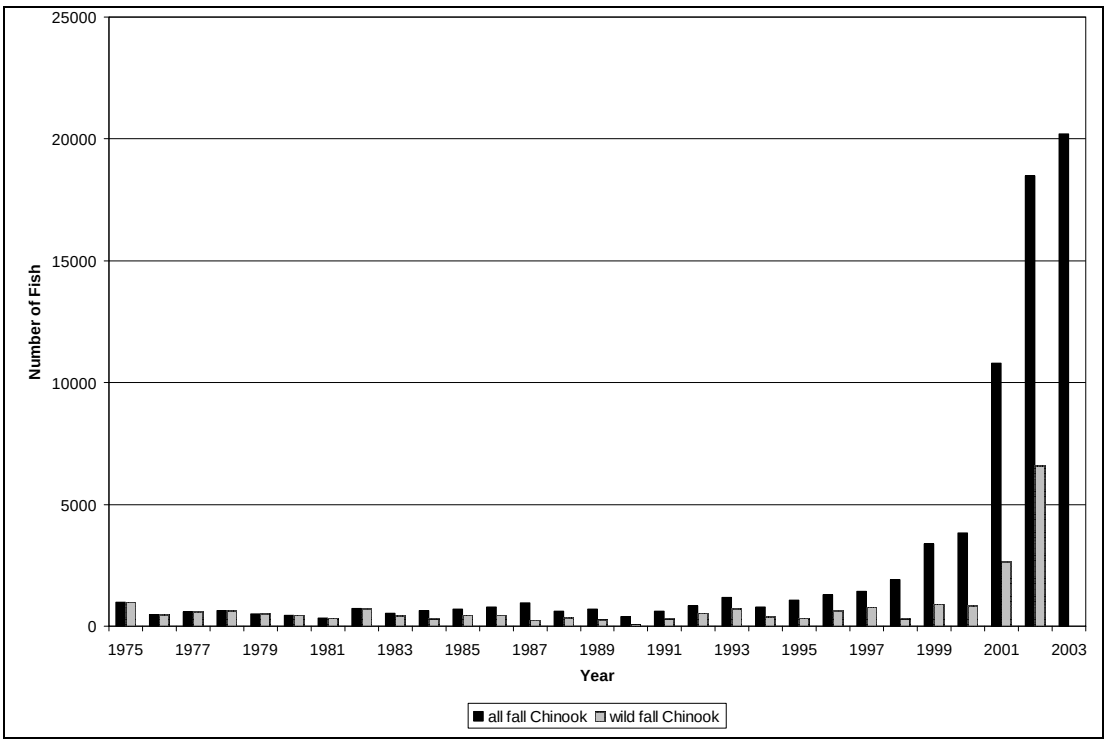
	Acclimation Sites									
	Lyons Ferry (direct)		Pittsburg Landing		Captain John		Big Canyon (Clearwater River)		Hells Canyon Dam[a]	
Release Year	Yearling	Sub-yearling	Yearling	Sub-yearling	Yearling	Sub-yearling	Yearling	Sub-yearling	Yearling	Sub-yearling
1985	650,300	539,392	--	--	--	--	--	--	--	--
1986	481,950	1,789,566	--	--	--	--	--	--	--	--
1987	386,600	1,012,500	--	--	--	--	--	--	--	--
1988	407,500	4,563,500	--	--	--	--	--	--	--	--
1989	413,017	1,710,865	--	--	--	--	--	--	--	--
1990	436,354	3,043,756	--	--	--	--	--	--	--	--
1991	224,439	--	--	--	--	--	--	--	--	--
1992	689,601	--	--	--	--	--	--	--	--	--
1993	206,775	--	--	--	--	--	--	--	--	--
1994	603,661	--	--	--	--	--	--	--	--	--
1995	349,124	--	--	--	--	--	--	--	--	--
1996	407,503	--	114,299	--	--	--	--	--	--	--
1997	456,872	--	147,316	--	--	--	199,399	252,705	--	--
1998	419,002	--	141,814	--	133,205	--	61,172	--	--	--
1999	432,166	204,194	142,885	--	157,010	--	229,608	347,105	--	--
2000	456,401	196,643	134,709	400,156	131,186	892,847	131,306	890,474	--	--
2001	338,757	199,976	103,741	374,070	101,976	501,129	113,215	856,968	--	115,251

[a] Hells Canyon dam releases increased to 500,000 in 2002.

Recent counts of fall Chinook salmon passing Lower Granite dam are shown in figure 108. The total number of adult fall Chinook salmon passing Lower Granite dam has increased from a low of 385 fish in 1990 to approximately 1,000 fish per year from 1993 to 1997, followed by steady increases up to 20,213 fish in 2003. Marked fish have comprised about 75 percent of the run since 1998, but the number of unmarked fish has been trending upward from 2000 through 2002. However, in its comments on the draft EIS, the Nez Perce Tribe reports that large numbers of unmarked fall Chinook salmon released from acclimation sites has complicated the estimation of natural production rates.

3.8.1.2 Spring/Summer Chinook Salmon

The Snake River spring/summer Chinook salmon ESU was listed as threatened on April 22, 1992, and its status was reaffirmed on June 28, 2005. The ESU includes all natural populations of spring/summer Chinook salmon in the mainstem Snake River and in the Tucannon, Grande Ronde, Imnaha, and Salmon River subbasins. NMFS includes 15 artificial propagation programs within the listed ESU, including the Pahsimeroi summer Chinook salmon stock. The Rapid River spring Chinook salmon stock is not included in the ESU, and is not listed. Critical habitat for the listed ESU includes the Columbia River upstream to the confluence of the Columbia and Snake rivers and the Snake River upstream to Hells Canyon dam. Critical habitat also includes river reaches currently or historically accessible (except reaches above impassable natural falls and Dworshak and Hells Canyon dams) to Snake River spring/summer Chinook salmon in the following hydrologic units: Hells Canyon, Imnaha, Lemhi, Little Salmon, Lower Grande Ronde, Lower Middle Fork Salmon, Lower Salmon, Lower Snake-Asotin, Lower Snake-Tucannon, Middle Salmon-Chamberlain, Middle Fork Salmon, Upper Middle Fork Salmon, Upper Grande Ronde, Upper Salmon, and Wallowa.



Note: Wild count for 2003 was not available.

Figure 108. Estimated total and wild escapement of fall-run Chinook salmon at Lower Granite dam, 1975–2003. (Source: NMFS, 2004, as modified by staff)

Counts of adult spring/summer Chinook salmon passing Lower Granite dam have fluctuated widely over the last several decades, including an exceptionally strong return in 2001. Total counts of spring/summer Chinook salmon ranged from a low of 1,797 fish in 1995 to a high of 185,693 fish in 2001 (figure 109). Wild fish typically comprise about 20 to 40 percent of the run, and the number of wild fish has trended upward from 2000 through 2003. The run size of spring Chinook salmon returning to the Snake River over the past 20 years has likely been affected by steelhead produced through the Lower Snake River Compensation Program, which includes increased production of salmon and steelhead at 12 hatcheries located throughout the basin.

3.8.1.3 Sockeye Salmon

The Snake River sockeye salmon (*Oncorhynchus nerka*) ESU was listed as endangered on November 20, 1991, and its status was reaffirmed on June 28, 2005. Critical habitat for this ESU includes river reaches currently or historically accessible (except reaches above impassable waterfalls or above Dworshak and Hells Canyon dams) in the Columbia River upstream to the confluence of the Columbia and Snake rivers. It also includes all Snake River reaches from its confluence with the Columbia River upstream to its confluence with the Salmon River; all Salmon River reaches from its confluence with the Snake River upstream to Alturas Lake Creek; Stanley, Redfish, Yellow Belly, Pettit, and Alturas lakes (including their inlet and outlet creeks); Alturas Lake Creek and the portion of Valley Creek between Stanley Lake Creek and the Salmon River.

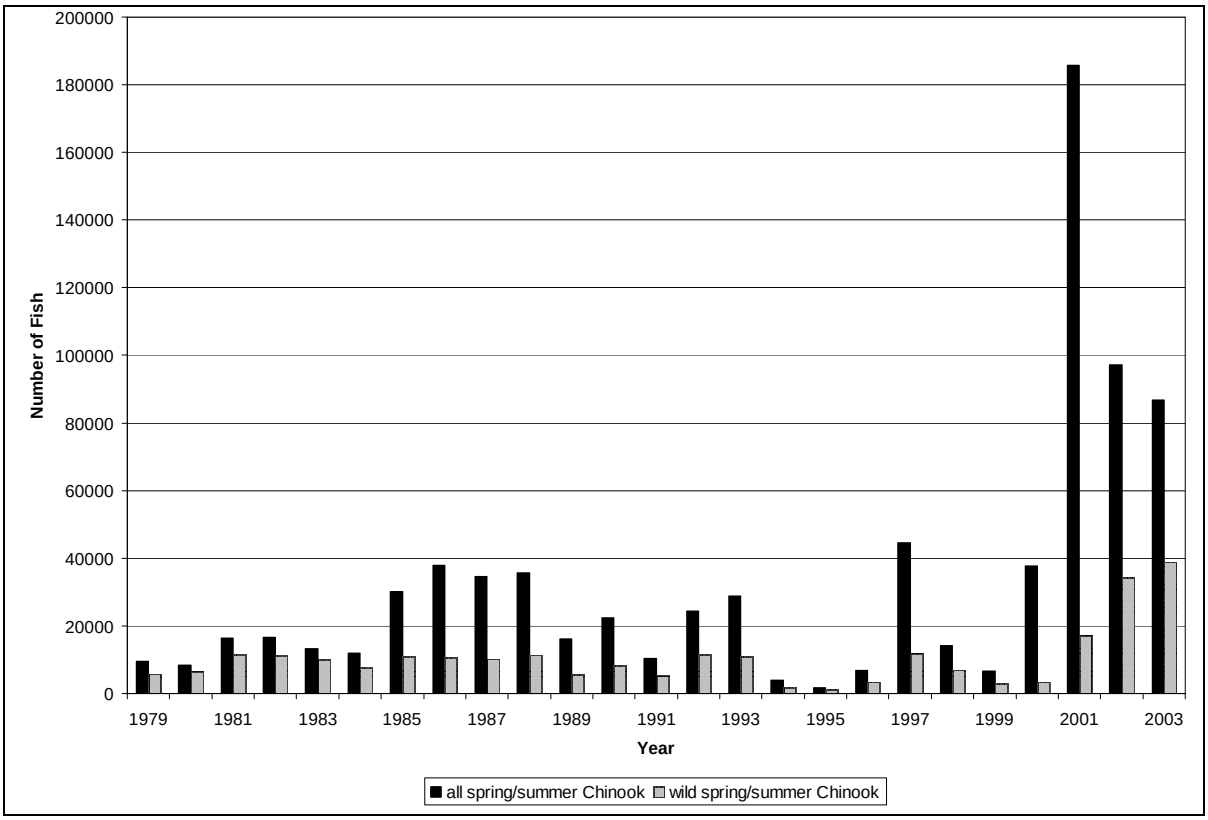


Figure 109. Estimated total and wild escapement of spring/summer Chinook salmon at Lower Granite dam, 1975–2003. (Source: NMFS, 2004, as modified by staff)

Historically, sockeye salmon spawned in the Payette, Wallowa, and upper Salmon River basins. NMFS estimates that about 25 percent of sockeye salmon major population groups in the Snake River basin were located upstream of the Hells Canyon Project (McClure et al., 2005). The construction and presence of Sunbeam dam between 1910 and 1934 blocked sockeye salmon from Redfish Lake and other

lakes in the upper Salmon River basin. After the dam was breached in 1934, it is believed that smolts produced from kokanee populations re-established the sockeye salmon runs by the late 1940s (Chapman et al., 1990). An irrigation diversion blocked sockeye salmon from Alturas Lake, and Idaho Fish and Game Department (IDFG) poisoned and eradicated kokanee and sockeye salmon populations in several other lakes in the upper Salmon River basin to convert the lakes to trout production. Currently, the Snake River sockeye salmon are reduced to a remnant population in Redfish Lake.

The Redfish Lake sockeye salmon population is currently being enhanced through a captive broodstock program. All Redfish Lake sockeye salmon are captured, and the fertilized eggs are used to support the program. Some juveniles are also captured for the broodstock program (BOR, 1998). Annual counts of adult sockeye salmon passing Lower Granite dam ranged between 0 and 14 fish from 1989 through 1999. Returns of adult sockeye salmon have increased somewhat over the last 5 years, but they are highly variable from year to year (figure 110).

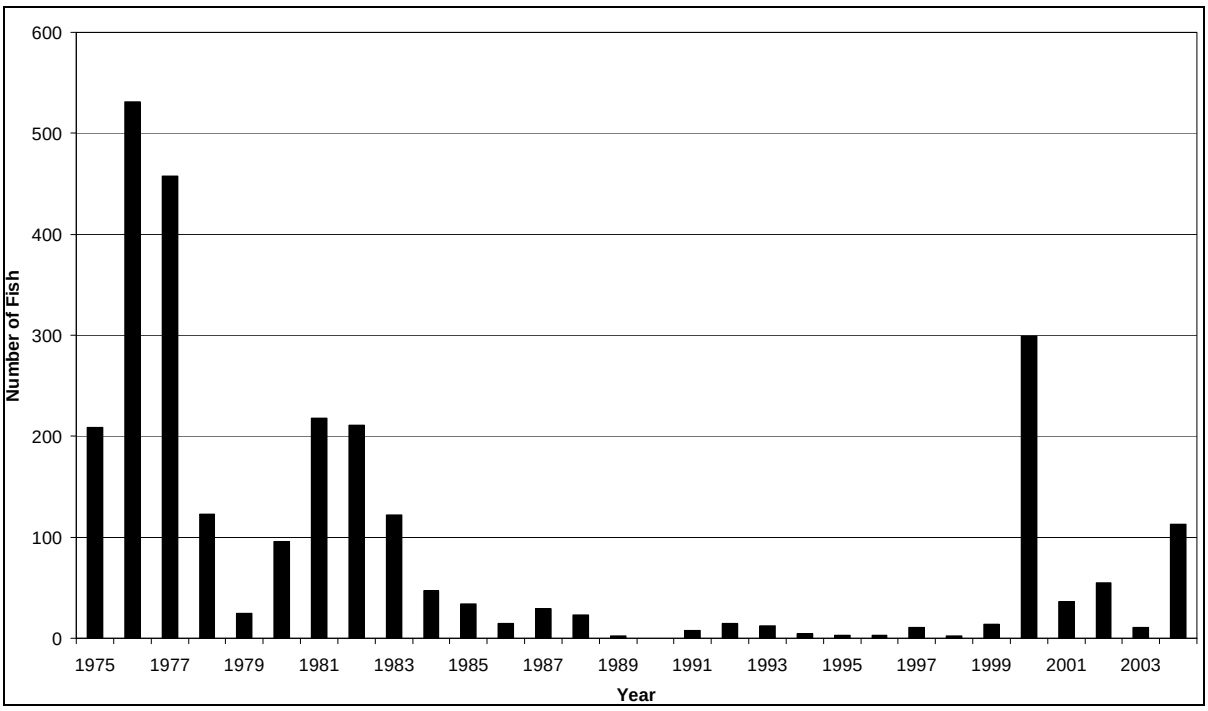


Figure 110. Sockeye salmon passage counts at Lower Granite dam for years 1975–2004. (Source: FPC, 2005, as modified by staff)

3.8.1.4 Steelhead

The Snake River steelhead (*O. mykiss*) ESU was listed as threatened on August 18, 1997, and its status was reaffirmed on January 5, 2006. The ESU includes all naturally spawned populations of steelhead (and their progeny) in streams in the Snake River basin of southeast Washington, northeast Oregon, and Idaho. NMFS designated critical habitat for steelhead on February 16, 2000, but the designation was later withdrawn via consent decree on April 30, 2002. Critical habitat for Snake River steelhead was re-designated on September 2, 2005. Of the 8,225 miles of habitat within this ESU, NMFS excluded 134 miles of stream because the economic benefits of exclusion outweighed the benefits of designation, and 39 miles of stream were excluded because they overlap with Indian lands.

On January 5, 2006, NMFS re-affirmed the threatened status of the anadromous Snake River steelhead population (excluding resident rainbow trout) as a distinct population segment (DPS) and also re-affirmed their designated critical habitat. NMFS determined that the following hatchery populations of

summer-run steelhead are included within the listed DPS: Tucannon River, Dworshak National Fish Hatchery, Lolo Creek, North Fork Clearwater River, East Fork Salmon River, and Little Sheep Creek/Imnaha River.

Recent counts of Snake River steelhead passing Lower Granite dam are shown in figure 111. The total number of adult steelhead passing Lower Granite dam generally ranged between 50,000 and 130,000 fish from the 1984/1985 to the 2000/2001 run years, and has exceeded 150,000 adult fish from the 2001/2002 run year through the 2003/2004 run year. The total run peaked at more than 250,000 adult fish with the 2001/2002 run, and has trended downward in the last several years. Wild steelhead comprised about 15 to 20 percent of the total adults passed at Lower Granite dam through most of the 1990s, increasing to 20 to 25 percent of the run in the last several years (figure 111). Like the spring Chinook salmon, the run size of steelhead returning to the Snake River over the past 20 years has likely been affected by steelhead produced through the Lower Snake River Compensation Program, which includes increased production of salmon and steelhead at 12 hatcheries located throughout the basin.

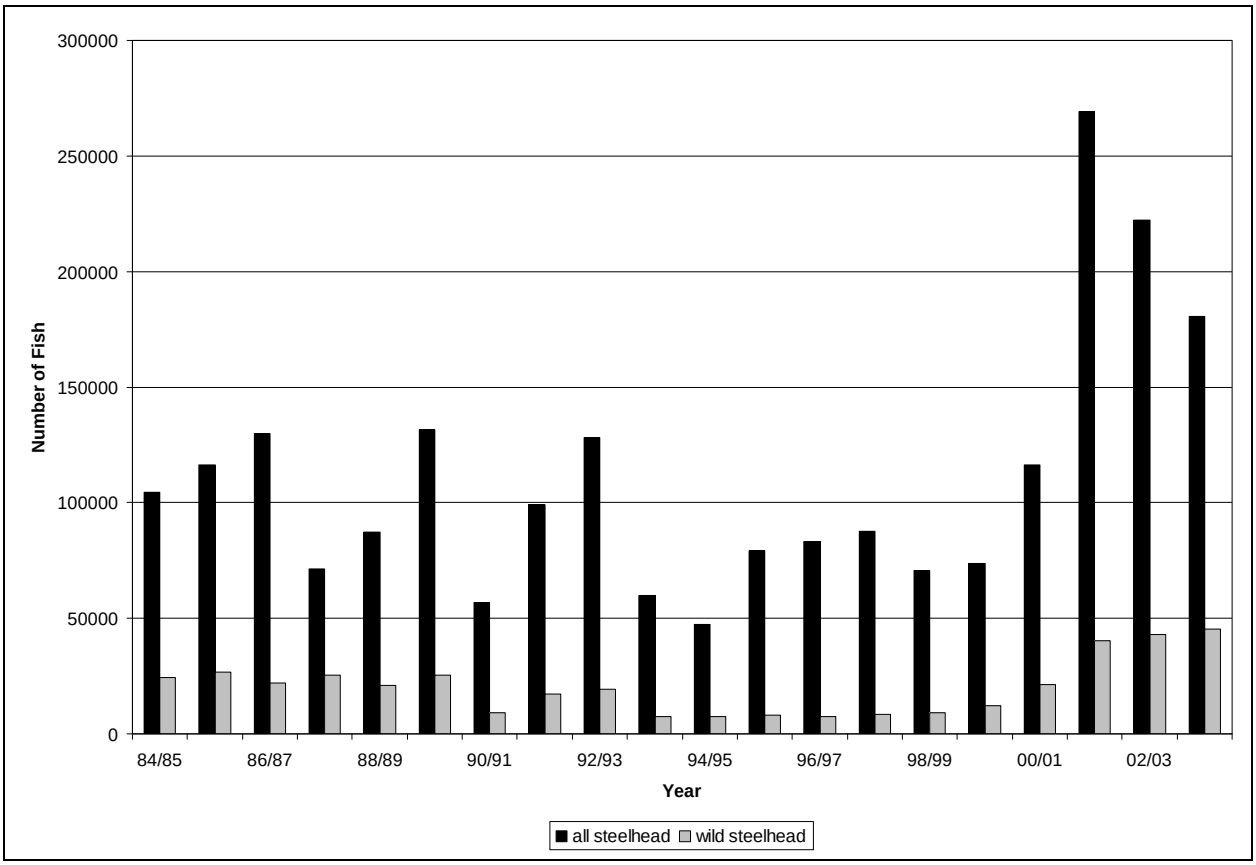


Figure 111. Estimated total and wild escapement of steelhead at Lower Granite dam for the 1984–1985 through 2003–2004 run years. (Source: NMFS, 2004, as modified by staff)

3.8.1.5 Bull Trout

Bull trout are estimated to have once occupied about 60 percent of the Columbia River basin; they currently occur in about 45 percent of the watersheds in their historical range, which amounts to approximately 27 percent of the basin (Quigley and Arbelbide, 1997). Reasons for the decline in the distribution and abundance of bull trout include habitat degradation and fragmentation, blockage of

migratory corridors, poor water quality, angler harvest and poaching, entrainment into diversion channels and dams, and introduced non-native species (FWS, 2002a).

The populations of bull trout in the Columbia and Klamath rivers were listed as threatened by the FWS in 1998 (63 FR 31,647). The Jarbridge River population was listed on April 8, 1999 (64 FR 177,110), and the Coastal-Puget Sound and St. Mary-Belly River populations were listed in 1999 (64 FR 58,910), which resulted in all bull trout in the coterminous United States being listed as threatened. The five populations noted above are listed as distinct population segments; that is, they meet the joint policy of FWS and NMFS regarding the recognition of distinct vertebrate populations (61 FR 4,722).

FWS published a draft Bull Trout Recovery Plan in 2002, and critical habitat was designated in 2005 (70 FR 56,212). The critical habitat designation includes currently or historically occupied habitat that was found to be essential to the conservation of the species. Critical habitat in the vicinity of the project includes 308 stream miles in the Grande Ronde River basin, 92 stream miles in the Imnaha River basin, 125 stream miles within the Hells Canyon Complex Unit (including tributaries to the Powder River and Pine Creek) and 17 stream miles in the Snake River Unit, which consists of multiple river segments located between Pine Creek and the Weiser River that were not subject to exclusion. Areas excluded from the designation included Tribal lands, lands managed under the Anadromous Fish Habitat and Watershed Conservation Strategy (PACFISH), the Inland Native Fish Strategy (INFISH), the Northwest Forest Plan Aquatic Conservation Strategy, the Southwest Idaho Land and Resource Management Plans, the Southeast Oregon Resource Management Plans, lands subject to the SRBA, and waters impounded by dams with primary purposes of flood control, energy production, or water supply for human consumption.

3.8.1.6 Bliss Rapids Snail

The Bliss rapids snail was first collected live and recognized as a new taxon by Dwight Taylor in 1959; however, it was not described until Hershler et al. (1994) placed the snail in the new genus *Taylorconcha* and in the new species *serpenticola*. FWS listed the Bliss Rapids snail as threatened on December 14, 1992 (57 FR 59,244–59,257), but chose not to designate critical habitat for the species. In its final rule, FWS stated that the species was known to exist only in discontinuous populations in the Snake River and associated spring habitats between King Hill (RM 546) and RM 749.8, above American Falls reservoir. Since that time, Idaho Power has found the species to be widely distributed within the Snake River between Lower Salmon Falls dam (RM 573) and Bliss dam (RM 560) (Cazier, 1997).

As discussed in section 3.6.1.2, *Benthic Macroinvertebrates*, one snail that was field-identified as a Bliss Rapids snail (*Taylorconcha serpenticola*) was collected during Idaho Power's general invertebrate survey near RM 227, about 20 miles downstream of Hells Canyon dam. A follow-up survey of this area conducted in 2002 resulted in the collection of three more individuals that were field-identified as Bliss Rapids snails. These specimens were sent to Dr. Robert Hershler at the Smithsonian Institution, who first described the species, for taxonomic identification. The results were inconclusive, and Dr. Hershler indicated that additional specimens were needed to resolve the taxonomic uncertainty (Myers and Foster, 2003). Additional specimens were collected during a subsequent survey targeting rare and sensitive species (Richards et al., 2005), which found *Taylorconcha* to occur in 36 percent of all sites surveyed between RM 183.5 and RM 235.5, reaching densities in excess of 100 individuals per square meter in 9 percent of the survey locations. Based on genetic analysis of these specimens, Dr. Hershler's preliminary findings indicate that the *Taylorconcha* that inhabit the Hells Canyon reach and the Owyhee River represent a separate species that is distinct from the Bliss Rapids snail (Richards et al., 2005). In its comments on the draft EIS, Interior stated that based on this species' limited and disjunct distribution, it should be regarded as sensitive, and notes that its presence in the Snake River is significant to the continuing survival of the species.

3.8.1.7 Idaho Springsnail

FWS identified the endangered Idaho springsnail (*Pyrogulopsis idahoensis*) as a species that may occur in the vicinity of the Hells Canyon Project. The results of Idaho Power's macroinvertebrate surveys in the project area found this species in a single reach between RM 365 and RM 370, about 25 miles upstream from the headwaters of Brownlee reservoir (Myers and Foster, 2003). Although this species is reported to be widely distributed in the reach between C.J. Strike and Swan Falls dam, no specimens were found downstream of RM 365 during surveys conducted in all three of the project reservoirs and in surveys of riverine habitat that extended downstream to the confluence with the Grande Ronde River at RM 168.5, 79.1 miles downstream of Hells Canyon dam (Myers and Foster, 2003; Richards et al., 2005).

3.8.1.8 MacFarlane's Four-o'clock

FWS listed MacFarlane's four-o'clock (*Mirabilis macfarlanei*) as an endangered plant species in 1979 (44 FR 209) and prepared a recovery plan in 1985. Because additional populations were discovered and some populations were being actively managed and monitored according to the recovery plan, FWS downlisted the species to threatened status in 1996 (61 FR 52). FWS completed a revised recovery plan in 2000 (FWS, 2000). No critical habitat has been designated.

MacFarlane's four-o'clock is an herbaceous perennial that produces bright pink flowers from May through June. During wet years, plants are generally large and flower abundantly. The thick taproot may extend up to 8 feet deep, and the root system may extend 6 feet beyond the stems. Vegetative reproduction may be important in this species, since seed germination is variable from year to year. Because different clones that are produced vegetatively may overlap in distribution and vary in size, it is difficult to determine the extent of a particular clone (FWS, 2000), and therefore, the size of a population.

Macfarlane's four-o'clock occurs in grassland habitats along river canyons where warm, dry conditions prevail. Occupied sites are typically dominated by bluebunch wheatgrass. Forbs that may also be present include yarrow, pale alyssum, and cheatgrass. Associated shrubs include netleaf hackberry, smooth sumac, and gray rabbitbrush. MacFarlane's four-o'clock grows on flat to steep slopes, in soils that vary from sand to talus, at elevations between 1,000 and 3,000 feet msl (FWS, 2000).

The only known populations of MacFarlane's four-o'clock are located in the Salmon, Imnaha, and Snake River basins (61 FR 52). In the Salmon River basin, FWS indicates that 8 sites, supporting about 1,660 plants, occur along 18 miles of river bank and canyonland slopes. Only 2 localities, with a total population of about 800 plants, have been documented in the Imnaha River basin, located along a 3-mile stretch of the river corridor. FWS describes 7 localities in the Snake River unit, occurring within a 6-mile stretch of the river (61 FR 52) that starts about 30 miles downstream of Hells Canyon dam. These include Kurry Creek, West Creek, Kurry Creek-West Creek divide, Tryon Bar, Cottonwood Landing, Island Gulch, and Mine Gulch. FWS estimates the seven localities support more than 4,750 plants. None of these sites are located within the Hells Canyon Project boundary.

As described in section 3.7.1, Idaho Power's rare plant surveys covered habitat within approximately 150 feet of the MHWM along each reservoir and on both sides of the Snake River from Hells Canyon dam to the confluence of the Salmon River (Krichbaum, 2000). Idaho Power used a sub-sampling approach to evaluate a representative proportion of the study area. Biologists divided each river mile into four segments and surveyed one segment of each river mile. Surveys were conducted in early September 1998 and in May 1999. Surveys focused on habitats along the river that could be affected by project operations (e.g., flow releases) or project-related activities (e.g., maintenance, recreation). Surveyors observed no MacFarlane's four-o'clock in either year, although the species would be readily identifiable in May if it were present.

Idaho Power also conducted rare plant surveys along transmission lines and service roads, covering a corridor that extended about 150 feet from each edge of a right-of-way or tower pad location

(Dumas et al., 2003a). Surveys were conducted in spring and summer of 1999 and 2000. Surveyors observed no MacFarlane's four-o'clock in either year.

3.8.1.9 Howell's Spectacular Thelypody

FWS listed Howell's spectacular thelypody (*Thelypodium howellii* ssp. *spectabilis*) as a threatened plant species in 1999 (64 FR 101) and completed a recovery plan in 2002 (FWS, 2002b). FWS has not designated critical habitat for this species.

Howell's spectacular thelypody is a member of the mustard family that typically blooms from late May through July, bearing showy pink-to-purple flowers in a loose spike. It grows in moist meadow habitats on alkaline clays and silts. Species commonly associated with occurrences of Howell's spectacular thelypody include greasewood, alkali saltgrass, and alkali cordgrass.

Howell's spectacular thelypody is endemic to the Baker-Powder River valley in northeastern Oregon; the only existing populations occur within a 13-mile radius of Haines, Oregon (64 FR 101). Haines is located approximately 40 miles west of the Powder River arm of Brownlee reservoir. Idaho Power's rare plant surveys did not detect any occurrences of Howell's spectacular thelypody (Krichbaum, 2000; Dumas et al., 2003a). Because of the low likelihood that this species would occur in the project area, we do not discuss it further in this document.

3.8.1.10 Spalding's Catchfly

FWS designated Spalding's catchfly (*Silene spaldingii*) as a threatened plant species in 2001 (66 FR 196). ICDC completed a conservation strategy for FWS in 2004 that will serve as the basis for a recovery plan (Hill and Gray, 2004). FWS has not designated any critical habitat for this species.

Spalding's catchfly is a member of the carnation family with sticky leaves and small, greenish-white flowers. It blooms from mid-July through September, and occasionally into October (Hill and Gray, 2004). Throughout its range, Spalding's catchfly occupies several different grassland, shrub, and forested habitat types. In canyon grasslands, such as those in the Snake River basin, Spalding's catchfly is associated with Idaho fescue-dominated plant communities on north-facing slopes between 1,380 feet and 4,000 feet (Hill and Gray, 2004).

Spalding's catchfly occurs at a total of 66 sites in British Columbia, Montana, Oregon, Washington, and Idaho. Several populations are known from the Snake River Canyon, including sites at Garden Creek Ranch and Craig Mountain, and from the lower Imnaha, Salmon, and Grande Ronde watersheds (Gray and Lichthardt, 2003). None of the known sites are within the Hells Canyon Project boundary.

The analysis presented in the conservation strategy for Spalding's catchfly indicates that suitable habitat for this species is present along the Snake River between Brownlee dam and Lewiston. However, Idaho Power's vegetation mapping did not identify any of the three plant communities (Idaho fescue/ snowberry, Idaho fescue/rose, and Idaho fescue/junegrass) that are known to support this species in canyon grassland settings. Rare plant surveys conducted within the riparian study corridor and along project-related roads and transmission lines did not detect any occurrences of Spalding's catchfly, although surveys in 1998 were conducted at a time of year (September) when this species would be readily identifiable (Krichbaum, 2000; Dumas et al., 2003a).

3.8.1.11 Gray Wolf

After near-total eradication, FWS listed the gray wolf (*Canis lupus*) as an endangered species in most of the United States in 1978 (43 FR 47). FWS continues to consider wolves in Washington and Oregon as endangered, but classifies wolves in areas of Idaho south of I-90 and west of I-15 (which includes the project area) as a Nonessential Experimental Population (70 FR 4). FWS prepared a

recovery plan for wolves in the northern Rocky Mountains in 1987, but did not designate critical habitat in the western United States (FWS, 1987). Currently, IDFG manages recovering populations in Idaho according to a plan that focuses on ensuring long-term species viability, while minimizing wolf-human conflicts (Idaho Legislative Wolf Oversight Committee, 2002). FWS approved the plan, effective February 7, 2005 (70 FR 4). On February 8, 2007, FWS proposed to establish a northern Rocky Mountain Distinct Population Segment, which would include wolves in the project area, and remove it from the list of threatened and endangered species (72 FR 26).

The historical range of the gray wolf includes most of North America. Wolves are highly adaptable, and habitat suitability appears to comprise almost any unoccupied territory where prey (primarily big game) is abundant, secluded den sites are available, and humans tolerate their presence (65 FR 135).

ODFW and WDFW have documented reports of wolves in eastern Oregon and eastern Washington from time to time, probably as the result of dispersal from established populations in British Columbia, western Montana, and Idaho (ODFW, 2005; Palmquist, 2002). FWS reintroduced wolves into Montana and Idaho in 1995 and 1996. Populations have steadily increased since that time, and as of 2004, biologists had documented more than 40 packs in central Idaho, with a total population of from 420 to 500 wolves (70 FR 206).

Maps of wolf activity in Idaho in 2004 show one pack located about 15 miles east of Hells Canyon reservoir and several observations of individuals near Brownlee and Oxbow reservoirs (IDFG, 2005b). Idaho Power reports incidental observations of gray wolves on the Idaho side of Hells Canyon reservoir near Allison Creek and near the headwater of the Wildhorse River, a tributary to Oxbow reservoir. Idaho Power also reports that radiotracking data show that wolves occasionally cross the Snake River, most likely through Hells Canyon (Idaho Power 2003a, section E.3.2.1).

3.8.1.12 Canada Lynx

FWS listed the Canada lynx (*Lynx canadensis*) as a threatened species in 2000, due in large part to the inadequacy of regulatory mechanisms to protect them on federal lands, which comprise most of the suitable habitat for this species (65 FR 58). In September 2005, FWS issued a recovery outline to serve as an interim strategy for management until critical habitat is designated and a formal recovery plan has been prepared (FWS, 2005c). FWS designated critical habitat on November 9, 2006 (71 FR 217). No critical habitat is designated in Idaho, Oregon, or Washington.

Canada lynx are medium-sized cats, with large feet adapted to walking on snow. In the western United States, lynx are typically associated with Douglas fir, spruce-fir, and fir-hemlock forest at elevations ranging from about 5,000 feet to 6,600 feet, although FWS considered fir and spruce forest above 4,000 feet in proposing critical habitat (70 FR 216). Most of the dens that have been documented in Washington have been located in mature or old-growth lodgepole pine, spruce, or subalpine fir stands (McKelvey et al., 1999). Lynx forage in younger stands, where greater understory structures support higher populations of its primary prey, the snowshoe hare.

FWS considers lynx in the U.S. (outside Alaska) to be part of a metapopulation with its core in central Canada (McKelvey et al., 1999). Populations in the U.S are at the southern edge of the species range, and were likely never as large as those farther north. At the current time, viable populations are known only in north central Washington, western Montana, and Maine, although there are numerous reports of sightings from northern Idaho, western Wyoming, Wisconsin, and Michigan.

The preliminary lynx recovery outline identifies three classifications of lynx recovery areas for the Rocky Mountain (FWS, 2005c). “Core” areas currently support lynx. “Secondary” areas have fewer and more sporadic records of lynx, and reproduction is not documented. “Peripheral” areas have few historical or recent records of occurrence, and habitat consists of small patches that are not well-

connected to larger patches of high quality habitat. Based on the preliminary mapping, the Hells Canyon Project area lies between a secondary recovery area in the Wallowa and Blue mountains of northeastern Oregon/southeastern Washington and a peripheral recovery area in Idaho that encompasses the Salmon River and Clearwater mountains and extends eastward into Montana. The nearest proposed critical habitat lies more than 200 miles to the northeast, in northwestern Montana (71 FR 217).

Three lynx specimens were collected in southeastern Washington in 1931, 1962, and 1963. Lynx were present in northeastern Oregon in the late 1800s and early 1900s, but there have been few verified occurrences since that time (McKelvey et al., 1999). One specimen was collected in Wallowa County in 1964, in the Imnaha Basin; this is the last confirmed occurrence in northeastern Oregon, although sightings have been reported on the Wallowa-Whitman National Forest (Forest Service, 2003). Winter tracking surveys for lynx on the Wallowa-Whitman between 1992 and 1994 and hair pad surveys between 1999 and 2001 did not result in any lynx detections. However, Idaho Power reports an unconfirmed sighting on the Idaho side of the Snake River below the confluence with the Salmon River, approximately 70 miles downstream of Hells Canyon dam (Idaho Power, 2003a, section E.3.2.1.4.13.1).

3.8.1.13 Northern Idaho Ground Squirrel

FWS listed the northern Idaho ground squirrel (*Spermophilus brunneus brunneus)* as a threatened species in 2000 (65 FR 66). Researchers attribute a dramatic population decline since 1985 to habitat loss, poisoning, recreational shooting, and competition with the larger Columbian ground squirrel (FWS, 2003b). FWS did not designate critical habitat, but completed a recovery plan for this species in 2003 (FWS, 2003b).

The northern Idaho ground squirrel is associated with dry montane meadows surrounded by ponderosa pine and/or Douglas fir forest, at elevations between 3,280 and 5,600 feet (IDFG, 2005c). This species forages primarily on grass seeds, but also takes roots, bulbs, stems and flower heads. It emerges from burrows in late March or early April and remains active until mid-July to early August, when it returns underground.

The northern subspecies of the Idaho ground squirrel is endemic to west-central Idaho, occurring only in Adams and Valley counties. As of 2004, IDFG survey results indicated that the total population is about 850 individuals, located in fewer than 40 colonies. Idaho Power conducted surveys for this species at Barber Flat and Indian Creek, both located east of Oxbow reservoir, outside the project boundary (Turley et al., 2003). Biologists documented one active burrow and heard a whistle near Barber Flat, but recorded no evidence of northern Idaho ground squirrel occurrence at Indian Creek.

3.8.1.14 Bald Eagle

In 1978, FWS listed the bald eagle (*Haliaeetus leucocephalus*) as an endangered species in almost every state in the U.S. Declines in bald eagle populations were due primarily to egg-shell thinning caused by the widespread use of DDT. With legal protection of birds and their habitat, banning of DDT, and implementation of a recovery plan (FWS, 1986), populations began to rebound, and bald eagles were down-listed to threatened status in 1995 (60 FR 133). Populations have continued to thrive, and on June 28, 2007, FWS announced its decision to remove the bald eagle from the list of threatened and endangered species, effective 30 days following publication in the Federal Register (FWS, 2007a). FWS will work with other federal agencies, tribes, and the states to monitor bald eagle populations at 5-year

intervals over a 20-year period after de-listing, and could re-list the species if results indicate it is again in need of ESA protection.[84] No critical habitat is designated for the bald eagle.

Throughout its range, bald eagles are found near open water, including lakes, reservoirs, rivers, and coastal shorelines, where prey is abundant. Their primary prey is fish, but eagles are opportunistic, and also prey on waterfowl and small mammals, and scavenge for carrion and refuse.

For nesting, bald eagles tend to choose large-diameter, canopy-dominant trees within clear view of the water. In the western U.S., the most common nest trees are ponderosa pine, Douglas fir, and black cottonwood (FWS, 1986). Breeding territories vary in size from less than 2 square miles to over 10 square miles. The size and shape of a territory depends to a great extent on food availability.

Bald eagles generally begin courtship and nest-building activities in January and February. They are most sensitive to disturbance during nest-building, incubation (in March), and brooding (late April through early May). Disturbance can cause reproductive failure (Anthony and Isaacs, 1989). However, some pairs of eagles habituate to human activity, and individual birds respond differently to human disturbance (Watson and Pierce, 1998).

In winter, bald eagles tend to congregate around ice-free water where forage is abundant. In addition to large trees that afford sturdy perches near open water, bald eagles need thermal cover that offers protection from wind, rain, snow, and cold temperatures. Disturbance of bald eagles during the winter is of concern because it can cause physiological stress (Stalmaster and Kaiser, 1998).

Bald eagle populations have been increasing throughout the United States: the number of nesting pairs increased from 1,188 in 1981 to 6,471 in 2000 (FWS, 2005a). Trends in Idaho and Oregon are also rising. FWS data show that the number of bald eagle nests in Idaho increased from 53 in 1990 to 128 in 2002 (FWS, 2005a). In Oregon, the number of nests increased from 175 in 1990 to 405 in 2003 (FWS, 2005a).

The number of bald eagle nests within or near the Hells Canyon Project boundary reflects similar upward trends (table 73). Idaho Power conducted surveys between 1995 and 1999, but did not locate any active nests until 1998 (Pope and Holthuijzen, 2003). Idaho Power found one bald eagle nest along Hells Canyon reservoir in 1998. The pair successfully fledged one young in 1998 and 1999, and two young in 2000 and 2001. Surveys located a second nest in 1999, at Oxbow reservoir. This pair successfully fledged one young in 1999, and two in 2000 and 2001. Idaho Power recently filed a bald eagle survey report that documents the discovery of four new nests in the project vicinity since 2003 (Carpenter and Holthuijzen, 2006). With these new nests, the Hells Canyon management zone (Zone 14 of the Pacific Bald Eagle Recovery Area) has reached the recovery plan target of six territories.

Table 73. Bald eagle nests in the Hells Canyon Project area, as of 2005. (Source: Idaho Power)

Nest Site	Land Ownership	Location	Nest Tree	First Reported
Birch Creek	Private	Brownlee reservoir	Black cottonwood	2003
Eagle Creek	Private (conservation easement)	Brownlee reservoir	Black cottonwood	2004
Cottonwood	Idaho Power	Oxbow	Ponderosa pine	1999

[84] Bald eagles are also protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. These laws will continue to provide protection for the bald eagle at the federal level when it is removed from listing under the ESA. State laws will also continue to provide protection in Oregon and Idaho, where the bald eagle is listed as threatened.

Nest Site	Land Ownership	Location	Nest Tree	First Reported
Airport	BLM	Hells Canyon	Ponderosa pine	1998
Hibble Gulch	Forest Service	Hells Canyon	Ponderosa pine	2003
Lamont Springs	Forest Service	Snake River below Hells Canyon dam	Ponderosa pine	2005

Idaho Power monitored productivity at five of the six nests in 2004 and 2005. As shown in table 74, they found an average of 2.54 young fledged in 2004 and an average of 1.4 fledged in 2005, exceeding the recovery plan target of 1.0 in previous years.

Table 74. Annual productivity for bald eagle nests in the Hells Canyon Project vicinity. (Source: Carpenter and Holthuijzen, 2006)

Year	Birch Creek	Eagle Creek	Cottonwood	Airport	Hibble Gulch	Lamont Springs	Total (not including nests with no numerical data)	Young Fledged per Successful Nest
1998	--	--	--	1 (N)	--	--	1	1.0
1999	--	--	1 (N)	1	--	--	2	1.0
2000	--	--	2	2	--	--	4	2.0
2001	--	--	2	2	--	--	4	2.0
2002	--	--	S	S	--	--	S	S
2003	S (N)	--	S	S	S (N)	--	S	S
2004	3	S (N)	3	2	2	--	10	2.5
2005	2	S	1	1	1	2 (N)	7	1.4
Total	5	--	9	9	3	2	28	NC

Note: -- – no nest at this site in this year

S – successful; no numerical data on number of fledglings

N – new nest NC – not calculated

Based on mid-winter surveys, the number of bald eagles that winter in Idaho and Oregon increased by about 1.9 and 1.4 percent, respectively, between 1986 and 2000 (Steenhof et. al., 2004). Idaho Power's mid-winter aerial surveys from 1993 through 1998 found that the total number of eagles in Hells Canyon ranged from 152 in 1994 to 68 in 1998, with an average of 102.5 (Holthuijzen, 2003c). Numbers varied from year to year, and did not appear to show any trend. Idaho Power observed most wintering bald eagles along Oxbow reservoir and the Powder River arm of Brownlee reservoir. Idaho Power noted that areas of concentration seemed to be those with reliable food resources, including fish, waterfowl, and winter-killed mule deer (Holthuijzen, 2003c).

3.8.2 Environmental Effects on Threatened and Endangered Species

3.8.2.1 Snake River Fall Chinook Salmon

The numbers of fall Chinook salmon that return to the Hells Canyon reach of the Snake River has increased approximately 20-fold since the early 1990s. While part of this increase is from hatchery supplementation, the escapement of wild fish has also shown a progressive increase in recent years (figure 108). The reach between Hells Canyon dam and lower Granite reservoir is the largest spawning area that remains accessible to the ESU.

The primary effects of the project on the Snake River fall Chinook salmon ESU include: (1) blocked access to historical spawning and rearing habitat upstream of the project; (2) effects on spawning habitat including provision of a beneficial flow regime during the spawning and incubation period, interruption of spawning gravel transport and recruitment to downstream spawning habitat and low DO and high temperature levels that extend into the early part of the spawning season; and (3) effects on rearing habitat including the occurrence of gas supersaturation during spill periods, suboptimal water temperatures during the early rearing period, and flow fluctuations associated with load following operations.

Idaho Power proposes the following measures that should benefit the Snake River fall Chinook salmon ESU:

- Continue reservoir operations in the fall, winter, and early spring for protection of fall Chinook spawning and salmon incubation
- Continue fall Chinook salmon redd and temperature monitoring to avoid the risk of dewatering developing salmon embryos, but discontinue deep-water redd monitoring until fall Chinook escapement increases significantly
- Install spillway flow deflectors at Hells Canyon and Brownlee dams, and install the most effective, safe and economically feasible measure designed to reduce TDG levels at Oxbow dam
- Implement in-reservoir aeration or upstream phosphorus trading to meet the 1,125 tons per year DO load allocation in Brownlee reservoir and aerating turbines at Hells Canyon or Brownlee dam to add 1,500 tons per year DO below Hells Canyon dam
- Implement watershed measures (which may include hydrologic measures or restoration of riparian vegetation or channel morphology) or a bubble upwelling system in Brownlee reservoir to compensate for the project's contribution to elevated water temperatures.

Resource agencies, tribes, and NGOs filed numerous recommendations that have the potential to benefit the ESU, including measures to improve the quality of, and restore access to, habitat within and upstream of the project, maintain the quality of spawning and rearing habitat downstream of the project, and to improve outmigration survival during the juvenile outmigration period.

Our Analysis

Blocked Access to Historical Habitat

The most recent assessment of the historical population structure of Snake River fall Chinook salmon prepared by NMFS (McClure et al., 2005) concludes that the Idaho Power projects extirpated two of the three major population groups of Snake River fall Chinook salmon that existed historically: the Salmon Falls major population group (extirpated by the Swan Falls Project in the early 1900s) and the Marsing Reach major population group (extirpated by the Hells Canyon Project in the early 1960s after efforts to provide fish passage failed). NMFS states that continued long-term blockage of access to the

remaining upstream habitat prevents both the increase in numbers and productivity of these fish and the development of a population structure and genetic diversity that would reduce the risk of extinction of this ESU.

Idaho Power conducted a comprehensive analysis of the condition of anadromous fish habitat upstream of the project and restoration alternatives that included a provision for fish passage at the project, passage at upstream Idaho Power dams, and passage at other man-made migration barriers in the basin. In its analysis of reintroduction alternatives, Idaho Power concluded that restoring fall Chinook salmon to areas upstream of the project was not likely to be feasible without extensive hatchery supplementation due to the degraded condition of historical spawning and rearing habitat and loss rates of juvenile and adult salmon during passage through the lower Snake/Columbia River migratory corridor (Chandler and Chapman, 2003b). As a result, Idaho Power did not propose any measures related to the restoration of fall Chinook salmon to habitat upstream of the project.

In section 3.6.2.6, *Anadromous Fish Restoration*, we evaluate a range of agency recommendations related to restoration of access to blocked habitat upstream of the project. These encompassed funding of water quality improvements in the upper basin to expedite habitat recovery, monitoring the condition of spawning gravels upstream of the project to determine when habitat conditions would warrant the initiation of reintroduction studies, and studies to evaluate the feasibility of collecting and transporting fall Chinook smolts past the project or to provide instream passage through the project. We conclude that water quality conditions in the intragravel incubation environment are too compromised to warrant reintroduction studies to the Swan Falls to Brownlee reach at this time, but that conditions could improve over time. We include in the Staff Alternative a proposal to track water quality conditions upstream of the project to determine when conditions would warrant reintroduction. Under this approach, any license issued for the project would include a mechanism to proceed with re-introduction studies and other efforts once water quality conditions have improved sufficiently.

Effects on Downstream Spawning Habitat

Idaho Power proposes to continue its fall Chinook spawning flow program, which provides a stable flow regime during the spawning season and prevents dewatering of any redds during the incubation season. This program is supported by the agencies and tribes, and we conclude that it is likely that this program has contributed to the substantial increase in the numbers of adult fall Chinook salmon that return to the Hells Canyon reach. Idaho Power also proposes to continue redd surveys and temperature monitoring to determine the timing and location of spawning activity, and to estimate the timing of emergence to determine the duration that redds must be protected from dewatering to avoid mortality. NMFS recommends monitoring survival-to-emergence of fall Chinook salmon at two sites in the Hells Canyon reach every 5 years. In its draft EIS comments, Idaho Power proposed a fall Chinook spawning and gravel monitoring program that includes detailed mapping of spawning substrate and incorporates monitoring of survival-to-emergence every 5 years, consistent with NMFS's proposal. Measures and recommendations associated with spawning flows are addressed in detail in section 3.6.2.1, *Effects of Project Operation of Aquatic Species*, and measures regarding spawning and gravel monitoring are discussed in 3.6.2.14, *Sediment Augmentation*.

Idaho Power does not propose any measures to augment or monitor the quantity of spawning gravel in the Hells Canyon reach. Our analysis of the sediment budget presented in section 3.4, *Sediment Supply and Transport*, indicates that the quantity of gravel trapped by the project reservoirs is relatively large compared to the amount contributed by tributaries in the upper Hells Canyon reach, suggesting that some reduction in the availability of spawning gravels may be occurring. In section 3.6.2.14, *Sediment Augmentation*, we concluded that the Fall Chinook Spawning and Gravel Monitoring Plan proposed by Idaho Power would provide an effective means of determining whether adverse effects on fall Chinook spawning habitat are occurring, and whether gravel augmentation or other measures to protect spawning habitat are warranted.

As shown in figures 48, 49, and 50, DO levels that are unsuitable for salmonids extend at least 3 miles downstream from Hells Canyon dam from July through October in extreme low flow years. Conditions in this reach also are below optimal over the same distance and time period even in extreme high flow years. In its license application, Idaho Power proposed to supplement DO into Brownlee reservoir; however, this measure is not expected to improve low DO levels that occur downstream of Hells Canyon dam. In its application for water quality certification, Idaho Power proposes to implement an in-reservoir aeration system or an upstream phosphorus trading program to meet the 1,125 tons per year DO TMDL load allocation in Brownlee reservoir. Idaho Power also proposes to aerate the turbines at Hells Canyon or Brownlee dam to add 1,500 tons per year DO below Hells Canyon dam. Measures are also included to compensate for the project's contribution to thermal load, which would decrease water temperatures near the start of the spawning season. Implementing the measures included in Idaho Power's application for water quality certification should help to alleviate high water temperature and low DO conditions that currently occur during the first several weeks of the spawning period, and is likely to improve gamete viability for early spawning fish.

Effects on Downstream Rearing Habitat

Idaho Power does not propose any operating constraints to stabilize outflows from the project during the fall Chinook rearing period after fry have emerged from the gravel, other than its current 12-inch-per-hour ramp rate as measured at Johnson Bar. Other stakeholders recommended a range of ramping rate and other operational restrictions that would serve to stabilize flows during the fall Chinook rearing season. In section 3.6.2.1, *Effects of Project Operations on Aquatic Resources*, we evaluate the effect of Idaho Power's proposed operations and agency proposed operations on fall Chinook salmon rearing habitat in terms of food production, habitat stability, and the potential for losses due to stranding or entrapment. We also discuss the potential benefits of a staff-developed measure of a 4-inch-per-hour ramping rate restriction from March 15 to June 15, which would increase the prey base available to rearing fall Chinook salmon by improving aquatic invertebrate production in shallow areas, and would reduce the potential for stranding juvenile fall Chinook salmon. We evaluate Idaho Power's analysis of 2005 entrapment monitoring studies, which indicate that a 4-inch-per-hour ramping rate would have reduced entrapment mortality by 93 percent under the flow conditions that occurred in 2005. We also discuss the potential benefits of continuing entrapment monitoring to evaluate stranding and entrapment losses in other hydrologic year types to determine whether operations need to be further modified or fish salvage operations undertaken to reduce mortality due to stranding and entrapment of juvenile fall Chinook salmon and other aquatic species. We also discuss an Invertebrate Monitoring Plan that would be designed to evaluate the effects of project operations on invertebrate production, and would include adaptive management process to address adverse effects on the invertebrate food base available to aquatic species.

Idaho Power proposed in its license application to install spillway flow deflectors at Hells Canyon dam and to continue preferential use of the upper spillgates at Brownlee dam during spill periods to reduce TDG concentrations in the Snake River downstream of Hells Canyon dam. In its application for water quality certification, however, Idaho proposes to install spillway flow deflectors at Brownlee dam and to install the most effective, safe and economically feasible measure designed to reduce TDG levels at Oxbow dam. These measures would reduce TDG levels downstream of Hells Canyon dam during most spill periods, and would thereby reduce the incidence of injuries to rearing juvenile fall Chinook salmon caused by gas supersaturation. Although the use of air-blowers as a means to increase DO levels downstream of Hells Canyon dam may increase TDG levels, Idaho Power proposes to conduct a pilot testing program where a blower would be rented for a finite period of time and tests completed with the blower in operation. This testing would ensure that DO objectives can be met and that the 110 percent TDG limit is not exceeded.

In section 3.5.2.1, *Effects of Project Operations on Water Quality*, we conclude that anoxic conditions in Brownlee reservoir result in the production, accumulation, and discharge of ammonia and trace metals (including mercury) that contribute to bioaccumulation of methylmercury and organochlorine compounds (including dieldrin, DDT/DDE, and PCBs) in fish in the project area. While the potential bioaccumulation of these materials in rearing fall Chinook salmon is limited by the relatively short duration in which they rear in the Snake River, the potential for sublethal effects is unknown. The concentration of these toxic materials would likely be gradually reduced over time as nutrient inputs are reduced through implementation of the phosphorus TMDL and anoxic conditions are reduced. However, full implementation of the TMDL is not expected to be attained within the term of the next license. In addition, summer flow augmentation would tend to expedite the discharge of ammonia and trace metals from Brownlee reservoir, and outflows during the fall would be expected to have lower concentrations of ammonia and trace metals.

Effects on the Downstream Migration Corridor

As we discussed in section 3.6.2.1, *Effects of Project Operation on Aquatic Resources*, Idaho Power does not propose any specific measures to benefit outmigrating juvenile fall Chinook salmon, but several stakeholders recommend measures that are intended to improve juvenile migration survival by increasing flows during the summer outmigration. We concluded that summer flow augmentation is one of three substantive measures (in addition to hatchery supplementation and Idaho Power's fall Chinook spawning and incubation flow program) that, in combination, have contributed to a 20-fold increase in fall Chinook salmon returns over the last decade. While we conclude that it is not possible to definitively evaluate the benefits of flow augmentation based on the available information, we outline a staff-developed measure that would continue Idaho Power's participation in the flow augmentation program. This program would be reviewed 6 years after license issuance to determine whether new information on the efficacy of flow augmentation warrants any adjustment in the timing or volume of flow augmentation water that is delivered from Brownlee reservoir.

3.8.2.2 Snake River Spring/Summer Chinook Salmon

The number of Snake River spring/summer Chinook salmon migrating past Lower Granite dam has fluctuated widely over the last several decades, but returns of both wild and hatchery-origin fish have been increasing over the last several years (figure 109). This ESU spawns in tributaries to the Snake River including the Imnaha and Salmon rivers. Their primary use of the mainstem Snake River is as a migratory corridor to access these tributary habitats.

The primary effects of the project on the Snake River spring/summer Chinook salmon ESU include: (1) blocked access to historical spawning and rearing habitat upstream of the project; (2) effects on the migratory corridor, including gas supersaturation during spills that coincide with the juvenile and adult migration periods, and (3) alteration of river flows during the juvenile migration period.

Idaho Power proposes the following measures that could benefit the Snake River spring/summer Chinook salmon ESU:

- Implement a tributary enhancement program that would improve habitat conditions for salmonids in Pine Creek and in the Wildhorse River.[85]
- Install spillway flow deflectors at Hells Canyon and Brownlee dams, and install the most effective, safe and economically feasible measure designed to reduce TDG levels at Oxbow dam.

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[85] Although tributary enhancement measures would also be implemented in Indian Creek, this stream is not known to have produced spring/summer Chinook.

- Implement in-reservoir aeration or upstream phosphorus trading to meet the 1,125 tons/year DO load allocation in Brownlee reservoir, and install aerating turbines at Hells Canyon or Brownlee dam to add 1,500 tons per year DO downstream of Hells Canyon dam.
- Implement watershed measures (which may include hydrologic measures or restoration of riparian vegetation or channel morphology) or a bubble upwelling system in Brownlee reservoir to compensate for the project's contribution to elevated water temperatures.

Resource agencies, tribes, and NGOs filed numerous recommendations that have the potential to benefit the ESU, including measures to improve the quality of, and restore access to, habitat within and upstream of the project and to improve flow and water quality conditions in the migratory corridor during the juvenile and adult migration periods.

Our Analysis

Blocked Access to Historical Habitat

NMFS estimates that about 37 percent of spring/summer Chinook salmon major population groups in the Snake River basin were located upstream of the Hells Canyon Project (McClure et al. 2005). NMFS[86] states that construction of Swan Falls Project in 1901 eliminated whatever was left of at least five spring/summer Chinook salmon major population groups, and that construction of the Hells Canyon Project eliminated whatever remained of up to eight major population groups of spring/summer Chinook salmon.

Idaho Power conducted a comprehensive analysis of the condition of anadromous fish habitat upstream of the project and restoration alternatives that included a provision for fish passage at the project, passage at upstream Idaho Power dams, and passage at other man-made migration barriers in the basin. In their analysis of reintroduction alternatives, Idaho Power concluded that restoration of self-sustaining runs of spring/summer Chinook salmon populations to habitat upstream of Hells Canyon dam was not likely to be feasible due to the degraded condition of historical spawning and rearing habitats and loss rates of juvenile and adult salmon during passage through the lower Snake/Columbia River migratory corridor (Chandler and Chapman, 2003-E.3.1-2, chapter 11). As a result, Idaho Power did not propose any measures related to the restoration of spring/summer Chinook salmon to habitat upstream of the project.

In section 3.6.2.6, *Anadromous Fish Restoration*, we evaluate a range of agency recommendations related to restoration of access to blocked habitat upstream of the project. These encompass funding of water quality and habitat improvements in tributaries and in the upper basin to expedite habitat recovery, studies to evaluate habitat capacity and the feasibility of collecting and transporting spring/summer Chinook smolts at tributary traps or to provide instream passage through the project. In the draft EIS, we concluded that water quality and habitat conditions are too compromised to warrant reintroduction studies upstream of the project at this time, but that conditions could improve over time. We include in the Staff Alternative a proposal to track water quality conditions upstream of the project to determine when conditions would warrant reintroduction. Under this approach, any license issued for the project would include a mechanism to proceed with re-introduction studies and other efforts once water quality conditions have improved sufficiently.

Comments received on the draft EIS indicate that habitat and water quality conditions in some of the tributaries may be sufficient to support anadromous fish at this time, particularly in Pine Creek and in

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[86] Letter from D.R. Lohn, Regional Administrator to M. Salas, Secretary, Federal Energy Regulatory Commission, dated January 24, 2006, submitting preliminary recommended terms and conditions for the Hells Canyon Project.

some of the tributaries to the Powder River. In this final EIS, we evaluate measures that would (1) explore the potential for anadromous fish restoration by continuing the release of surplus adult hatchery steelhead into Hells Canyon reservoir, and (2) construct the Pine Creek weir in a manner that would support restoration studies by allowing operation during the spring smolt outmigration. We also evaluate a measure that would expand the stocking program for surplus adult hatchery fish into the reservoir to include the stocking of spring Chinook salmon, which have also been released to support put-and-take recreational fisheries in the basin upstream of Hells Canyon dam.[87] Information gained from these efforts would help inform decisions for, and evaluate the prospects of, implementing a successful restoration effort in other suitable tributaries, including tributaries in the Powder River basin.

Effects on the Downstream Migration Corridor

As described above, Idaho Power proposes several measures to reduce TDG levels downstream of Hells Canyon dam. Because TDG levels exceeding 120 percent of saturation currently persist up to 60 miles downstream from Hells Canyon dam, the measures proposed by Idaho Power may benefit spring Chinook salmon smolts migrating from the Imnaha and Salmon river basins.

As we discuss in section 3.6.2.1, *Effects of Project Operation on Aquatic Resources*, Idaho Power does not propose any specific measures to benefit outmigrating juvenile salmon and steelhead, but several stakeholders recommend measures that are intended to improve juvenile migration survival by increasing flows during the spring outmigration of yearling smolts. These include measures to ensure that Brownlee reservoir is not drafted any more than is needed to meet flood control requirements, and that it is refilled as early as possible to avoid reducing outflows during the spring yearling smolt outmigration period. Maintaining higher flows during the smolt outmigration period would speed migration and should increase the survival rate of smolts passing through the lower Snake/Columbia River migratory corridor.

3.8.2.3 Snake River Sockeye Salmon

The number of Snake River sockeye salmon migrating past Lower Granite dam has started to increase in the last several years from previous near-extinction levels as the result of an intensive conservation aquaculture program (figure 110). Although the species historically occurred in Payette Lake upstream of the project, the only remaining population exists in Redfish Lake in the Salmon River basin. These fish use the mainstem Snake River downstream of its confluence with the Salmon River as a migratory corridor to and from the Pacific Ocean.

The primary effects of the project on the Snake River sockeye salmon ESU include: (1) blocked access to historical spawning and rearing habitat upstream of the project; and (2) effects on the migratory corridor including gas supersaturation during spill periods and alteration of river flows during the juvenile and adult migration periods.

Idaho Power proposes the following measure that would benefit the Snake River sockeye salmon ESU:

- Install spillway flow deflectors at Hells Canyon and Brownlee dams, and install the most effective, safe and economically feasible measure designed to reduce TDG levels at Oxbow dam.

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[87] During the section 10(j) meeting, Interior stated that surplus spring Chinook salmon have been released into the Payette River, which enters the Snake River between Swan Falls and Hells Canyon dams.

- Implement watershed measures (which may include hydrologic measures or restoration of riparian vegetation or channel morphology), or a bubble upwelling system in Brownlee reservoir to compensate for the project's contribution to elevated water temperatures.

Resource agencies, tribes, and NGOs filed several recommendations that have the potential to benefit the ESU, including measures to improve flow and water quality conditions in the migratory corridor during the juvenile and adult migration periods.

Our Analysis

Blocked Access to Historical Habitat

Idaho Power conducted a comprehensive analysis of the condition of anadromous fish habitat upstream of the project and restoration alternatives that included provision of fish passage at the project, passage at upstream Idaho Power dams, and passage at other man-made migration barriers in the basin. In their analysis of reintroduction alternatives, Idaho Power concluded that restoration of self-sustaining runs of salmon and steelhead was not likely to be feasible due to the degraded condition of historical spawning and rearing habitats and loss rates of juvenile and adult salmon during passage through the lower Snake/Columbia River migratory corridor (Chandler and Chapman, 2003b). As a result, Idaho Power did not propose to restore passage for anadromous fish species to habitat upstream of the project. In addition to passage at the Hells Canyon Project, restoring sockeye salmon to Payette Lake would require passage at Cascade reservoir on the Payette River. No agency, tribe, or NGO made any specific recommendations to restore sockeye salmon to habitat upstream of the project.

Effects on the Downstream Migration Corridor

As described above, Idaho Power proposes several measures to reduce TDG levels downstream of Hells Canyon dam. Because TDG levels exceeding 120 percent of saturation currently persist up to 60 miles downstream from Hells Canyon dam, the measures proposed by Idaho Power may benefit sockeye salmon smolts migrating from the Salmon River basin.

As we discuss in section 3.6.2.1, *Effects of Project Operation on Aquatic Resources*, Idaho Power does not propose any specific measures to benefit outmigrating juvenile salmon and steelhead, but several stakeholders recommend measures that are intended to improve juvenile migration survival by increasing flows during the spring outmigration of yearling smolts. These include measures to ensure that Brownlee reservoir is not drafted any more than is needed to meet flood control requirements, and that it is refilled as early as possible to avoid reducing outflows during the spring yearling smolt outmigration period. Maintaining higher flows during the smolt outmigration period would speed migration and should increase the survival rate of smolts passing through the lower Snake/Columbia River migratory corridor.

3.8.2.4 Snake River Steelhead

The number of wild and hatchery-origin Snake River steelhead migrating past Lower Granite dam has increased two to three-fold from the run sizes that predominated in the 1990s (figure 111). This ESU spawns in tributaries to the Snake River including the Imnaha and Salmon rivers. Their primary use of the mainstem Snake River is as a migratory corridor to access tributary habitats.

The primary effects of the project on the Snake River steelhead ESU include: (1) blocked access to historical spawning and rearing habitat upstream of the project; and (2) effects on the migratory corridor including gas supersaturation during spills that coincide with the juvenile and adult migration periods, and alteration of river flows during the juvenile migration period.

Idaho Power proposes the following measures that could benefit the Snake River steelhead ESU:

Implement a tributary enhancement program that would improve habitat conditions for salmonids in Pine Creek, Indian Creek and in the Wildhorse River.

Idaho Power proposes the following measures that could benefit the Snake River steelhead ESU:

- Implement a tributary enhancement program that would improve habitat conditions for salmonids in Pine Creek, Indian Creek and in the Wildhorse River.
- Install spillway flow deflectors at Hells Canyon and Brownlee dams, and install the most effective, safe and economically feasible measure designed to reduce TDG levels at Oxbow dam.
- Implement in-reservoir aeration or upstream phosphorus trading to meet the 1,125 tons/year DO load allocation in Brownlee reservoir, and install aerating turbines at Hells Canyon or Brownlee dam to add 1,500 tons/year DO below Hells Canyon dam.
- Implement watershed measures (which may include hydrologic measures or restoration of riparian vegetation or channel morphology) or a bubble upwelling system in Brownlee reservoir to compensate for the project's contribution to elevated water temperatures.

Resource agencies, tribes, and NGOs filed numerous recommendations that have the potential to benefit the ESU, including measures to improve the quality of and restore access to habitat within, and upstream of, the project and improve flow and water quality conditions in the migratory corridor during the juvenile and adult migration periods.

Our Analysis

Blocked Access to Historical Habitat

NMFS estimates that about 38 percent of steelhead major population groups in the entire Snake River basin were located upstream of the Hells Canyon Project and have been extirpated (McClure et al., 2005). NMFS[88] states that the construction of the Swan Falls Project in 1901 eliminated three steelhead major population groups, and that construction of the Hells Canyon Project eliminated four major population groups of steelhead and the core production center of one additional steelhead major population group.

Idaho Power conducted a comprehensive analysis of the condition of anadromous fish habitat upstream of the project and restoration alternatives that included a provision for fish passage at the project, passage at upstream Idaho Power dams, and passage at other man-made migration barriers in the basin. In their analysis of reintroduction alternatives, Idaho Power concluded that restoring self-sustaining runs of steelhead to habitat upstream of Hells Canyon dam was not likely to be feasible due to the degraded condition of historical spawning and rearing habitats and loss rates of juvenile and adult salmon during passage through the lower Snake/Columbia River migratory corridor (Chandler and Chapman, 2003-E.3.1-2, chapter 11). As a result, Idaho Power did not propose any measures related to the restoration of steelhead to habitat upstream of the project.

In section 3.6.2.6, *Anadromous Fish Restoration*, we evaluate a range of agency recommendations related to restoration of access to blocked habitat upstream of the project. These encompassed funding of water quality and habitat improvements in tributaries and in the upper basin to expedite habitat recovery, studies to evaluate habitat capacity and the feasibility of collecting and

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[88] Letter from D. Robert Lohn, Regional Administrator to Magalie Salas, Secretary, Federal Energy Regulatory Commission, dated January 24, 2006, submitting preliminary recommended terms and conditions for the Hells Canyon Project.

transporting steelhead smolts at tributary traps or to provide instream passage through the project. We conclude that water quality and habitat conditions are too compromised to warrant reintroduction studies upstream of the project at this time, but that conditions could improve over time. We include in the Staff Alternative a proposal to track water quality conditions upstream of the project to determine when conditions would warrant reintroduction. Under this approach, any license issued for the project would include a mechanism to proceed with re-introduction studies and other efforts once water quality conditions have improved sufficiently.

Comments received on the draft EIS indicate that habitat and water quality conditions in some of the tributaries may be sufficient to support anadromous fish at this time, particularly in Pine Creek and in some of the tributaries to the Powder River. In this Final EIS, we evaluate measures that would (1) explore the potential for anadromous fish restoration by continuing the release of surplus adult hatchery steelhead into Hells Canyon reservoir, and (2) construct the Pine Creek weir in a manner that would support restoration studies by allowing operation during the spring smolt outmigration. Information gained from these efforts would help inform decisions for, and evaluate the prospects of, implementing a successful restoration effort in other suitable tributaries, including tributaries in the Powder River basin.

Effects on the Downstream Migration Corridor

As described above, Idaho Power proposes several measures to reduce TDG levels downstream of Hells Canyon dam. Because TDG levels exceeding 120 percent of saturation currently persist up to 60 miles downstream from Hells Canyon dam, the measures proposed by Idaho Power may benefit steelhead smolts migrating from the Imnaha and Salmon River basins.

As we discuss in section 3.6.2.1, *Effects of Project Operation on Aquatic Resources*, Idaho Power does not propose any specific measures to benefit outmigrating juvenile salmon and steelhead, but several stakeholders recommend measures that are intended to improve juvenile migration survival by increasing flows during the spring outmigration of yearling smolts. These include measures to ensure that Brownlee reservoir is not drafted any more than is needed to meet flood control requirements, and that it is refilled as early as possible to avoid reducing outflows during the spring yearling smolt outmigration period. Maintaining higher flows during the smolt outmigration period would speed migration and should increase the survival rate of smolts passing through the lower Snake/Columbia River migratory corridor.

3.8.2.5 Other Columbia River Basin Salmon and Steelhead ESUs

In addition to the four Snake River salmon and steelhead ESUs addressed above, NMFS indicated in its November 28, 2005 letter to the Commission that the Hells Canyon Project, or its operations, are likely to affect nine other Columbia Basin salmon and steelhead ESUs or their designated critical habitat. These are the Upper Columbia River spring Chinook salmon, Middle Columbia River steelhead, Lower Columbia River Chinook salmon, Columbia River chum salmon, Lower Columbia River coho salmon, Lower Columbia River steelhead, Lower Columbia River steelhead, Upper Willamette River Chinook salmon, and the Upper Willamette River steelhead.

The primary effects of the project on these ESUs involve direct effects on water quantity and primarily indirect effects on water quality in the lower Columbia River migratory corridor. The magnitude of direct effects on water quality is small due to the substantial distance between Hells Canyon dam and the confluence of the Snake and Columbia rivers (247.6 river miles). Such direct effects on TDG, DO, and water temperatures would likely equilibrate with ambient conditions by the time the water leaving the project area reaches the Columbia River. Also, the relatively small proportion that flow passing Hells Canyon dam constitutes of the total flow in the Lower Columbia River at McNary dam

(about 12.3 percent) likely minimizes such effects.[89] However, flood control operations at Brownlee reservoir, when combined with flood control operations at other reservoirs in the basin, contribute to a substantive overall reduction in the spring flow freshet.

NMFS (2005) describes both adverse and beneficial effects from reduction of the spring freshet on fish survival. The adverse effect is a reduction in mainstem Federal Columbia River Power System dam and reservoir passage survival, particularly for spring migrants that traverse the system in-river (that is, they are not transported). The beneficial water quality effects are associated with water temperature and TDG effects. Reducing Snake River spring flows at Brownlee reservoir increases the influence of cooler tributary inflows (e.g., the Salmon and Clearwater rivers) on downstream water temperatures. Also, reducing the magnitude of the spring freshet reduces the frequency and magnitude of involuntary spills through the eight mainstem Federal Columbia River Power System projects. When river flows exceed a project powerhouse's hydraulic capacity, the dam is forced to spill (termed "involuntary spill"). High rates of involuntary spill can create adverse TDG conditions in downstream waters. Elevated TDG levels (i.e., above the State of Oregon's or Washington's water quality standard waiver level of 120 percent in tailraces and 115 percent in forebays of mainstem Federal Columbia River Power System dams) can adversely affect all life stages of fish. The beneficial effects of reduced spill would occur only in high flow years.

To assess the timing and magnitude of the effect of Idaho Power's proposed operations on flows downstream of Hells Canyon dam, we compared simulated outflows for three representative water years under Idaho Power's proposed operations with flows that would occur under run-of river operations at two locations, one below Hells Canyon dam, and one at Anatone, WA, just upstream of Lower Granite reservoir (figures 112, 113, and 114). The largest difference in outflow occurs during the flood control season in medium and extreme high flow years. During these year-types, outflows are typically increased by 2,000 to 3,000 cfs in January, February and March as the reservoir is drafted to meet target elevations specified by the Corps, and then flows are reduced in May and June by as much as 10,000 to 15,000 cfs in medium and high flow years during the spring freshet. In October, outflows are typically increased by about 2,000 to 3,000 cfs during October to vacate space to manage flows for the fall Chinook spawning period, when outflows are typically reduced by about 7,000 to 8,000 cfs from peak flows that would otherwise occur between November through December.

The provision of 237,000 acre-feet of flow augmentation from Brownlee reservoir over a 41-day period from June 20 to July 31 as recommended by NMFS would increase flows by an average of 2,914 cfs, which represents a 1.5 percent increase over the average July flow at McNary dam of 199,351 cfs. Similarly, while flood control operations at Brownlee reservoir have the capacity to substantially reduce the magnitude of peak flows for several days or weeks, refilling the reservoir at the end of the flood control season typically occurs over a longer period and has less effect on downstream flows. For example, refilling from a 200,000 acre-foot draft over a 30-day period in May would reduce the flow contribution from the Snake River by an average of 3,361 cfs, or 1.2 percent of the average May flow at McNary dam of 285,560 cfs. Drafting Brownlee reservoir to control flows as part of Idaho Power's fall Chinook spawning and incubation flow program may have a more notable effect due to lower prevailing flows in the fall. For example, drafting 200,000 acre feet over a 30-day period in October would reduce flow contributions from the Snake River by 3,361 cfs, or about 3.0 percent of the average October flow of 112,344 cfs at McNary dam, and refilling the reservoir over a 30-day period in November would reduce flows by about 2.7 percent.

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[89] Based on comparison of mean annual flow data from 1971 to 1980 at USGS gage 14019200 at McNary dam and USGS gage 13290450 at Hells Canyon dam.

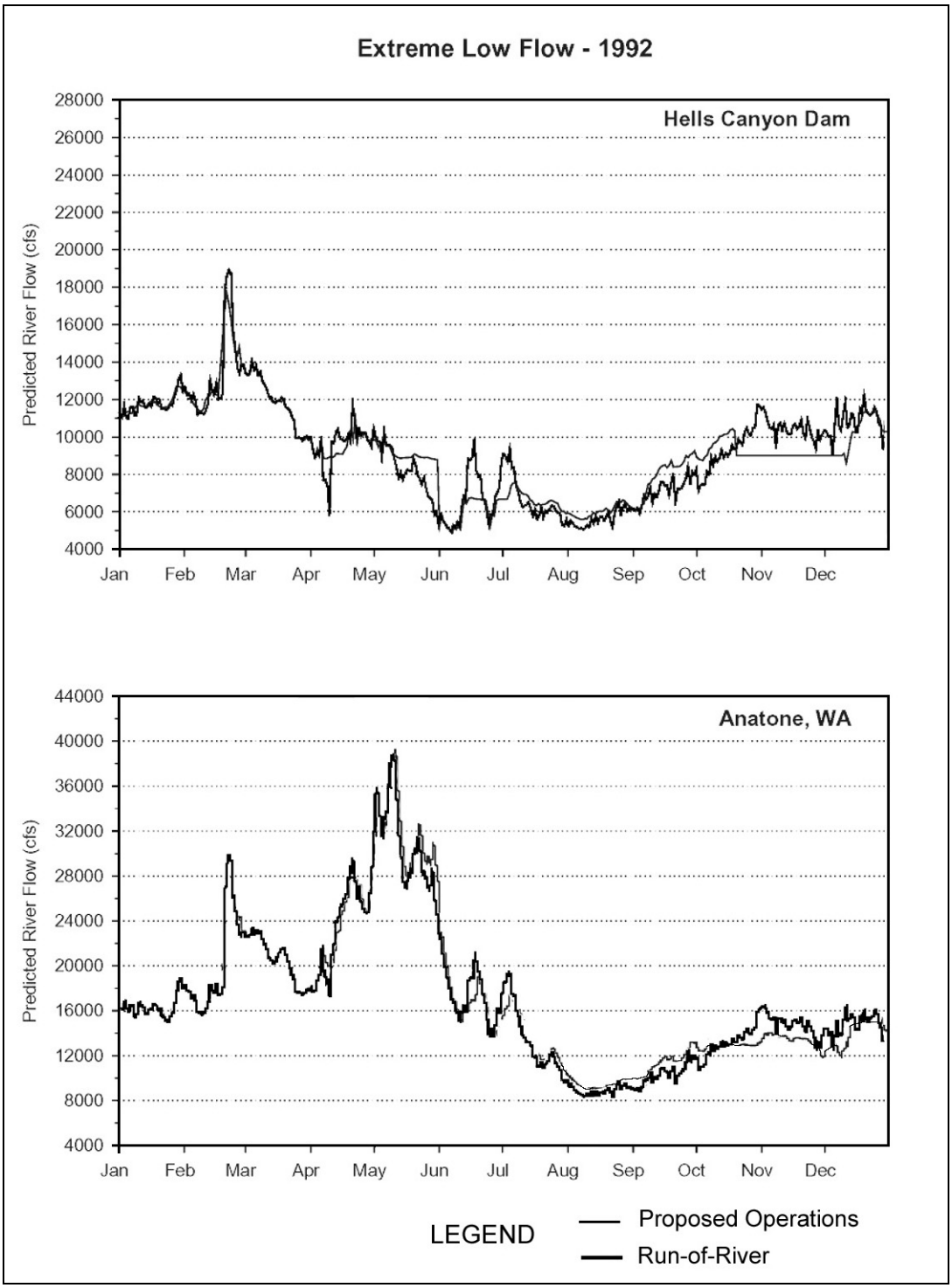

Figure 112. Simulated flows below Hells Canyon dam and at Anatone, WA for a representative extreme low flow year (1992) for proposed operations (scenario 1d used as surrogate) and with Brownlee reservoir held at minimum operating pool (scenario 5). Scenario 1d was used to remove diurnal fluctuations caused by load following operations to facilitate the visual comparison of daily average flows. Source: (Brink and Chandler, 2005)

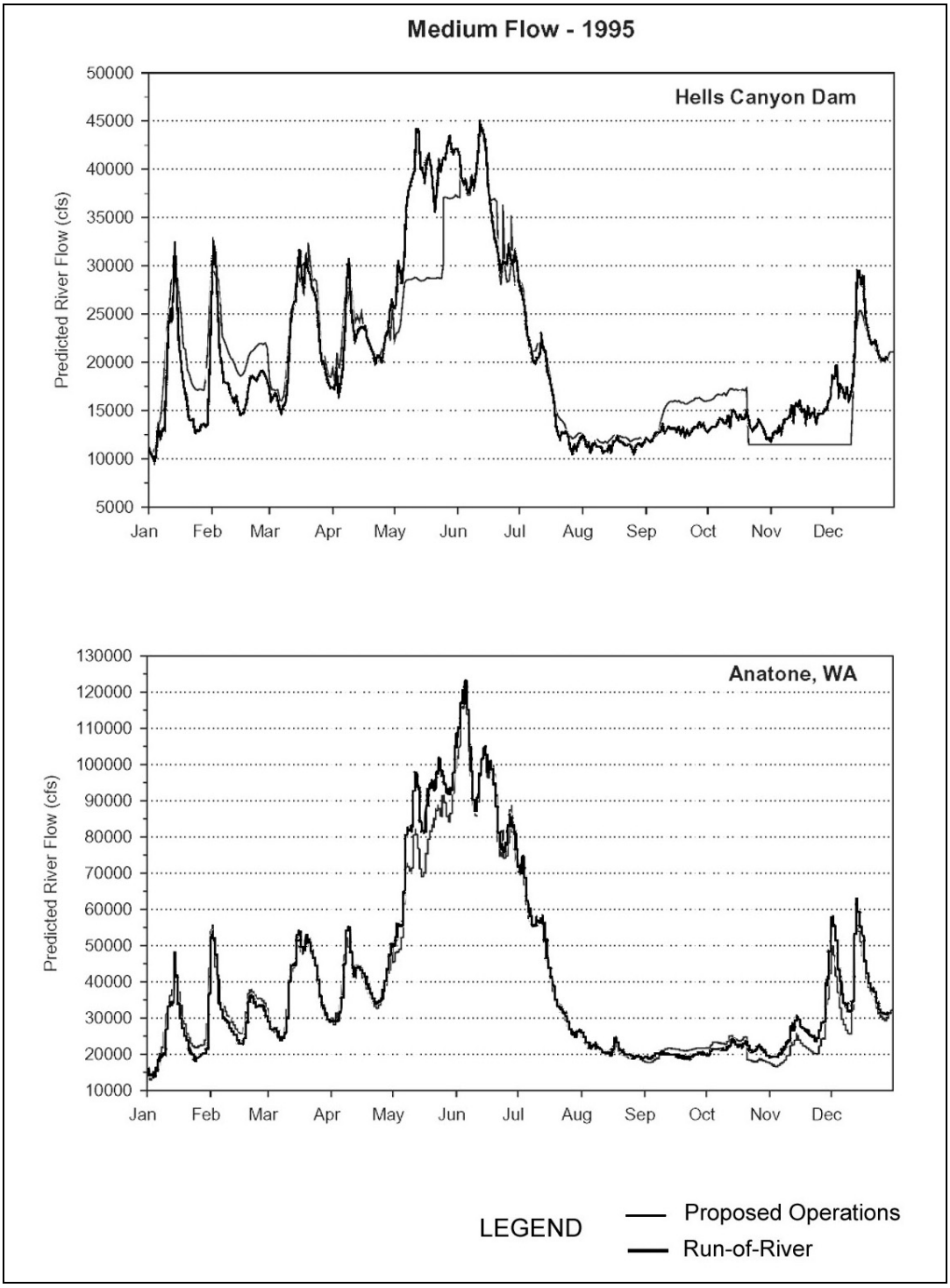

Figure 113. Simulated flows below Hells Canyon dam and at Anatone, WA for a representative medium flow year (1995) for proposed operations (scenario 1d used as surrogate) and with Brownlee reservoir held at minimum operating pool (scenario 5). Scenario 1d was used to remove diurnal fluctuations caused by load following operations to facilitate the visual comparison of daily average flows. (Source: Brink and Chandler, 2005)

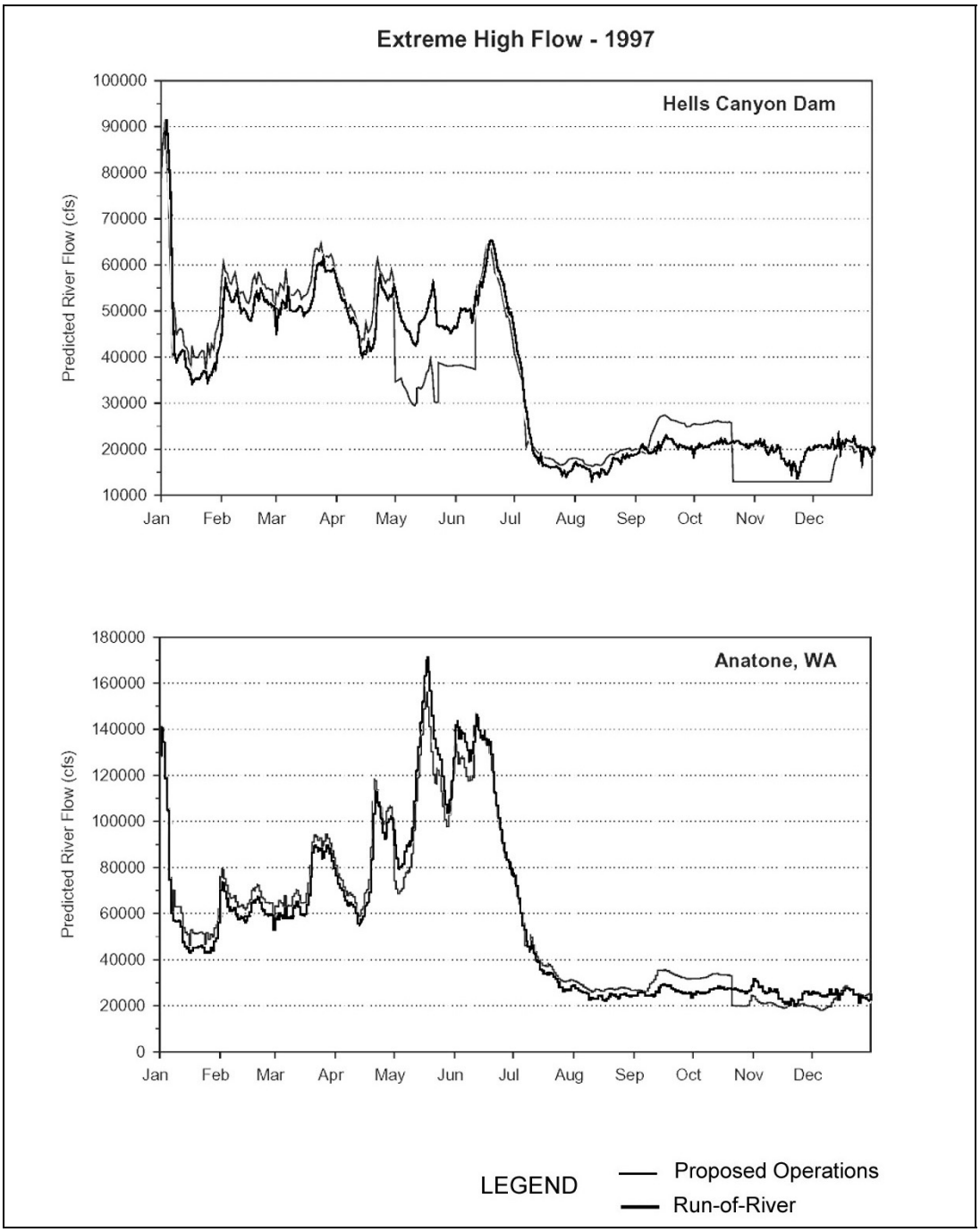

Figure 114. Simulated flows below Hells Canyon dam and at Anatone, WA for a representative extreme high flow year (1997) for proposed operations (scenario 1d used as surrogate) and with Brownlee reservoir held at minimum operating pool (scenario 5). Scenario 1d was used to remove diurnal fluctuations caused by load following operations to facilitate the visual comparison of daily average flows. (Source: (Brink and Chandler, 2005)

3.8.2.6 Bull Trout

Bull trout populations in tributaries to the project reservoirs are small, occur primarily in headwater areas, and are isolated from each other by impediments to passage and scarcity of the fluvial life form. The fluvial form is important for providing gene flow between sub-populations and maintaining population stability. Downstream of Hells Canyon dam, the fluvial life form is more prevalent and populations in the Imnaha and Salmon River basins are comparatively robust. Competition and hybridization with brook trout represent major threats to bull trout populations in the reservoir tributaries, but these threats are less prevalent in the populations downstream of Hells Canyon dam.

The primary effects of the project on bull trout are: (1) partial or complete barriers to movement through migratory corridors formed by project dams and reservoirs; (2) loss of the anadromous fish prey base upstream of Hells Canyon dam; and (3) effects on downstream rearing habitat including gas supersaturation during spill periods and flow fluctuations associated with load following operations. As we discussed in section 3.6.1.4, *Native Resident Salmonids*, it is possible that some mortality may occur from entrainment of bull trout through project turbines. However, no evidence of turbine entrainment was observed among the 7 bull trout and 132 redband trout whose movements were monitored using radio telemetry techniques after they were released into the three project reservoirs.

Idaho Power proposes the following measures that would benefit bull trout:

- Prepare and implement a plan to allow for the capture of resident salmonids and other species migrating upstream and for their transfer to areas above Hells Canyon and Oxbow dams, including a survey to assess the risk of spreading disease pathogens.
- Design, construct, and monitor a permanent monitoring weir at Pine Creek to establish a long-term monitoring program of fluvial fish migrating upstream and downstream in the Pine Creek System.
- Supplement marine-derived nutrients to enhance the forage base within the Pine, Indian, and Wildhorse core area.
- Implement a tributary enhancement program that would improve habitat conditions and population connectivity within Pine Creek, Indian Creek the Wildhorse River, and other smaller tributaries.
- Evaluate the feasibility of, and possibly implement, an experimental brook trout suppression program in Indian Creek.
- Conduct a presence/absence survey to determine, with statistical probability, the presence or absence of bull trout within the Eagle Creek Basin.
- Install spillway flow deflectors at Hells Canyon and Brownlee dams, and install the most effective, safe and economically feasible measure designed to reduce TDG levels at Oxbow dam.
- Implement in-reservoir aeration or upstream phosphorus trading to meet the 1,125 tons/year DO load allocation in Brownlee reservoir, and install aerating turbines at Hells Canyon or Brownlee dam to add 1,500 tons/year DO below Hells Canyon dam.
- Install and operate a destratification system in the Oxbow bypassed reach at the deep pool just upstream of the Indian Creek confluence to prevent anoxic conditions at this location.
- Implement watershed measures (which may include hydraulic measures or restoration of riparian vegetation or channel morphology) or a bubble upwelling system in Brownlee reservoir to compensate for the project's contribution to elevated water temperatures.

Resource agencies, tribes, and NGOs filed numerous recommendations that have the potential to benefit bull trout, including measures to improve the condition of rearing habitat and connectivity between populations, increase the available food supply, and improve habitat conditions in the mainstem Snake River downstream of Hells Canyon dam. We analyze the proposed and recommended measures below.

Our Analysis

Population Connectivity and Marine Derived Nutrients

Idaho Power's proposed measures to provide upstream passage for bull trout at Hells Canyon and Oxbow dams, and install and operate a permanent monitoring weir at Pine Creek, have the potential to improve connectivity between bull trout populations in Pine Creek and downstream of Hells Canyon dam. Implementing upstream passage at Oxbow dam would allow upstream gene flow to the Wildhorse River to be restored, but without making provisions for downstream passage it would increase the potential for losses from mortality during turbine passage, risking losses to the small fluvial component of the Pine Creek bull trout population.

We evaluate Idaho Power's proposed measures to restore connectivity among bull trout populations and related agency recommendations in section 3.6.2.8, *Resident Salmonid Passage*. There was widespread support for modifying the Hells Canyon trap to accommodate the collection of bull trout and enable on-site sorting to reduce stress on bull trout and other federally listed salmon and steelhead. Most parties supported construction of an adult trap at Oxbow dam, although IDFG expressed reservations about the potential effects of upstream transfers on bull trout on populations in Pine and Indian creeks. Most parties also supported the installation of migrant traps at the mouths of key tributaries, including Pine and Indian creeks, the Wildhorse River, and several tributaries to the Powder River. FWS filed a preliminary fishway prescription that included trap modifications at Hells Canyon dam and the installation of a weir trap at Pine Creek, with other facilities including a weir on Indian Creek, an adult trap at Oxbow dam and a weir on the Wildhorse River to be constructed on a schedule that would be controlled by habitat-based triggers. Idaho Power filed a similar alternative prescription, but included a more specific set of trigger criteria based on the status of bull trout within these tributaries (e.g., abundance, the potential for hybridization with non-native brook trout, the potential of the fishways to contribute toward recovery, and habitat conditions necessary to support bull trout). Interior subsequently filed a modified prescription that included the more specific set of triggers. The modified prescription also specified that the Pine Creek weir would be constructed within 2 years and that flows needed to provide bull trout passage through the Oxbow bypassed reach would be examined if and when the Oxbow adult trap is constructed.

In section 3.6.2.11, *Marine-derived Nutrients*, we evaluate Idaho Power's proposal to supplement marine-derived nutrients by distributing hatchery carcasses or carcass analogs into Pine and Indian creeks and the Wildhorse River. We conclude that while Idaho Power's proposed measure would benefit bull trout, restoring access for anadromous fish could yield a greater benefit by distributing carcasses more widely and by providing access to rearing and migrating juvenile anadromous salmonids. While we also conclude that it is unlikely that self-sustaining runs of anadromous fish can be developed at this time, this would not preclude the release of surplus hatchery adults into Hells Canyon reservoir when they are available. Finally, we also conclude that the disease risks associated with this practice should be evaluated through Idaho Power's proposed pathogen risk assessment.

Tributary Habitat Enhancement

Idaho Power's proposal to implement habitat enhancement measures in Pine Creek, Indian Creek and the Wildhorse River would benefit bull trout populations in these basins, and this proposed measure is widely supported by the agencies, tribes and NGOs. In section 3.6.2.10, *Tributary Habitat*

Improvements, we evaluate the potential benefits of the measures proposed by Idaho Power and by others. We conclude that tributary enhancement measures could help to increase the number of bull trout and connectivity among populations in the Pine-Indian-Wildhorse core area. Several entities recommend implementing additional tributary enhancement measures in other watersheds, including the Powder, Burnt, and Weiser River basins. These measures could facilitate restoration of bull trout to additional habitat in these watersheds.

Idaho Power also proposes to conduct an intensive, 3-year survey effort to determine whether bull trout are present in the Eagle Creek watershed. This proposal would help to identify potential opportunities for habitat enhancement efforts in this important Powder River tributary.

Downstream Rearing Habitat

Idaho Power does not propose any new operating constraints to stabilize outflows from the project outside of the fall Chinook spawning and incubation period, other than its current 12-inch-per-hour ramp rate as measured at Johnson Bar. Other stakeholders recommended a range of ramping rate and other operational restrictions that would serve to stabilize flows downstream of the project. In section 3.6.2.1, *Effects of Project Operations on Aquatic Resources*, we evaluate the effect of Idaho Power's proposed operations and agency recommended operations on bull trout rearing habitat in terms of food production, habitat stability, and the potential for losses due to stranding or entrapment. We also discuss the potential benefits of a 4-inch-per-hour ramping rate restriction from March 15 to June 15 to protect rearing fall Chinook, which is a staff measure. The latter ramping rate would provide some benefit to bull trout during the spring months. We also discuss the potential benefits of expanding entrapment monitoring to evaluate stranding and entrapment losses of other species including bull trout, and a separate program to evaluate effects of load following on invertebrates. Both measures would include adaptive management provisions to determine whether operations need to be further modified or fish salvage operations undertaken to reduce mortality due to stranding and entrapment of juvenile fall Chinook and other aquatic species.

In its license application, Idaho Power proposed to install spillway flow deflectors at Hells Canyon dam and continue preferential use of the upper spillgates at Brownlee dam during spill periods to reduce TDG concentrations in the Snake River downstream of Hells Canyon dam. In its application for water quality certification, however, Idaho Power proposes to install spillway flow deflectors at Brownlee dam and to install the most effective, safe and economically feasible measure designed to reduce TDG levels at Oxbow dam, based on effectiveness monitoring of the proposed Brownlee dam spillway deflectors. Idaho Power also proposes to monitor the effectiveness of these measures and to implement additional measures if needed to meet the TDG criterion or to protect aquatic life. These measures would reduce TDG levels downstream of Hells Canyon dam during most spill periods, and would thereby reduce the potential for injuries to bull trout that use the mainstem Snake River as overwintering habitat.

As shown in figures 48, 49, and 50, DO levels unsuitable for salmonids extend at least three miles downstream from Hells Canyon dam from July through October in extreme low flow years. Also, conditions in this reach are below optimal over the same distance and time period in extreme high flow years. In its license application, Idaho Power proposed to supplement DO into Brownlee reservoir; however, this measure is not expected to improve low DO levels that occur downstream of Hells Canyon dam. In its application for water quality certification, Idaho Power proposes to implement in-reservoir aeration or upstream phosphorus trading to meet the 1,125 tons/year DO TMDL load allocation in Brownlee reservoir. Idaho Power also proposes aerating turbines at Hells Canyon or Brownlee dam to add 1,500 tons per year DO downstream from Hells Canyon dam. The application for water quality certification also outlines measures to compensate for the project's contribution to thermal load, which would make water temperatures slightly more suitable for bull trout in early November. Implementing the measures included in Idaho Power's application for water quality certification would improve DO levels and benefit bull trout within the project reservoirs and downstream of Hells Canyon dam.

In section 3.6.2.1, *Effects of Project Operations on Aquatic Resources*, we estimate that flow fluctuations caused by load following operations may reduce the food base available to bull trout by approximately 10 to 20 percent, and could expose some bull trout to the risk of stranding or entrapment. We conclude that additional monitoring of the effects on invertebrate production, as well as on stranding and entrapment, would help to determine the extent of project effects on bull trout and to determine whether additional measures are warranted.

3.8.2.7 Idaho Springsnail

Because the Idaho springsnail was found to occur only upstream of Brownlee reservoir, we conclude that the project would have no effect on this species.

3.8.2.8 MacFarlane's Four-o'clock and Spalding's Catchfly

Ongoing project operations, changes in flow regime, and project-related ground disturbance would have the potential to adversely affect the federally listed MacFarlane's four-o'clock and Spalding's catchfly, if present in the project area. Idaho Power's surveys did not document any occurrences of these species within the survey area, and Idaho Power does not propose any specific protection measures. To address protection for rare plants (which would include MacFarlane's four-o'clock and Spalding's catchfly), Idaho Power proposes to formalize cooperative relationships with regulatory management agencies and neighboring landowners to provide for protection and management of rare plants. Idaho Power would establish a rare plant advisory board to coordinate monitoring and enhancement projects. The rare plant advisory board would coordinate with the noxious weed advisory board, as well, because the spread of non-native invasive plants is one of the most serious threats to rare plants at many sites.

Idaho Power also proposes to develop and implement a transmission line O&M plan, with BMPs to protect rare plants. The IWHP and WMMP would provide similar BMPs and site specific protection measures for rare plants on any newly acquired lands.

As discussed in section 3.7.2.2, *Special Status Plant Protection*, Interior-34 and Interior-78 call for Idaho Power to develop and implement plans to manage threatened, endangered and sensitive plants. Interior-34 would apply only to BLM-administered lands, while Interior-78 would apply to all lands affected by the project. Both recommendations call for that Idaho Power to conduct baseline surveys in areas not yet surveyed that could support rare plants and to monitor certain sites annually for 5 years following license issuance and then every 2 years thereafter. Idaho Power would use the results of monitoring to identify any site protection or restoration measures.

The Forest Service (FS-8) specifies that Idaho Power should consult with the Forest Service to develop a Threatened and Endangered Species Management and Monitoring Strategy to address federally listed terrestrial species and their habitats on National Forest System lands affected by the project. This strategy would address any measures required by FWS as a result of ESA consultation.

Our Analysis

MacFarlane's four-o'clock and Spalding's catchfly are known to occur along the Snake River downstream of Hells Canyon dam. Both species are typically associated with native grassland habitats. Changes in the flow regime would not be likely to affect potential habitat for these species because they are not associated with riparian plant communities. None of the flow alternatives we considered would reduce the availability or quality of native grasslands.

Idaho Power's surveys did not identify MacFarlane's four-o'clock or Spalding's catchfly at any sites within the project boundary, but it is possible that occurrences were overlooked during the field surveys because surveys covered only one-fourth of the river corridor. As mentioned in section 3.7.1.2, *Special Status Plants and Plant Communities*, Idaho Power used a sub-sampling approach in conducting

the pre-licensing inventory. This approach provided adequate baseline data, given the extent of the study area, but would not allow Idaho Power to analyze the effects of ground-disturbing activities, such as construction of new recreation facilities, on a site-by-site basis.

Development and implementation of a Threatened, Endangered, and Sensitive Species Management Plan would provide a mechanism for identifying sites that should be surveyed for MacFarlane's four-o'clock and Spalding's catchfly, focusing survey efforts on sites where project-related activities could affect rare plants, rather than conducting an inventory of the Snake River Canyon. If project-related activities would cause ground disturbance outside Idaho Power's ownership, Idaho Power could identify and implement cooperative protection measures, as outlined in its proposal to establish a rare plant advisory board.

If Idaho Power's surveys identified MacFarlane's four-o'clock or Spalding's catchfly occurrences, the plan would also provide a mechanism for identifying appropriate monitoring schedules. Monitoring schedules could be based on site-specific characteristics. For example, monthly surveys during the summer for 2 years might be prudent at a high-use recreation site; annual surveys for 3 years might be reasonable at a site where weed control measures are implemented; and surveys at 10-year intervals might be adequate for remote sites where little habitat disturbance is anticipated.

3.8.2.9 Gray Wolf

Idaho Power's studies did not identify any project effects on the gray wolf (Dumas et al., 2003b). Non-essential experimental populations of gray wolves in Idaho have expanded dramatically over the past 10 years. Their numbers are likely to continue to increase, and wolf observations in the project area may become more common. Where wolves and people come into contact, wolves are often destroyed to reduce the risk of direct confrontation.

Idaho Power does not propose specific measures for protection or management of the gray wolf. Interior-34 and FS-8, as described above, would address the gray wolf within management plans or strategies for threatened, endangered, and special status species.

Our Analysis

Idaho Power's studies did not indicate any project effects on this species. The movement of radio-collared wolves between Oregon and Idaho indicates that the project reservoirs do not impede movement. Project O&M and project-related recreation activities would likely continue to prevent wolves from using portions of the project area where human activities are concentrated. More remote areas would provide suitable habitat for wolves. Idaho Power's proposals to acquire, protect, and enhance mule deer winter range are intended to improve habitat conditions for mule deer, an important prey species for the gray wolf. Wolves would benefit from any increase in mule deer populations.

Including this species within a project-wide Threatened, Endangered, and Sensitive Species Management Plan would provide a means of evaluating changes in wolf use of the project area and identifying protective measures, if needed. Including the gray wolf in a Threatened, Endangered, and Sensitive Species Management Plan would be especially valuable as a coordinating mechanism because of the differing status that various federal and state agencies assign the gray wolf.

3.8.2.10 Canada Lynx

Idaho Power's studies did not identify any project effects on the Canada lynx (Dumas et al., 2003b). Canada lynx populations in core areas may increase, if recovery measures are successful in protecting suitable habitat and reducing disturbance. Lands within the Hells Canyon Project boundary do not provide suitable denning or foraging habitat, due to low elevations and the absence of cold, moist forest. The dominant cover types are shrub-steppe and grassland.

Idaho Power does not propose specific measures for protection or management of the Canada lynx. Interior-34 and FS-8, as described above, would provide a means of addressing the Canada lynx within management plans for threatened, endangered, and special status species; however none of these recommendations identify the Canada lynx as being of concern in terms of potential project effects.

Our Analysis

Idaho Power's studies did not indicate any project effects on the Canada lynx. It is possible that lynx may use shrub-steppe in moving between forested areas (Ruediger et al., 2000), and lynx could occur in the project area as transients, from time to time. However, no proposed or recommended terrestrial resource measures would affect suitable habitat, and no project effects would be likely to occur as a result of relicensing.

3.8.2.11 Northern Idaho Ground Squirrel

Idaho Power's studies did not identify any project effects on the Northern Idaho ground squirrel (Dumas et al., 2003b). The northern Idaho ground squirrel occurs within a very restricted range. Only 34 sites are known to be occupied, with 13 of these located on private land. Protection of occupied sites and of connectivity habitat between sites will be critical to recovery of the subspecies.

Idaho Power does not propose specific measures for protection or management of northern Idaho ground squirrel. Interior-34 and FS-8, as described above, would address the northern Idaho ground squirrel within management plans for threatened, endangered, and special status species. None of the recommendations include any specific measures pertaining to the northern Idaho ground squirrel.

Interior-84 recommends that Idaho Power consult with FWS and the Northern Idaho Ground Squirrel Technical Team to develop and implement a northern Idaho ground squirrel management plan. The plan would focus on management and possible reintroduction of this species at the Barber Flats site.

Our Analysis

Mapping provided in the FWS recovery plan (FWS, 2003b) indicates that the probable historical distribution of the northern Idaho ground squirrel does not overlap with lands affected by the Hells Canyon Project. Suitable habitat for this subspecies occurs at higher elevations (i.e., generally between 3,000 and 6,000 feet) than those occupied by project reservoirs, roads, or transmission lines. Idaho Power owns a parcel of land east of Oxbow reservoir at Barber Flats that supports northern Idaho ground squirrels, but no suitable habitat is present within the project boundary.

As part of its IWHP and WMMP, Idaho Power may acquire lands that provide suitable habitat for the northern Idaho ground squirrel. Ground disturbance associated with habitat management and enhancement measures (such as burning, mowing, weed control or fence construction) could adversely affect this subspecies. If Idaho Power acquires lands with potential habitat for this species, including the northern Idaho ground squirrel within a project-wide Threatened, Endangered, and Sensitive Species Management Plan, as discussed above, would prove beneficial. At that point, consultation with FWS and the interagency technical team would be useful in developing site-specific measures that would contribute to recovery of this species.

3.8.2.12 Bald Eagle

The number of bald eagles that nest and winter in the Hells Canyon Project area is increasing, and the project does not appear to be adversely affecting this species. However, some ongoing project operations and proposed or recommended measures would have the potential to cause adverse effects. Noise disturbance caused by maintenance, traffic, land management activities and recreation has the potential to interfere with breeding and cause physiological stress to wintering birds. Contaminants that

accumulate in bottom sediments of Brownlee reservoir may be passed up the food chain to bald eagles, which feed primarily on fish. The presence of the project transmission line may pose a risk of collision and electrocution.

In addition to potential adverse effects, relicensing the Hells Canyon Project may also positively affect bald eagle populations. Each of the eagle pairs currently nesting near the Hells Canyon Project boundary is likely reliant, to some degree, on perching habitat on reservoir shorelines and fish populations in the project reservoirs and Snake River downstream of Hells Canyon dam. Protection of riparian habitat, improvements in water quality, and increases in anadromous and/or resident fisheries could benefit bald eagles.

To protect bald eagles, Idaho Power proposes to monitor bald eagle nests and winter roosts and to implement timing constraints on O&M activities and recreation, as needed, to protect bald eagles from human disturbance. Idaho Power's current management guidelines are as follows:

- No transmission line or other major construction activities are implemented within 800 m of any occupied bald eagle nest between February 1 and July 15 (or July 31, depending on documented nesting chronology);
- No transmission line or service road maintenance activities, other than patrols, are implemented within 400 m of an occupied nest between February 1 and July 15 (or July 31, depending on documented nesting chronology);
- No helicopter or fixed-wing flyovers, unless the specific objective of the flight is to confirm incubation, are implemented within 100 m of an occupied nest.

Interior-34 would address the bald eagle as part of a management plan for threatened, endangered, and special status species. This recommendation would apply to BLM-administered lands affected by the project.

Under Interior-81 and ODFW-60, Idaho Power would consult with the appropriate agencies to develop and implement a bald eagle management plan and incorporate it into the IWHP and WMMP. The plan would include annual nesting and productivity surveys, development of nest site management plans, annual fall and winter communal roost surveys. Interior also recommends development of roost site management plans and winter surveys. ODFW recommends that Idaho Power fund habitat enhancement measures on its lands.

The Forest Service (FS-8) specifies that Idaho Power should consult with FWS to develop a Threatened and Endangered Species Management and Monitoring Strategy to be incorporated into the WMMP. This condition specifies that Idaho Power would comply with any measures identified during ESA consultation with FWS regarding listed species.

Our Analysis

The increase in the number of active and successful bald eagle nest territories in the project area is consistent with upward trends in bald eagle populations in Oregon and Idaho, and more generally, across the United States. These increases suggest that ongoing project operations are not reducing habitat availability or suitability for bald eagles, and that Idaho Power's existing timing constraints on maintenance activities are adequately protecting bald eagles from disturbance. However, monitoring through any new license period would be needed to identify adverse effects of new project-related facilities, increases in project-related recreation, reductions in water quality resulting from contaminant accumulations in Brownlee reservoir, increases in electrocution or collision with the transmission line as bald eagle numbers increase, or other changes from existing conditions, including establishment of new bald eagle nests.

Potential Disturbance

Construction of new facilities, implementation of mitigation measures in or near nest sites or foraging areas, or increases in recreation activity could directly affect bald eagles because many pairs are sensitive to noise, vehicle traffic, pedestrians, and boaters. The level of disturbance depends not only on the decibels of noise, but also its distance from a nest, its frequency and duration, the presence or absence of topographic or vegetative screening around the nest, and the time of year and time of day the activity takes place. Although bald eagles vary in their responses to human activity, the potential for disturbance is generally highest during courtship, nest building, egg laying, incubation and hatching. Disturbance during these phases of nesting chronology can cause bald eagles to abandon their nests permanently. Even temporary absence of adults can expose eggs or young to overheating, hypothermia, predation, and injury.

In the Pacific region (including Idaho), nest building usually begins in early January (FWS, 2007b). Idaho Power's 2006 report on nesting and productivity in the Hells Canyon Project area (Carpenter and Holthuijzen, 2006) found that bald eagle pairs began incubating between February 1 and March 21. Incubation typically lasts about 35 days, and nestlings may remain at the nest for another 8 to 14 weeks (Buehler, 2000). Idaho Power reported that juveniles fledged between May 22 and July 12 (Carpenter and Holthuijzen, 2006).

Idaho Power mapped the six bald eagle nests in the project vicinity in relationship to recreation sites, roads, transmission lines, development, jurisdictional boundaries, and lands proposed for wildlife habitat acquisition and management (Idaho Power, 2007b).[90] At FERC staff's request, Idaho Power mapped 330-foot, 660-foot, and 1-mile buffers around each nest and described vegetation types[91] so that we could evaluate potential sources of disturbance in relation to FWS national guidelines for bald eagle management (FWS, 2007b) that are likely to be implemented now that the bald eagle has been removed from the list of threatened and endangered species. Table 75 summarizes this information, and identifies potential sources of disturbance.

Table 75. Bald eagle nest sites, potential noise disturbance, and potential buffers. (Source: Idaho Power, 2007b, as modified by staff)

Nest Site	Distance from Existing Activities that Could Cause Disturbance	Proposed or Recommended Environmental Measures that Could Cause Disturbance	Screening Around Nest Sites
Lamont Springs	Within 330 feet of trail; within 660 feet of Snake River and dispersed recreation site; trail and dispersed recreation sites within 1 mile	Gravel augmentation and sandbar replenishment	No screening; steep slope above trail and river; shrub-steppe vegetation
Hibble Gulch	Within 330 feet of road, transmission line and reservoir shoreline; trail within 1 mile	Possible dispersed recreation enhancements or improvements to Hells Canyon Road turn-outs	No screening; steep slope above road, transmission line and reservoir; shrub-steppe vegetation

[90] These maps were filed with the Commission as confidential information to prevent disturbance of sensitive sites.

[91] Vegetation cover type mapping is not available for the Birch Creek nest site, which is located outside the terrestrial resource study area.

Nest Site	Distance from Existing Activities that Could Cause Disturbance	Proposed or Recommended Environmental Measures that Could Cause Disturbance	Screening Around Nest Sites
Airport	Within 660 feet of road and transmission line; airstrip, roads and several recreation sites within 1 mile	Recreation enhancements at Airstrip A, B, and C; possible dispersed recreation enhancements or improvements to boat moorage	No screening; steep slope above road and transmission line; shrub-steppe vegetation
Cottonwood	Within 660 feet of road; roads and several recreation sites within 1 mile	Possible fish habitat enhancements in Pine Creek; possible dispersed recreation enhancements or improvements to boat moorage	No screening; steep slope above road; shrub-steppe vegetation
Eagle Creek	Within 660 feet of reservoir shoreline; roads and rural/residential development within 1 mile	Possible fish habitat enhancements in Powder River and wildlife habitat enhancements in Powder River SMA	Relatively flat site; forested wetland may provide vegetative screening from some aspects.
Birch Creek	Within 330 feet of trail; within 660 feet of road; no other mapped development within 1 mile	None proposed or recommended within 1 mile (site is approximately 3 miles southwest of Brownlee reservoir)	Flat site; no screening; shrub-steppe vegetation

In general, the guidelines recommend construction timing restrictions that apply to blasting, clearing, grading, truck traffic, and operation of heavy equipment and motorized machinery (FWS, 2007b). They also apply to work that involves alteration of shorelines (e.g., boat launches) and installation of docks and moorings.

Based on the guidelines, eagles are unlikely to be disturbed by routine use of roads and other facilities; construction of roads, trails, and power lines; agriculture; alteration of shorelines; or installation of docks or moorings, where such activities pre-date successful nesting in a given area. If similar activities are planned for implementation within 1 mile of a nest, FWS recommends restricting activities within 660 feet (where topography or vegetation do not screen activities from view) or within 330 feet (where screening is present). FWS also recommends implementation of timing restrictions for temporary disturbance, including boating (FWS, 2007b).

Proposed or recommended recreation facility enhancements would be located at Carters Landing, Oxbow boat launch, Copperfield boat launch, Airstrip A and B, Bob Creek, Westfall, Hells Canyon Park, Copper Creek, Eckels Creek, Big Bar, Eagle Bar, Deep Creek, Hells Canyon Creek Launch, Old Carters Landing, McCormick Park, Hewitt Park, Holcomb Park, Swedes Landing, and Spring recreational site. Of these locations, only the Airstrip sites are located within 1 mile of an existing bald eagle nest. Improvements of Hells Canyon road pull-outs, dispersed recreation sites, and boat moorages on Hells Canyon, Oxbow, or Brownlee reservoir may also occur within 1 mile of existing nests.

Proposed or recommended aquatic resource measures that require in-water or near-water construction along Pine Creek or the Powder River could occur within 1 mile of nesting bald eagles. Beach replenishment or gravel augmentation downstream from Hells Canyon dam could also cause temporary disturbance within 1 mile of an eagle nest.

Land-based and water-based recreation activity clearly pre-dates successful nesting in the project area, and pairs that occupy existing nests appear tolerant of this activity. However, recreation activity may increase through any new license period, and the potential for disturbance could also increase. In the future, timing restrictions could be helpful in minimizing the risk of adverse effects if these activities occur near active eagle nests. A comparison of bald eagle nest site maps and data regarding nesting chronology at each nest site with proposed recreation and other enhancement activities would provide a useful foundation for determining where and when any timing restrictions may be needed, unless construction is scheduled outside the nesting season.

Idaho Power proposes to monitor nest and roost sites, but does not indicate how often monitoring would occur. Idaho Power does not propose to develop nest or roost site management plans, except where they would be needed on specific land parcels, as part of the IWHP/WMMP.

Interior-34 does not specify how bald eagles would be addressed within the Threatened, Endangered and Sensitive Species Plan. The Forest Service (FS-8) does not specify monitoring requirements, instead recommending that Idaho Power consult with FWS to define a management strategy. Interior-81 and ODFW-64 provide detailed outlines for development of bald eagle management plans.

Interior and ODFW are similar in their approach to monitoring schedules and requirements for development of nest site management plans, with more intensive productivity monitoring if problems are identified. However, Interior limits nest monitoring to pairs that use Hells Canyon reservoir and nest site management plans for pairs that nest adjacent to Hells Canyon reservoir. Interior and ODFW both call for annual monitoring of roost sites associated with project lands in February, March, October, and November. Interior calls for development of roost site management plans, while ODFW does not. Interior calls for winter monitoring of reservoir use in January, February and March, while ODFW does not.

Implementing Interior's recommendation to focus monitoring and nest site management plans on pairs that use Hells Canyon reservoir would not provide adequate information about pairs that are associated with Oxbow and Brownlee reservoirs. Implementation of ODFW's recommendation would encompass all project reservoirs.

Idaho Power could coordinate habitat protection, access control, and management of activities that could disturb nesting birds at nests that are located within the project boundary, or where project activities occur within 1 mile of a nest (e.g., Hibble Gulch, Airport, Cottonwood, and Eagle Creek). Idaho Power would not have control over activities or disturbance at nest sites on lands where it has no management authority or responsibility (e.g., Lamont Springs and Birch Creek), but could participate in the implementation of such plans because project reservoirs are a key element of bald eagle habitat in the vicinity.

Implementation of Interior and ODFW recommendations to monitor annually in March/April and June/July would enable Idaho Power to track trends in productivity. As mentioned in section 3.7.2.1, the average number of young fledged at 5 of the 6 nests in the project area dropped from 2.4 in 2004 to 1.4 in 2005. Two years of data have little significance, but these findings suggest a need for long-term monitoring, including more intensive monitoring if trends turn downward, as described in Interior and ODFW recommendations.

Disturbance during the winter can interfere with eagle foraging and increase their exposure to harsh weather conditions. Monitoring roost sites annually in February, March, October, and November

(as Interior and ODFW recommend) would provide information needed to determine whether timing restrictions should be implemented around any roost sites and whether roost site management plans are needed. Fall surveys would be especially important if construction is planned outside the breeding season, in order to minimize disturbance during the nesting season.

Implementation of Interior's recommendation to annually monitor winter use of the project reservoirs in January, February, and March may be excessive, in that only one survey is needed to allow Idaho Power to track winter trends in the project area over time. Planning the winter survey to coincide with regional surveys would also allow Idaho Power to continue contributing to a large, region-wide dataset.

Bioaccumulation of Contaminants

As discussed in section 3.7.2.1, *Fish-Eating Wildlife Species*, predation on fish in Brownlee reservoir may expose bald eagles to contaminants that accumulate in bottom sediments. Bioaccumulation of mercury and organochlorine compounds can interfere with normal behavior patterns, impair reproduction, or cause death. An analysis of DDE in the blood of juvenile bald eagles from three Hells Canyon nests was found to be well below the threshold considered to cause observable adverse effects. The levels of mercury found in adults from these nests were much higher than the accepted level of concern (Bechard et al., 2006); however, levels of mercury were comparable to levels found in bald eagles in other states, where it has not appeared to adversely affect reproductive success.

The process of bioaccumulation would likely continue to occur during any new license period, even if TMDLs are implemented, because reversal of poor water quality conditions would take many years. In addition, installing a bubble upwelling system or temperature control structure to withdraw water from low levels in Brownlee reservoir could increase mixing of near-bottom water, which would increase the rate of discharge of contaminants into the water column, and thereby, into the food chain.

Under ODFW-57, Idaho Power would evaluate bioaccumulation of mercury, dieldrin, and DDT/DDE in Brownlee reservoir fish. Idaho Power could collect tissue samples of fish during routine population sampling efforts, if requested to do so by the state water quality management agencies, and submit them to IDEQ and ODEQ for analysis. The results of these analyses could be evaluated along with the results of annual nest productivity monitoring to help evaluate potential effects of contaminants on bald eagles. Implementation of Interior and ODFW recommendations to conduct more intensive analysis if productivity is found to decrease would also serve as a means of identifying any correlations between nesting success and contaminant levels in fish.

Transmission Line Interactions

Transmission lines often pose a risk of collision or electrocution for bald eagles, depending on siting and design. The 69-kilovolt (kV) project transmission line extends from Oxbow dam to Hells Canyon dam, a distance of about 22 miles. It runs parallel to a paved road adjacent to the Hells Canyon reservoir. Idaho Power's studies indicate that this line poses a high risk of collision because it is located downslope from an eagle nest territory (SAIC and Spatial Dynamics, 2000). However, Idaho Power has not identified any collision mortalities associated with this line. ODFW describes an undated personal communication attributing an eagle mortality on the east side of Oxbow reservoir to collision with the transmission line, but provides no specific information about this occurrence (ODFW-70). To reduce the risk of collisions, it would be beneficial for Idaho Power to evaluate installation of warning spheres on transmission line 945.

To reduce the risk of electrocution, Idaho Power modified power poles within 0.62 mile of the nest on Hells Canyon reservoir to make them raptor safe, including the only pole associated with an electrocution mortality (SAIC and Spatial Dynamics, 2003). Idaho Power proposes to re-evaluate all poles along transmission line 945 that are considered to be of medium to high risk to perching raptors.

Idaho Power annually monitors bird electrocutions and maintains a database of reported mortalities. Idaho Power proposes to continue to conduct annual inventories to identify new raptor nests along the transmission line, and document any electrocutions that may occur. To ensure an up-to-date approach to monitoring, Idaho Power could review its plans for consistency with current guidelines (APLIC, 2006).

Potential Benefits of Aquatic Resource Enhancement Measures

Several measures that are intended to improve aquatic resources in the project area would also benefit bald eagles through their effects on fish, the primary prey base for bald eagles. For example:

- Beach replenishment may result in small improvements to rearing habitat for juvenile Chinook salmon downstream of Hells Canyon dam, and could lead to increased adult returns over time.
- Gravel augmentation could increase the area of spawning habitat, and also increase the availability of salmon carcasses following spawning.
- Supplementation of DO and installation of spillway deflectors at Brownlee reservoir could slightly increase DO and reduce TDG, which would improve water quality, reducing the risk of gas bubble trauma.
- More restrictive ramping rates during the rearing period could reduce fall Chinook mortalities due to stranding and entrapment and increase food supplies for juvenile fall Chinook salmon.
- Continued flow augmentation would maintain suitable outmigration conditions for juvenile fall Chinook salmon, with potential increases in adult returns.
- Tributary enhancement for redband trout, bull trout, and anadromous fish, such as riparian corridor fencing, purchase or lease of water rights and conservation easements, and instream habitat improvements, could lead to increased fish populations, as well as increasing the potential for establishment and success of cottonwood stands that could provide suitable nest or perch trees.
- Release of surplus hatchery adults into Hells Canyon reservoir when available, plus possible outplanting of carcasses in Pine and Indian creeks and the Wildhorse River, could provide an additional forage resource.
- Limiting the extent of the Brownlee reservoir drawdown to enhance reproductive success of smallmouth bass, crappie and early spawning channel catfish could provide an additional forage resource.

Potential Benefits of Land Use Enhancement Measures

The HCRMP identifies broad terrestrial resource goals and objectives, which include protecting, maintaining, and enhancing existing riparian ecosystems and developing new riparian ecosystems in suitable areas, as well as minimizing adverse human impacts. Specific efforts to meet these goals and objectives (e.g., restrictions on shoreline development; land use designations to provide additional protection for sensitive sites, such as bald eagle nest sites; pre-disturbance surveys and mapping to identify sensitive resources and plans for carrying out protective actions and addition of survey data to the project GIS) would protect habitat currently used by bald eagles, as well as habitat that may develop in the future.

Potential Benefits of Terrestrial Resource Enhancement Measures

The increase in nesting activity in the project area since 1998 indicates that habitat is not limiting at the current time. As part of the IWHP and WMMP, Idaho Power would protect younger forest stands,

in addition to known nests, roosts and perches. This approach would help ensure recruitment of suitable habitat on wildlife lands in the future, and help meet ODFW's objectives for increasing bald eagle habitat.

Enhancement of native shrub-steppe and grassland communities, in addition to riparian plant communities, would benefit a wide variety of birds and mammals. Many of these, including waterfowl and mule deer, may serve as important forage resources in addition to fish, or when fish are not available.

In summary, Idaho Power proposes and the agencies recommend a variety of measures for bald eagle management. Development of a bald eagle management plan would provide a coordinated mechanism for collecting, compiling, and mapping information about bald eagle populations and use of the project area. Overlaying this information with maps of proposed construction, maintenance activities, and potential sources of disturbance would help ensure rapid detection of resource conflicts, if any occur. However, it may streamline agency consultation, monitoring and reporting efforts to include the bald eagle management plan as one element of the Threatened, Endangered, and Sensitive Species Management Plan discussed above in section 3.8.2.2. As mentioned above, Idaho Power could take the lead in working with agencies and landowners to develop cooperative nest site management plans at locations where Idaho Power also has management authority and responsibility for activities that could affect nesting birds, i.e., at the Hibble Gulch, Airport, Cottonwood, and Eagle Creek nest sites. Idaho Power does not manage habitat, access, or recreation activities that could affect the Lamont Springs or Birch Creek nest sites. However, Idaho Power's participation in cooperative nest site management plans developed by others would help to protect birds that are likely reliant, to some degree, on reservoir fish populations.

3.8.3 Cumulative Effects

Development of the Snake and Columbia River basins has altered seasonal flow regimes, affecting rearing habitat and migration corridors for federally listed salmon and steelhead. The operation of storage reservoirs for flood control and irrigation have caused a substantial decrease in river flows from April through July, while average monthly flows have increased slightly from August through October in comparison to the historical flow regime. Since the late 1980s, river flows in the spring and summer have been augmented to meet flow objectives specified in NMFS Biological Opinions on operation of the mainstem Federal Columbia River Power System projects, with the goal of improving the migration survival of juvenile salmon and steelhead. As part of its strategy to maximize the attainment of flow objectives in the lower Snake and Columbia rivers, NMFS has also been seeking to optimize the allocation of flood storage space in the basin and to maintain reservoir elevations near their upper rule curves in order to maximize the amount of water that is available to augment river flows during the spring and summer migration seasons. As part of the flow management process, coolwater releases from Dworshak reservoir are used to compensate for warmer flows that are released from Brownlee dam and upstream BOR storage reservoirs, to meet temperature objectives in the lower Snake River.

Idaho Power owns and operates eight mainstem hydroelectric dams on the Snake River within the reach that was used by anadromous fish, which ascended the Snake River up to the base of Shoshone Falls at RM 614.7. Idaho Power's six upstream dams inundate 51.7 linear miles of river, or 33 percent of the mainstem Snake River between Swan Falls dam and Shoshone Falls. Brownlee, Oxbow and Hells Canyon dams inundate 89.3 miles or 43.4 percent of the mainstem habitat that existed between Hells Canyon and Swan Falls dams. Collectively, Idaho Power's eight dams and the four federal dams inundate 275.8 miles of the mainstem Snake River, 44.9 percent of the mainstem Snake River downstream from Shoshone Falls. Anadromous fish historically spawned and reared in nine major tributaries and a number of smaller tributaries that enter the Snake River in areas upstream of Hells Canyon (RM 247.6), including Salmon Falls Creek and the Bruneau, Owyhee, Boise, Malheur, Payette, Weiser, Burnt, and Powder rivers. Smaller tributaries within this reach include the Wildhorse River, Indian Creek, and Pine Creek, as well as a group of small creeks that are referred to collectively as the Rock Creek basins. Elimination of access to areas upstream of Hells Canyon dam has deprived the Burns

Paiute, Shoshone-Paiute and Shoshone-Bannock tribes of access to anadromous fish, and the loss of marine-derived nutrients and the eggs and young of anadromous fish has reduced the forage base that is available to bull trout within the basin upstream from Hells Canyon dam.

3.8.3.1 Snake River Fall Chinook Salmon

The settlement and development of the Snake and Columbia River basins has caused substantial adverse cumulative effects on the habitat and population size of Snake River fall Chinook salmon. Habitat losses in the Snake River basin began primarily with placer mining, which took place throughout the basin, followed by development of the basin for agricultural production, timber harvest, and livestock production. Construction of numerous additional tributary dams and agricultural development of the basin has reduced the recruitment of spawning gravel to historical habitats, altered river flows, and adversely affected water quality by increasing water temperatures and nutrient loads, reducing DO, and introducing pesticides. Construction of additional mainstem dams on the lower Snake and Columbia rivers has substantially reduced the survival rates of anadromous fish passing through the migration corridor due to mortality factors associated with reservoir and dam passage, although survival rates have been improving in recent years, as measures to improve survival have been implemented.

Access to prime historical fall Chinook salmon production areas upstream of RM 458 was blocked when Swan Falls dam was constructed in 1901, and another key production area known as the Marsing reach was blocked when Brownlee dam was constructed at RM 284.6 and attempts to maintain anadromous fish runs upstream of Brownlee dam were abandoned in 1964. Access to anadromous fish habitat upstream of RM 247.6 was precluded with the closure of Hells Canyon dam in 1967.

Applying a geomorphic spawning model to the entire Columbia River basin, Dauble et al. (2003) estimated that during the pre-hydro development period, the Snake River provided 52 percent of the fall Chinook spawning habitat in the Columbia River basin. Of the habitat in the Snake River that was available prior to development, 58 percent was located upstream of the current site of Hells Canyon dam. The habitat upstream of Hells Canyon dam includes the reach that was reported by Evermann (1896) to be the most important historical spawning grounds for fall Chinook salmon in the state of Idaho, which extended from Huntington (RM 328) to Auger Falls (RM 606.7). This section includes the Thousand Springs reach, where water temperatures are buffered by substantial spring inflows, providing a thermal regime that is well suited for fostering early emergence, rapid growth, and early migration of juvenile fall Chinook salmon, which likely contributed to the productivity of the population that spawned in this reach.

In addition to blocking passage to upstream habitat, construction of the Hells Canyon Project contributed to a reduction in the supply of spawning-sized gravels and finer sediments that are associated with fall Chinook rearing habitat downstream of Hells Canyon dam. Other project effects that may have contributed to the decline of fall Chinook salmon include the effects of ramping associated with load following operations on food production and fish stranding, low DO and high water temperatures during the start of the fall Chinook spawning season, and gas supersaturation when spill occurs.

Beneficial effects of the project on fall Chinook salmon include: (1) stable streamflows during the spawning season and sufficient flows to prevent dewatering of redds during the incubation season; (2) a warmer incubation environment in the Hells Canyon reach than existed pre-project; (3) cooler water temperatures during the spring and summer juvenile outmigration season; and (4) flow augmentation water releases from Brownlee reservoir to expedite juvenile fish migration. Other factors that have likely contributed to a recent increase in the number of fall Chinook salmon returning to the project area include: (1) the acclimation and release of a substantial number of yearling and subyearling fall Chinook salmon at three sites upstream of Lower Granite dam (see section 3.8.1.1, *Fall Chinook Salmon*); (2) augmentation of river flows during the spring and summer juvenile migration season using storage from Brownlee and Dworshak reservoirs, and from BOR storage reservoirs in the upper Snake River basin;

(3) measures implemented to improve migration survival of juvenile anadromous fish migrating through the lower Columbia River; and (4) favorable ocean conditions.

In addition to their role in extirpating anadromous fish runs upstream of Swan Falls dam, Idaho Power's mid-Snake projects likely contribute a slight increase in the warming of water passing through the project reservoirs and may increase the nutrient load that is delivered to downstream areas during algae blooms. However, the licenses for the Upper Salmon Falls, Lower Salmon Falls, and Bliss projects require Idaho Power to remove and dispose of aquatic vegetation that gathers at the project intakes, which removes nutrients from the river. These ongoing effects will likely play some role during the time that will be required before the mainstem habitat upstream of the project is capable of supporting the spawning, incubation, and rearing of fall Chinook salmon.

The upstream Idaho Power projects can potentially affect the success of any future fall Chinook restoration efforts through blocked fish passage, inundated river reaches, flow fluctuations associated with load-following, entrainment and turbine mortality, and reduced flows in bypassed reaches. Restoration of anadromous fish upstream of the Hells Canyon Project is not constrained by license conditions at the upstream projects. As part of future anadromous fish restoration efforts in the upper Snake River basin, however, additional measures may be required at the Idaho Power projects downstream of Shoshone Falls. It is premature to evaluate measures at those projects at this time given the uncertainty of the timing of restoration efforts. The Commission retains sufficient authority in those licenses to incrementally deal with those issues at the proper time.

It seems reasonable to expect that measures to improve survival through the downstream migratory corridor would continue to be developed, and TMDL implementation is likely to result in gradual improvements in water quality conditions over coming decades. Conversely, continuation of the current climate warming trend has the potential to reduce the amount of rearing habitat that is suitable to support salmonid species and to adversely affect survival rates in the migratory corridor.

Under any of the action alternatives, access to historical fall Chinook spawning habitat upstream of Hells Canyon dam would continue to be blocked for at least the near future. Under the Staff Alternative, the potential for restoration of access to upstream habitat would be monitored, and if conditions warrant, the question of whether to provide passage to this habitat would be addressed through a license amendment.

Under any of the action alternatives, TDG levels are expected to exceed state standards when spills at the project exceed approximately 30,000 cfs, which may cause injury or death to rearing fall Chinook salmon. However, installation of spillway flow deflectors at Hells Canyon dam and Brownlee dam and implementation of other measures at Oxbow dam as proposed in Idaho Power's application for water quality certification, would reduce the project's contribution to high TDG levels under most flow conditions. The water quality certification application outlines other measures to reduce the project's contribution to cumulative effects on fall Chinook salmon, including measures to increase DO levels and reduce water temperatures during the first several weeks of the fall Chinook spawning season.

3.8.3.2 Snake River Steelhead and Spring/Summer Chinook Salmon

Snake River steelhead and spring/summer Chinook salmon have been affected by many of the same cumulative factors as fall Chinook salmon. Because they use smaller tributary streams for spawning, habitat for these species has been more directly impacted by tributary development, especially from streamflow reductions and passage obstacles associated with irrigation diversions. Recent increases in adult returns of these species, though not as pronounced as those observed for fall Chinook salmon, are likely attributable to many of the same factors, except that these species do not benefit from controlled spawning and incubation flows downstream of Hells Canyon dam. Future effects of changes in water quality, water temperature, and conditions in the migratory corridor will likely be similar to those described for fall Chinook salmon.

Under any of the action alternatives, access to historical steelhead and spring/summer Chinook spawning and rearing habitat upstream of Hells Canyon dam would continue to be blocked for at least the near future, except that surplus adult steelhead, when they are available, may continue to be released into Hells Canyon reservoir to support recreational fisheries and to increase forage opportunities for bull trout, and this program may be expanded to include surplus spring Chinook salmon, and stocking of surplus hatchery fish of both species[92] in the Owyhee and Malheur rivers to support tribal ceremonial and subsistence fisheries. Under the Staff Alternative, the potential for restoration of access to upstream habitat would be monitored, and if conditions warrant, the question of whether to provide passage to this habitat would be addressed through a license amendment.

Under any of the action alternatives, TDG levels are expected to exceed state standards when spills at the project exceed approximately 30,000 cfs, which can cause levels to exceed state standards far enough downstream to adversely affect migrating juvenile and adult steelhead and spring/summer Chinook salmon produced in the Imnaha and Salmon River basins. However, installation of spillway flow deflectors at Hells Canyon dam and at Brownlee dam, as well as other measures at Oxbow dam, as proposed by Idaho Power, would reduce the project's contribution to high TDG levels under most spill conditions.

3.8.3.3 Snake River Sockeye Salmon

Snake River sockeye salmon have been affected by many of the same cumulative factors as the other anadromous salmonids. However, this species historically occurred only in Payette Lake and in several lakes and their tributaries in the Stanley Lakes area of the upper Salmon River basin. Construction of dams and diversions on the Payette River extirpated the species from Payette Lake prior to construction of the Hells Canyon Project.

Under any of the action alternatives, access to historical spawning habitat upstream of Hells Canyon dam would continue to be blocked for the term of the next license. TDG levels may also exceed state standards as far downstream as the Salmon River when spills at the project exceed approximately 30,000 cfs, which may adversely affect migrating juvenile sockeye salmon as they emigrate from the Salmon River basin. However, installation of spillway flow deflectors at Hells Canyon dam and Brownlee dam and implementation of other measures at Oxbow dam, as proposed by Idaho Power, would reduce the project's contribution to high TDG levels under most spill conditions. The project also acts to delay the cooling of water temperatures in the fall, which contributes to a cumulative increase in water temperatures that may adversely affect adult sockeye salmon migrating through the lower Snake River as they return to the Salmon River.

3.8.3.4 Other Columbia River Basin Salmon and Steelhead ESUs

Because the project acts to delay the cooling of water temperatures in the fall, the Project may contribute to a cumulative increase in water temperatures in the Lower Columbia River that could adversely affect adult fall Chinook salmon, but is unlikely to affect the spring migrating spring/summer Chinook salmon and steelhead ESUs. However, given the long distance between Hells Canyon dam and the confluence of the Snake and Columbia Rivers over which temperatures can equilibrate with ambient conditions, and the relatively small volume of flow that is contributed from the Snake River upstream of Hells Canyon dam, we conclude that the cumulative effect of the project on water temperatures in the Lower Columbia River is likely to be insignificant. However, as we discuss in section 3.8.2.5, flood control operations at Brownlee reservoir, when combined with flood control operations at other reservoirs in the basin, contribute to a substantive overall reduction in the spring flow freshet, which may have both positive and negative effects on conditions in the Lower Columbia River migratory corridor. Maintaining

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[92] Hatchery stocks of both species are not federally listed.

Brownlee reservoir levels within a foot or less of the Corps flood control rule curves would help to minimize adverse effects. Also, continued participation in the regional flow augmentation program would help to reduce the project's contribution to cumulative adverse effects.

3.8.3.5 Bull Trout

Bull trout in the project area have been affected by many of the same cumulative factors as the anadromous salmonid species. Because they use smaller tributary streams for spawning and rearing, habitat for these species has been more directly impacted by tributary development, especially from streamflow reductions and passage obstacles associated with irrigation diversions. In addition, because the species prefers very cold water, land use practices that contribute to increased water temperatures have restricted the amount of habitat that is suitable for the species, and the introduction of brook trout has resulted in extensive competition and hybridization.

Because the project reservoirs impede migration between tributaries and the dams block upstream migration, the project contributes to a cumulative loss of connectivity among the remaining tributary bull trout populations. Under Idaho Power's proposal, upstream connectivity over Hells Canyon dam would be restored, and installation of a permanent monitoring weir at Pine Creek would allow outmigrating bull trout to be transported past Hells Canyon dam without being exposed to the risk of turbine mortality. A second phase, which would occur at least 5 years later, would involve construction of a trap at Oxbow dam to provide upstream passage into the Wildhorse River. Interior's preliminary prescription and Idaho Power's alternative prescription, as well as Interior's modified prescription, would increase connectivity between bull trout populations in the Pine-Indian-Wildhorse core area. All of these proposals would help to compensate for cumulative impacts on bull trout.

Under any of the action alternatives, access to forage opportunities provided by anadromous fish would continue to be blocked for at least the near future, except that surplus adult fish, when they are available, may continue to be released into Hells Canyon reservoir to support recreational fisheries and to increase forage opportunities for bull trout. The reduction in forage opportunities would also be compensated for, to some extent, by distributing spawned salmon carcasses in Pine and Indian Creeks and in the Wildhorse River. The habitat enhancement measures proposed by Idaho Power for the Pine, Indian and Wildhorse basins, and recommended by other stakeholders in several additional basins, would help to address adverse cumulative effects on habitat conditions in these basins.

Under any of the action alternatives, TDG levels are expected to exceed state standards when spills at the project exceed approximately 30,000 cfs, which has the potential to cause injury to bull trout that migrate from tributaries into the Snake River downstream of Hells Canyon dam. However, installation of spillway flow deflectors at Hells Canyon dam and at Brownlee dam, as well as implementing measures at Oxbow dam, as proposed by Idaho Power, would reduce the project's contribution to high TDG levels under most spill conditions.

The Hells Canyon Project contributes to the occurrence of elevated water temperatures in the late summer and early fall, and to low DO levels in the first 7 to 10 miles downstream from Hells Canyon dam, which may adversely affect habitat conditions for bull trout. However, radio telemetry studies conducted by the applicant (Chandler et al., 2003a) indicate most bull trout move into tributaries prior to the onset of project-related increases in water temperature, and those that remain in the mainstem river appear to seek out thermal refugia near the confluence of tributaries, most of which are downstream of the section where the DO deficit occurs. In addition, measures proposed by Idaho Power in its application for water quality certification would improve DO levels within, and downstream of, the project, reducing the project's contribution to low DO levels downstream of Hells Canyon dam. During the spring and summer months, delayed warming caused by the project likely improves habitat conditions for bull trout downstream of Hells Canyon dam.

3.8.3.6 MacFarlane's Four-o'clock

Participants in scoping identified MacFarlane's four-o'clock as a resource that could be cumulatively affected by relicensing the Hells Canyon Project. MacFarlane's four-o'clock occurs at low elevations (i.e., 1,000 to 3,000 feet), and it is possible that populations have been inundated as a result of dam construction along the Snake River and its tributaries since 1904. Mining, road construction, and livestock grazing may also have affected MacFarlane's four-o'clock populations in the past. FWS indicates that threats to existing populations include invasive weeds, landslides and flood damage, herbicide and pesticide spraying, and recreational activity such as OHV use, trail construction and maintenance, and hiking, as well as continued livestock grazing (FWS, 2000).

Under current conditions, BLM and the Forest Service manage occupied MacFarlane's four-o'clock sites to prevent ground disturbance, including grazing. Management of these sites should be effective in making progress toward the recovery goal of a minimum of 11 secure populations with stable or increasing population trends for at least 15 consecutive years. Implementation of protective measures (e.g., focused surveys, with monitoring and management, as indicated) on lands within Idaho Power's ownership would help ensure that relicensing the Hells Canyon Project does not contribute to cumulative adverse effects on MacFarlane's four-o'clock.

3.8.3.7 Bald Eagle

Several factors have contributed to cumulative effects on bald eagles in the Snake River basin since the late 1800s and early 1900s. These include placer mining; livestock grazing; agriculture; and urban, residential, industrial, and commercial development, as well hydropower development and operation. Several of these land uses continue to cumulatively affect bald eagle habitat and prey.

Almost 23 million acres of land in Idaho are considered rangeland (Pease, 1993); BLM alone administers permits on about 11.6 million acres of public land in the state (BLM, 2007). Overgrazing on public and private rangeland since the turn of the last century has reduced the cover of native riparian vegetation, including cottonwoods that could provide eagle nest or perch trees, and reduced habitat quality for fish that could provide forage for bald eagles.

As of 2000, USGS estimated that approximately 3.75 million acres of land were irrigated to support agriculture in Idaho (Hutson et al., 2004). Water diversions for irrigated agriculture reduce natural streamflows and may impair cottonwood regeneration, thus reducing the availability of nest and perch trees for bald eagles. Water diversions may also impede fish passage and reduce fish abundance, thus reducing the availability of prey.

Irrigation return flows and run-off also adversely affect bald eagles through their impacts on water quality. Warmer temperatures, lower DO, and excess nutrients can adversely affect fish populations and reduce the forage supply for eagles. Contaminants such as organochlorines and metals accumulate in the bottom sediments of lakes and reservoirs, and can be transferred up the food chain where they may adversely affect behavior, reproduction, and survival. Aerial and ground applications of pesticides also introduce contaminants into the food chain.

Human populations in southern Idaho are growing rapidly; Idaho was the nation's third fastest-growing state between 2004 and 2005 (ICL, 2005), and this trend is likely to continue. Urban and rural development often encroaches into riparian habitats, reducing habitat availability for bald eagles as well as contributing pollutants, nutrients, and sediment that reduce water quality, which in turn affects the eagle prey base.

Development and operation of hydropower facilities in Idaho has resulted in both positive and negative effects on bald eagles. Many reservoirs support large resident fish populations, providing an accessible, year-round prey base for bald eagles. However, dams (including the Hells Canyon Project) also have inundated riparian forests, blocked anadromous fish runs, altered geomorphology and natural

hydrographs that supported native fish populations, and allowed the accumulation of contaminants in sediments trapped behind the dams.

Despite cumulative adverse impacts, trends in bald eagle populations in the Snake River basin are positive. As discussed in section 3.8.2.12, the number of nests in the Hells Canyon Project area has increased dramatically since 1998, reflecting increases throughout the U.S. since enactment of the ESA and restrictions on the use of DDT. In 2006, bald eagles occupied 83 territories along the Snake River in Idaho (including bald eagle management zones 16, 18 and 20) upstream of Hells Canyon (Sallabanks, 2006), up from 51 in 1998 (Beals and Melquist, 1998). The BOR's Biological Assessment provides detailed information about bald eagle territories and nesting success along the Snake River and major tributaries from the Wyoming border to the Columbia River, reporting positive trends at BOR reservoirs and associated riverine reaches between 1995 and 2003 (BOR, 2004).

Some future actions that may be implemented by federal, tribal, state, or private entities would also benefit bald eagles. For example, the upper mid-Snake and Snake Hells Canyon Subbasin plans identify specific recommendations for improving wetland and riparian habitats, forests, and habitat conditions for anadromous and resident fish (Nez Perce and Ecovista, 2004). BPA and BOR fund numerous watershed improvement projects (e.g., removal of barriers to fish passage, installation of fish screens to prevent diversion of fish into irrigation canals, and restoration of riparian habitat) in the Snake River basin both upstream and downstream of the project that could also lead indirectly to benefits for bald eagles.

Under any of the project alternatives, the Hells Canyon Project would continue to allow the accumulation of sediments behind Brownlee dam, thus allowing continued bioaccumulation of contaminants and mercury that could adversely affect bald eagles. The project would continue to block upstream migration of anadromous fish. However, as discussed in section 3.5.2, *Water Quality*, implementation of TMDLs could improve the quality of the prey base for bald eagles over time, and implementation of an anadromous fish restoration plan could provide additional forage opportunities in the future.

Under any of the action alternatives, Idaho Power would implement measures that would directly benefit bald eagles during any new license period (e.g., BMPs to protect riparian habitat and minimize disturbance near nest sites), and contribute to positive cumulative effects in the region. Idaho Power would also implement measures that would indirectly benefit bald eagles by enhancing fish populations. These measures include improving tributary habitat for resident salmonids; replenishing sandbars and reducing ramping rates downstream of Hells Canyon dam to improve habitat for anadromous salmonids; implementing watershed measures or installing a Brownlee upwelling system to improve water quality; and limiting reservoir drawdown to improve spawning conditions for warmwater fish.

3.8.4 Unavoidable Adverse Effects

We identified no unavoidable adverse effects on threatened or endangered plants or wildlife species, but we identified several unavoidable adverse effects on listed fish species. The project reservoirs would continue to inundate historical anadromous fish habitat and bull trout migratory corridors, and would be likely to impede passage of bull trout, salmon, and steelhead to some extent even if state-of-the-art fish passage facilities were constructed. The suitability of bull trout habitat in Brownlee reservoir will continue to be adversely affected by low DO levels. Although we have found no direct evidence of turbine mortality, it is possible that some bull trout may be entrained into the project intake and may suffer mortality during turbine passage. Salmon, steelhead and bull trout will also continue to be adversely affected by gas supersaturation when spills exceed approximately 30,000 cfs. Altered water temperatures downstream of the project during the fall months would continue to adversely affect fall Chinook spawning and bull trout rearing habitat, but would improve conditions for the rearing lifestages of both species by lowering water temperatures during the summer months. Cooler than optimal spring

temperatures would continue to provide a less favorable environment for fall Chinook salmon fry during the early rearing lifestage.

3.9 CULTURAL RESOURCES

3.9.1 Affected Environment

3.9.1.1 Area of Potential Effect

Section 106 of the National Historic Preservation Act

Section 106 of the National Historic Preservation Act of 1966 (NHPA), as amended (section 106), requires the Commission to evaluate potential effects on properties listed or eligible for listing in the National Register prior to an undertaking. An undertaking means a project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a federal agency, including, among other things, processes requiring a federal permit, license, or approval. In this case, the undertaking is the proposed issuance of a new license for the project. Potential effects that may be associated with this undertaking include any project-related effects associated with the day-to-day O&M of the project after issuance of a new license.

Historic properties are cultural resources listed or eligible for listing in the National Register. Historic properties represent things, structures, places, or archeological sites that can be either Native American or European-American in origin. In most cases, cultural resources less than 50 years old are not considered eligible for the National Register. Cultural resources also have to have enough internal contextual integrity to be considered historic properties. For example, dilapidated structures or heavily disturbed archeological sites may not have enough contextual integrity to be considered eligible.

Section 106 also requires that the Commission seek concurrence with the State Historic Preservation Officer (SHPO) on any finding involving effects or no effects on historic properties, and allow the Advisory Council on Historic Preservation (Advisory Council) an opportunity to comment on any finding of effects on historic properties. If Native American properties have been identified, section 106 also requires that the Commission consult with interested Native American tribes that might attach religious or cultural significance to such properties.

Section 106 also requires that the Commission consult with interested Native American tribes that might attach religious or cultural significance to resources in areas under the Commission's licensing jurisdiction. Indian tribes hold certain rights and privileges reserved under treaty, statute, and executive order. Courts have recognized the origins of certain treaty rights as being "reserved" by tribes from land cessions made by tribes to the United States, rather than as rights "granted" to tribes by the United States. Indian reserved rights continue to be exercised by tribes and their members today under tribal regulation, and remain enforceable under the supremacy clause of the Constitution until extinguished by express Congressional action.

The concept of a federal trust responsibility comes from early Supreme Court decisions that sought to interpret Indian treaties and to determine the relationship among Indian tribes, Indian property rights, and the federal government. These early cases determined that Indian tribes occupy a unique position as "domestic dependent nations"; that is, they are sovereign entities with authority to prohibit state intrusions but with a "ward-guardian" relationship with the federal government. The tribes trusted the federal government to fulfill its promises, and the government has thereby incurred a duty to protect the best interests of the tribes.

Area of Potential Effects

Pursuant to section 106, the Commission must take into account whether any historic property could be affected by a proposed new license within the project's area of potential effects (APE). The APE is defined as the geographic area or areas within which an undertaking may directly or indirectly

cause alterations in the character or use of historic properties, if any such properties exist. In this case, the APE for the project includes lands within the FERC project boundary as it is delineated in the current FERC license, plus lands outside the project boundary where project operations may affect the character or use of historic properties and/or TCPs.

As delineated by Idaho Power, the APE encompasses the likely extent of project operations and project-related environmental measures that could be undertaken during the term of the new license. The reservoir section of the APE includes both sides of the Brownlee, Oxbow, and Hells Canyon reservoirs from the drawdown zone to a line 0.1 mile upslope from the high-pool level. The APE for the reservoir section extends from the upstream margin of Brownlee reservoir (RM 343) to Hells Canyon dam (RM 247.0). The riverine section of the APE includes both sides of the free-flowing Snake River from the shoreline to 100 meters (328 feet) inland. The APE for the riverine section extends from Hells Canyon dam (RM 247.0) downstream to the mouth of the Salmon River (RM 188.2). The transmission line section of the APE encompasses the Pine Creek-Hells Canyon 69-kV line (Line 945) extending from the Oxbow switchyard to the Pine Creek substation and to the Hells Canyon substation, a distance of 22 miles. The right-of-way for the line is 50 feet wide.

3.9.1.2 Cultural History Overview

The Hells Canyon area is an area of both physiographic and cultural transition. Physiographically, the area marks an intersection of the Columbia Plateau and Great Basin provinces, and of the plant and animal communities commonly associated with those provinces. This diversity of natural resources attracted Native populations associated with both regions: Sahaptin-speaking Plateau cultures, such as the Nez Perce, Umatilla, Cayuse and Palouse; and Numic-speaking Great Basin cultures (Northern and Western Shoshone, Bannock, and Northern Paiute). The linguistic separation of Plateau and Great Basin peoples was reflected in ethnohistoric cultural differences in subsistence practices arising from environmental differences.

Archaeologists have proposed a number of cultural chronologies (e.g. Lower Snake, Developmental, Great Basin) based on radiocarbon dates; changes in artifact assemblages, traits and styles; and changes in site types that have applicability to the Hells Canyon area. Although the chronologies differ in terms of how each divides the period from about 11,000 years before present (BP) to the present, taken together they offer a useful approach to interpreting evidence from the past. All propose first occupation by small, highly mobile groups who primarily hunted large game, with lesser exploitation of smaller animals and plants. By about 8000 BP, a shift in settlement and subsistence was in process, in which Native populations made greater use of regionally variable, locally available plant and animal resources to diversify their subsistence, including increased use of roots, river mussels and salmon. Evidence of bulk food processing and storage, construction of house pits along the Snake River (suggesting winter occupation), and growing reliance on salmon and other fish point to a semi-sedentary foraging strategy among Native populations in the area beginning about 4200 BP. Important developments beginning about 1,000 years ago included establishment of large, permanent villages and introduction of the bow and arrow and pottery. Introduction of the horse and European-American goods followed, which augmented and partly replaced aboriginal goods beginning about 250 years ago. Adoption of the horse led to changes in economic and social organization to accommodate use of much wider foraging ranges and trade networks, and in some areas also to raiding, warfare and territorial displacement.

The first contact between Native Americans and European-Americans occurred in the region around A.D. 1750, but the effects of European disease, introduction of the horse, and trade goods arrived much earlier, possibly as early as A.D. 1600. Horses not only changed subsistence and trade patterns but likely caused shifts in social organization as a result of political alliances created with neighboring groups. By the time of first contact with European-Americans, Shoshone and Northern Paiute groups

from the south and the Nez Perce from the north appear to have had access to or claimed some territorial prerogative over the general Hells Canyon area.

The mass European-American migrations into Oregon via the Snake River Plain in the 1840s (see below) bypassed Hells Canyon. Native resistance to European-American intrusion, however, led to U.S. military intervention and ultimately negotiation of treaties with the region's tribes. Plateau tribes relinquished most of their traditional lands in two treaties signed in 1855. One treaty established the Warm Springs reservation in north-central Oregon for the Warm Springs and Wasco tribes. The other established two reservations: one in northeastern Oregon for the Umatilla, Cayuse and Palouse, the other, including land in southeastern Washington, northeastern Oregon, and western Idaho, for the Nez Perce. The latter reservation extended south to encompass Hells Canyon and up the Snake River to just below the present location of Brownlee dam.[93] Tribal resistance to continued European-American encroachment, however, was substantial and ongoing for several decades. It was manifested in the numerous irregular conflicts of 1866–1868 known as the "Snake Wars," and in the Nez Perce (1877), Bannock (1878) and Sheepeater (1879) "wars" thereafter. In the course of these conflicts, reservations were established for the Shoshone-Bannock Tribes at Fort Hall in 1868, and for the Shoshone-Paiute Tribes at Duck Valley, Idaho in 1877. Although the Malheur reservation was established for Northern Paiutes in southeastern Oregon in 1874, the U.S. government subsequently designated it public domain and opened it to white settlement in 1883. Land farther north and west was acquired for the Northern Paiutes in 1934, but was not formally established as the Burns reservation until 1972.

Although European Americans explored the project area from the 1810s into the 1830s, it was not until the Oregon Trail was well established, by the early 1840s, that white settlers first appeared in great numbers. Thousands of emigrants brought wagons, cattle, and other stock across the Snake River on the Oregon Trail between c. 1840 and c. 1870. The emigrant trains often stopped for a time at former Indian camps, taking advantage of nearby grass, wood, and other natural resources. During the 1850s thousands of pioneers passed through southern Idaho, but few stayed in the region. It was the discovery of gold in southwestern Idaho in the 1860s that brought settlement to the area. People congregated near the mines and several boomtowns were established, including Centerville, Ruby City, Silver City, and Weiser. Miners dug numerous mines into the canyon walls and mountains of the Hells Canyon area.

The discovery of gold also was the stimulus to find a practical way to travel through Hells Canyon. Attempts with steamships and railroads failed to locate a suitable route. Ore was shipped over the mountains. Boats run by local operators did serve small ranching and mining operations and made it possible for settlements at Schoolman Gulch and Squaw Creek along with mines at Leep, Kinney, and Kirby. Towns were rare along the Snake River in the Hells Canyon area. Copperfield, Oregon was settled in the 1870s and Homestead was established with the opening of a post office in 1898.

The growth of regional mining communities spurred establishment of ranches and farms, initially at river crossings near mining operations. As settlers claimed public lands along the creeks and rivers, they established gardens and small ranching enterprises, raising produce and livestock for the mining "market." With the opening of the 1870s, intensive use of natural resources occurred in the Hells Canyon area and greatly accelerated landscape change. As the mining industry reached its peak, the European-American population swelled, augmented in the 1880s by Chinese immigrants seeking abandoned placer mines to rework. Road, railroad, and river transportation networks developed to serve the expanding population and industries, while a number of area mines evolved into major commercial and industrial operations with the introduction of new mining methods and technology; all of these developments altered the landscape, vegetation, and wildlife. Natural water sources were exploited not only for mining but also for livestock and, to an increasing degree by the late nineteenth century, for irrigating crops.

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[93] The Nez Perce were forced to relinquish much of their 1855 reservation in 1863, as a result of which the Hells Canyon area became part of the public domain.

Economic conditions remained strong for most Hells Canyon resource-based communities into the 20th century, as markets were enhanced at the beginning of World War I.

The postwar agricultural depression, coupled with the larger Great Depression of the 1920s and 1930s, saw a decline in the area's farming, ranching, and even mining communities, the latter as a result of low prices for copper and gypsum. Semi-subsistence placer mining and farming supported those residents who remained in the Hells Canyon area. After World War II, farm consolidation and increased mechanization led to larger farm sizes and a shrinking agrarian labor force, although ranching experienced something of a boom. Mining remained a part of the local economy, but was characterized chiefly by small-scale placer and dredging operations.

The first hydroelectric project in the Hells Canyon area was begun in 1908 at the "Ox Bow" on the Snake River. It operated for only a few years, and the business failed by 1913. In 1947, Idaho Power filed an application with the Federal Power Commission to build three new hydroelectric developments on the Snake River at and near Hells Canyon; this application overlapped in time with efforts by both the BOR and the Corps to build a single, high dam in Hells Canyon, and there was a great deal of controversy over which, if any, project to build. The Federal Power Commission issued a license for Idaho Power's proposed project in 1955, although three more years passed before Congress defeated the last of several bills calling for a single, high, government-owned dam. Idaho Power completed the Brownlee development in 1957 to 1958, Oxbow in 1961, and Hells Canyon in 1967.

3.9.1.3 Previous Cultural Resource Investigations

Almost forty different archaeological investigations have taken place in the Hells Canyon area since 1950 (Chatters et al., 2001b). They generally fall into three periods: reservoir surveys by the Corps of Engineers and Idaho Power in the 1950s and 1960s, inventory surveys by the Forest Service and for the HCNRA in the 1970s and 1980s, and Idaho Power's relicensing surveys in the 1990s. Survey results from the first two periods contributed toward the listing of four Hells Canyon area archaeological districts in the National Register between 1976 and 1986. The Snake River Archaeological District (listed l976) is located in Washington from China Gardens on the Snake River down to Asotin. That district, along with the Nez Perce Snake River Archaeological District (listed 1978) on the Idaho side of the river, were based on investigations conducted for the Corps' proposed Asotin reservoir. The Lower Salmon Archaeological District, extending along that river from Hammer Creek to the Snake River, was listed in 1986. The Hells Canyon Archaeological District, listed in 1984, extends along both sides of the Snake River from Hells Canyon dam to just below Cougar Rapids, its boundaries coinciding with that of the Wild and Scenic Rivers unit of the HCNRA. This district, much of which lies within the Hells Canyon Project's APE, encompasses 152 historic period sites (most mining-related) and 384 prehistoric sites comprising rock shelters, open sites, and other sites containing a mix of rock shelters, house pits, and other features.

Rock images in the Hells Canyon area have been the focus of a variety of studies, all but one undertaken since the middle 1960s. The first systematic corridor survey, however, did not occur until the late 1980s, when 177 rock art sites were documented between RMs 176 and 247. Idaho Power's archaeological surveys downstream of Hells Canyon dam in the 1990s (described in the following section) recorded numerous additional rock images associated with sites containing other manifestations of the Native American presence in the area.

3.9.1.4 Prehistoric and Historic Archeological Resources

The reservoir APE of the Hells Canyon Project and the Pine Creek-Hells Canyon 69-kV line APE contain no archaeological sites listed in the National Register. The riverine APE contains one historic district (the Hells Canyon Archaeological District) and one site (10IH538) listed in the National Register. As originally documented, the Hells Canyon Archaeological District contains 384 prehistoric and 152 historic sites. The prehistoric sites include open sites, rockshelters, and sites with a combination of

rockshelters, housepits, and other features. The historic sites include mining placers, lode-mining properties, agricultural properties, and ranching properties. Site 10IH538 (Idaho Power-RR0109) consists of the remains of a historic homestead at Bernard Creek.

Idaho Power completed four archaeological surveys in association with the new license application for the Hells Canyon Project. In consultation with the Idaho and Oregon SHPOs, federal and state agencies, and other interested parties, Idaho Power conducted an intensive archaeological survey of the APE of the Brownlee reservoir drawdown zone in 1997 and the reservoir margin in 2000 (Mauser et al., 2001). The drawdown zone survey employed parallel transects at 5- to 20-meter intervals on river terraces and bars that were not silt-covered, and also included a thorough examination of cutbanks, mouths of drainages, and low terraces where possible. The reservoir margin survey used parallel transects at 15-meter intervals except in locations where slopes were greater than 30 percent. These two survey phases covered approximately 3,695 acres.

Also, in 1997, Idaho Power conducted an intensive archaeological survey of the APE for the Pine Creek-Hells Canyon 69-kV line (Mauser, 1997). The survey, which employed a single 10-meter interval transect in non-disturbed areas where slopes were less than 30 percent, covered approximately 128 acres.

The third intensive archaeological survey, from 1998 through 2000, was of the APE for the riverine section between Hells Canyon dam and the Salmon River (Druss and Gross, 2001). The survey, using parallel transects at 15-meter intervals except in locations where slopes were greater than 30 percent covered approximately 7.3 square miles.

In 1999 and 2000, Idaho Power conducted an intensive archaeological survey of the APE of the Oxbow and Hells Canyon reservoirs (Gross, 2001). This survey, employing parallel transects at 15-meter intervals except in locations where slopes were greater than 30 percent covered approximately 2,368 acres.

Idaho Power included the reports from all its cultural resources surveys as confidential technical appendices to its draft and final license applications. By letter dated June 26, 2003, Idaho Power filed its National Register eligibility determinations, which it made in consideration of comments on the draft license application received from the Idaho SHPO, the former Idaho State Archaeologists, and from BLM.[94]

The archaeological survey associated with the Pine Creek-Hells Canyon 69-kV line (Mauser, 1997) identified two sites. Site 10AM 1 is a prehistoric campsite and historic farm with two graves. Site 10AM 77 is a prehistoric lithic scatter. Idaho Power's June 26, 2003 eligibility determination lists both of these archaeological sites as eligible for inclusion in the National Register, following consideration of comments from the Idaho SHPO and BLM on the draft license application.

The Brownlee reservoir drawdown zone and margin surveys (Mauser et al., 2001) recorded 56 prehistoric, 31 historic, and 10 dual component sites; among these numbers were 20 isolates, all but two prehistoric. The prehistoric sites include lithic scatters, midden deposits, and a quarry area with shell, bone, fire modified rock (FMR), lithics, and ceramics. They also include prehistoric material recorded in historic sites, and special purpose sites such as talus pits, cairns, and other rock features. Sites were classified into types based on the numbers of material classes (lithics, ground stone, ceramics, shell, bone, and presence/absence of FMR). Complex or base camps were defined as having three or more material classes; temporary camps had FMR alone, and simple lithic scatters consisted only of lithics. The surveys noted artifacts that include chipped, battered, and ground stone objects, with projectile points, bifaces,

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[94] Although the archaeological survey reports evaluated some sites as "potentially eligible" rather than "eligible," Idaho Power proposes to treat all "potentially eligible" sites as eligible for management purposes, unless and until determined otherwise through further field investigation.

cores, and flaked cobbles, though flakes are the most common artifact type. The survey recorded ceramics, found at one site, as Shoshone ware. Using projectile point styles and late period ceramics, the archaeologists could date 15 of the recorded sites. Of the sites with datable projectile points, all but two were between 3300 and 700 years old (variously exhibiting Columbia Corner-Notched, Columbia Side-Notched, Elko Corner-Notched, Rosespring, Cascade, Northern Side-Notched, and Elko styles. Sites that the archaeologists were unable to date included talus pit sites, isolated cairns, rock alignments, and rock enclosures.

Historic archaeological sites, or components of sites, recorded in the Brownlee reservoir APE include railroad stops, railroad features, roads, townsites, a cemetery, a railroad camp, a cabin, a historic rock alignment, and a historic irrigation ditch as well as debris scatters, dumps, and building foundations. All historic archaeological sites are associated with Euro-Asian settlement in the region. The oldest sites date to the 1880s.

Idaho Power's June 26, 2003, eligibility determination lists 42 of the 70 prehistoric and historic archaeological sites identified in the Brownlee reservoir area of the APE as eligible for inclusion in the National Register.

The Oxbow reservoir survey (Gross, 2001) identified 4 prehistoric sites, 2 dual component sites and 2 isolates. The prehistoric sites consist of lithic scatters. They also include prehistoric material recorded in historic sites. Artifacts noted include a possible projectile point, bifaces, and cores, though flakes are the most common artifact type. No datable artifacts were recorded. The projectile point cannot be definitively dated.

Historic archaeological components of sites recorded in the APE include a homestead and a debris scatter. Amethyst bottle glass from the debris scatter indicates an 1880s to 1915 date for the historic component of this site. No datable artifacts are recorded at the other site. No cultural affiliation was determined for either site.

Idaho Power's June 26, 2003, eligibility determination lists 5 of the 6 archaeological sites identified in the Oxbow reservoir area of the APE as eligible for inclusion in the National Register.

The Hells Canyon reservoir survey (Gross, 2001) identified 6 prehistoric sites, 3 historic period sites, and 1 dual component site, plus 7 isolates. The prehistoric sites consist of lithic scatters and rockshelters with pictographs. They also include prehistoric material recorded in historic sites. Artifacts noted include bifaces, a uniface, a used flake, and a modified flake, with flakes as the most common artifact type. No datable artifacts were recorded.

Historic archaeological sites, and historic components of sites, recorded in the APE include homesteads and a townsite as well as debris scatters and dumps. "Straw"-colored glass and milk cans at one site indicate a 1908 to 1913 date for the historic component of one homestead site. No datable artifacts were recorded at the other sites. No cultural affiliation was determined for any site.

Idaho Power's June 26, 2003, eligibility determination lists 10 of the 11 prehistoric and historic archaeological sites identified in the Brownlee reservoir area of the APE as eligible for inclusion in the National Register.

In the survey of the riverine section, archaeologists both re-located or revisited previously recorded sites, primarily in the Hells Canyon Archaeological District, and recorded heretofore unknown sites. The combined efforts of two archaeological consulting firms resulted in documentation of 856 sites (Druss and Gross, 2001).[95] The prehistoric sites include lithic scatters, habitation sites, lithic procurement

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[95] Of 446 sites recorded on the Oregon side of the river, 336 have Native American components, according to the survey report by Rain Shadow Research. The archaeological report by Applied

sites, rockshelters, rock art (petroglyphs), house pit complexes, and quarry areas with lithics, shell, bone, and fire cracked rock (FCR). They also included prehistoric material recorded in historic sites, and special purpose sites such as talus pits, cairns, and other rock features. Artifacts that were noted include chipped, battered, and ground stone objects, with projectile points, bifaces, and cores. Lithic debitage (flakes) is the most common artifact type.

Using projectile point styles, dates are known for 52 (15 percent) of the sites surveyed by Rain Shadow Research archaeologists. Of the sites with datable projectile points, the six oldest locations are from the Cascade phase (which is 8500–4000 years old). However, the Harder through Numipu phases (from 2500 to 150 years old) are the most common, represented at 26 (50 percent) of the datable sites. Applied Paleoscience archaeologists found similar trends, with most sites from late in the prehistoric period; they could date only 31 (10 percent) of their prehistoric sites. Harder through Numipu phases are present at 10 sites, 10 sites are identified as Harder Phase indeterminate, 6 sites as Early Harder phase, and 5 sites as Tucannon phase. The Tucannon phase points are the oldest at 4000 to 2000 years old.

Historic archaeological sites, or components of sites, recorded in the APE include ranches, farmsteads, placer mines, lode mines, dam construction features, graves, historic petroglyphs/pictographs, irrigation systems, and historic rock features as well as debris scatters, dumps, and building foundations. All historic archaeological sites are associated with European-American, European, or Chinese settlement in the region. The oldest sites date to the 1870s and1880s.

Idaho Power's June 26, 2003, eligibility determination lists 820 of the 868 sites inventoried in the riverine section as eligible for inclusion in the National Register. Most of these sites contain components that contribute to the significance of the Hells Canyon Archaeological District.

3.9.1.5 Historic Buildings and Structures

No buildings or structures in the Hells Canyon Project APE are listed in the National Register. Idaho Power conducted a reconnaissance-level survey of Brownlee, Oxbow, and Hells Canyon facilities and associated structures in 1999 (Gross, 2002). Project construction began in 1955 with Brownlee dam. Oxbow dam was completed in 1961 and the Hells Canyon dam was completed in 1967. The architectural reconnaissance inventory report described the various components of the project, including 129 structures distributed among 89 properties at the Brownlee, Oxbow, and Hells Canyon dams. The types of properties at Brownlee dam include operators' residences in Brownlee Village, station yard buildings, the Old Brownlee Trailer Court, McCormick Park, and Woodhead Park. Properties at Oxbow dam are located in six areas: the Oxbow Dam Village, Copperfield Park/trailer park fish hatchery, powerhouse and maintenance areas, Oxbow dam, and reservoir boat launches. Hells Canyon dam contains the dam, visitor's center, reservoir, and park.

The Idaho SHPO has determined that the three dams (Brownlee, Oxbow, and Hells Canyon) and their associated powerhouses are individually eligible for inclusion in the National Register (letter from K.C. Reid, State Archaeologist and Deputy SHPO, and S. Pengilly Neitzel, Compliance Coordinator and Deputy SHPO, Idaho State Historical Society, Boise, ID, to C. Jones, Hells Canyon Relicensing Project Manager, Idaho Power, Boise, ID, dated January 10, 2003). Additionally, three buildings at Brownlee and two buildings at Hells Canyon would be considered contributing elements to a potential Hells Canyon Complex historic district, as yet to be identified, that could include all buildings and structures associated with the project built prior to 1968. Although they were not included in the Idaho SHPO's list of eligible resources, Idaho Power considers two operators' cottages at Oxbow and a historic barn at Brownlee also eligible for the National Register (Druss and Gross, 2003).

Paleoscience does not provide equivalent information for the Idaho side of the river.

3.9.1.6 Traditional Cultural Properties, Sacred Sites, and Rock Art

Lands important to the Shoshone-Bannock Tribes, Shoshone-Paiute Tribes, Burns Paiute Tribe, the Confederated Tribes of the Warm Springs Reservation (Warm Springs Tribes), the Confederated Tribes of the Umatilla Indian Reservation, and the Nez Perce Tribe are within the APE of the Hells Canyon Project. Idaho Power consulted with these tribes to identify issues related to tribal use of the area and sites of tribal importance. To this end, Idaho Power commissioned an anthropological literature review from an outside consultant (Myers, 2001) as well as separate oral history studies from each of the tribes (Druss, 2002).[96] The literature review concluded that there was little written ethnographic information specifically about Native occupation of the Hells Canyon Project area. Although none of the four oral history studies completed for the application discuss traditional cultural places in terms of National Register criteria or National Park Service guidelines for National Register evaluation of such resources, the studies provide information about types of natural resources and places that each of the tribes considers to be of cultural importance.

The Burns Paiute Tribe has traditionally used natural resources in the project area for gathering, hunting, fishing, and medicinal purposes. The tribe's oral history study offers a partial list of plants traditionally gathered by tribal members for food, "art and utility" (for baskets, mats, twine, duck decoys, cradleboards and dreamcatchers), and medicine. Tribal members seek redband trout in the Malheur River System and salmon on the Snake River. Year-round hunting provides food and also hides used to make clothing, saddles, and jewelry. The oral history does not identify specific locations of importance to the tribe, with the exception of Castle Rock, which the tribe has asked the Vale district of BLM to designate as an Area of Critical Concern

The Warm Springs Tribes' report includes a list of 41 plants ("cultural use items") recorded in the course of a 2000 field visit to the project and concurrent interviews with tribal members. The report indicates that "general" locations of "culture areas" (places of importance that the tribes define on the basis of activities that have taken place there) may be revealed only at the recommendation of the tribes' Cultural and Heritage Committee and with permission from the Tribal Council.

The report from the Umatilla Tribes identified 15 "areas" (primarily named according to river or tributary) in and in the vicinity of the project that the tribes consider TCPs by virtue of their connection to or association with traditional beliefs, customs and practices of importance to the people of the tribe. Within each area, the report lists native place names and activities and/or natural features associated with those locations.

The report from the Nez Perce Tribe offers a list of plants with cultural use that may occur in the Hells Canyon Project area. It also identifies 30 general and specific locations of camps, villages, and fishing areas associated with the Tribe's historical occupation and use of land and resources in the Hells Canyon area.

More than 200 of the archaeological sites contributing to the Hells Canyon Archaeological District feature rock art components, these being pecked, scratched or painted designs (and in a very small number of instances, written inscriptions of European-American origin) (Leo, 2001). Most are highly abstract, but a significant number feature representations of animals and anthromorphic figures. Anthropologists and ethnographers consider the spatial distribution, styles, and motifs of rock art such as those in the Hells Canyon area valuable sources of information about the distribution of ethnic groups in

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[96] Technical report appendix E4-13 presents results of the oral history studies conducted by the Warm Springs Tribes, Burns Paiute Tribe, and Confederated Tribes of the Umatilla Indian Reservation. The oral history study conducted by the Nez Perce Tribe and submitted to Idaho Power in 2005 was filed with the Commission in February 2007. According to Idaho Power, the Shoshone-Paiute Tribes and the Shoshone-Bannock Tribes declined to participate in the oral history study program.

the Canyon in the past. Anthropologists believe that the rock art was derived from and developed within shamanism, a basic aspect of the belief system among many hunting and gathering societies. As such, the geometric designs and pictographs may possess cultural and spiritual values for Native peoples as well as being of scientific interest.

3.9.2 Environmental Effects

3.9.2.1 Effects of Project Operations on Cultural Resources

We describe Idaho Power's Proposed Operations in section 2.2.2, *Proposed Project Operations*, and we assess the effects of the proposed operation on natural landforms in *Beach and Terrace Erosion* in section 3.4.2.1, *Effects of Project Operations on Sediment Transport*. We assess the effects of the proposed operation on natural resources of concern to Native American tribes in *Game Species and Plants of Cultural Importance* in section 3.7.2.1, *Effects of Project Operations on Terrestrial Resources*.

In this section, we evaluate the effects of Idaho Power's Proposed Operations, and of operation-related recommendations received from agencies, tribes, and other parties, on the following resources: (1) prehistoric and historic-period archaeological resources; (2) historic buildings and structures; and (3) TCPs and sacred sites, including Native American rock art.

Prehistoric and Historic Archaeological Resources

Archaeological sites can be disturbed by any action (natural, animal, or human) that disturbs the soils or ground surfaces on which they occur. Archaeological sites are susceptible to disturbance from grazing, pedestrian and vehicular traffic, construction, vandalism, and wind erosion. Sites on shorelines are also susceptible to erosion by changes in water levels and by wind- or boat-induced wave action. In this section, we evaluate the effects that proposed and alternative operations would have on archaeological resources.

Archaeological surveys commissioned by Idaho Power included assessments of site conditions and descriptions of effects observed by the archaeologists during the surveys (Mauser et al., 2001; Gross, 2001). According to the archaeologists, siltation, erosion, and deflation are the primary agents affecting sites along the margins and in the fluctuation zone of Brownlee reservoir. At Oxbow reservoir, archaeologists reported evidence of erosion at three archaeological sites; they also recorded damage to sites from road use, recreational activities, and removal of artifacts exposed during a period of low water. Sites at Hells Canyon reservoir show effects from recreational activities and other human access; archaeologists recorded two sites as threatened by pool fluctuations that are causing cutbank erosion.

Archaeologists surveying the riverine section from Hells Canyon dam to the Salmon River confluence reported a wide range of impacts on archaeological sites, caused by various agents (Druss and Gross, 2001). These agents include bank and terrace erosion, deflation, grazing, road use, and damage (both inadvertent and deliberate) by recreational visitors.

In its license application, Idaho Power (2003a) stated that it has no control over recreational or other access downstream of Hells Canyon dam, and that adverse effects on archaeological sites from such activities are not attributable to project operations. Idaho Power modeled the geographic extent of four flow scenarios below the dam to the Salmon River: 9500–30,000 cfs; 30,000–50,000 cfs; 50,000–75,000 cfs; and 75,000–100,000 cfs, and overlaid the results on archaeological site location maps. According to Idaho Power, flow effects on archaeological sites located beyond the geographic range of flows exceeding the Hells Canyon dam's hydraulic capacity of 30,500 cfs are not attributable to project operations. Idaho Power maintains that sites within the 30,000-cfs flow range could be affected by operational flows, natural flows that rise above 30,000cfs, or a combination of both.

The Idaho State Historical Society states that all sites within the 30,000-cfs zone should be assumed to have experienced erosional effects from project operations. The Idaho State Historical Society and the Oregon SHPO also state that archaeological surveys completed after (and unrelated to) Idaho Power's license application indicate that the project currently adversely affects sites downstream of the Salmon River confluence, potentially as far as the Grande Ronde River.

The Umatilla Tribes state that boat use on the reservoirs is part of project operations and that effects from boat wakes on sites along the reservoir shorelines are attributable to project operations.

Our Analysis

Fluctuation of water levels can destabilize soils and lead to seepage failure that affects not only shorelines but also archaeological materials that may be present in those soils. Erosion of soils containing archaeological materials can result in displacement or loss of artifacts, and also to exposure of artifacts where they may be vulnerable to unauthorized collecting or inadvertent damage. Although shoreline erosion appears to have less effect on archaeological sites on Oxbow and Hells Canyon reservoirs than sites along Brownlee reservoir (perhaps in part due to the greater amount of stabilizing shoreline vegetation at Oxbow and Hells Canyon), continued project operation presents the possibility that sites on these reservoirs could experience erosion from water level fluctuations in the future. Idaho Power recognized this possibility early in the application process when it proposed Study 8.4.7, *Effects of Reservoir Water Level Fluctuations on Cultural Resources,* in its Formal Consultation Package. Consultation with the Cultural Resources Work Group led to Idaho Power's deferral of this study. In its draft HPMP, Idaho Power indicates its plan to obtain information to complete this study during its periodic monitoring of archaeological sites on the reservoirs. We analyze proposed measures and address erosion of archaeological sites on all three reservoirs in section 3.9.2.2, *Site Treatment*.

Regarding the Umatilla Tribes' statement about boat wakes, we acknowledge that requiring Idaho Power to provide boat access to the reservoirs creates a nexus between the project and erosion resulting from boat wakes. However, we also note that state and federal land management agencies provide boat access to the reservoirs as well.

Idaho Power's responses to comments made following the Commission's Ready for Environmental Analysis notice indicate that it discovered several flaws in the flow simulations it laid over archaeological site maps for the area downstream of Hells Canyon dam. Nevertheless, modeling of the geographic extent of various flows in the context of the dam's hydraulic capacity represents a reasonable baseline for attributing erosional effects on cultural resources to project flows (as stated by the Idaho SHPO) as well as to flows that exceed the project's turbine capacity. However, effects on soils containing archaeological sites downstream of Hells Canyon dam are generally attributable more to the extent of fluctuations in flow than to the amount or time of year of flow. This is applicable not only to the area between Hells Canyon dam and the Salmon River, but also in the areas downstream of the Salmon River. As noted in section 3.3.2.1, *Effects of Project Operations on Water Quantity*, flow fluctuations downstream of the Salmon River at Anatone mirror those at Hells Canyon dam, but are much reduced due to the inflow from tributaries entering the Snake River between the two locations. We also note that flow in the Snake River more than doubles with the addition of the Salmon River, and flow from the Grande Ronde River increases flow by another 13 percent. Although fluctuations at Hells Canyon dam are translated downstream to Anatone without dispersing, they constitute a substantially smaller fraction of the total flow. As a result, erosional effects below the Salmon River cannot reasonably be assigned to operation of the Hells Canyon Project.

Operational measures that reduce flow fluctuations downstream of Hells Canyon dam could reduce direct effects on archaeological sites, and also provide additional benefits through growth of riparian and beach habitat that would help to stabilize locations containing archaeological sites. Although reduced ramping rates would occur under all three of the operational scenarios modeled by Idaho Power,

Scenario 1 is specifically designed to reduce the extent of flow fluctuation. In particular, Scenario 1b (Year-round 2-Inches-Per-Hour Ramping Rate) would appear to have the greatest potential to reduce erosion and by extension to reduce adverse effects on natural and cultural resources in and immediately above the fluctuation zone. We describe the three operational scenarios in section 3.3.2.2, *Operational Recommendations and Alternative Evaluation Scenarios*, and in section 3.2.2.8, *Flow Fluctuations below Hells Canyon Dam*.

The surface visibility of many archaeological sites leaves them vulnerable to damage or destruction, both inadvertent and purposeful, by recreational and other users. To the extent of Idaho Power's obligations under the license, effects resulting from access to locations containing archaeological site may be attributable to project operations. Idaho Power's draft HPMP contains measures for monitoring and as necessary further treatment of archaeological sites within the APE, including those potentially subject to adverse effects from its proposed recreational measures (analyzed in section 3.10.2.3, *Recreation Site Improvements*), and by extension to those measures that may be ultimately required in a license. We analyze Idaho Power's proposed measures for treatment of archaeological sites and TCPs in section 3.9.2.2.

Historic Buildings and Structures

Buildings and structures require maintenance, repair, and sometimes replacement of components if they are to remain functional. However, such actions can result in alteration or loss of elements or characteristics that may qualify them for inclusion in the National Register. Underused historic buildings and structures are vulnerable to deterioration or even removal. In this section, we evaluate the effects that proposed and alternative operations would have on historic project facilities (e.g., dams, powerhouses) and on buildings and structures historically associated with these facilities.

In its draft HPMP, Idaho Power proposes to maintain and use historic buildings and structures where possible, with adaptive use preferred over destruction or removal of significant features of such resources. Idaho Power's draft HPMP also provides for maintaining historic buildings and structures in accordance with the Secretary of the Interior's Standards for Rehabilitation, and for consultation with the appropriate SHPO to resolve unavoidable adverse effects.

Our Analysis

Although project operations could beneficially affect historic project facilities through continued use and maintenance, necessary repairs and upgrades to the structures could degrade the character-defining elements that qualify these resources for inclusion in the National Register. Historic project facilities such as the dams and powerhouses would remain in active use, since they are integral to the functioning of the hydroelectric project. Other buildings and structures may become obsolete or simply unnecessary to project operation, potentially leaving them vulnerable to neglect or demolition. Continued use of historic buildings and structures, as proposed by Idaho Power, would enhance the likelihood that they would be repaired as needed and maintained in good condition. Use of maintenance techniques consistent with the Secretary of the Interior's Standards for Rehabilitation whenever possible, as proposed by Idaho Power, would ensure that significant characteristics of historic buildings and structures are not inadvertently damaged, inappropriately altered, or lost. When adverse effects on historic buildings or structures, such as alterations affecting their historical integrity or demolition, cannot be avoided, consultation with the SHPO as proposed by Idaho Power would ensure that such adverse effects are resolved in a manner consistent with the requirements of section 106 of NHPA.

We also considered the fact that over time, buildings evaluated in 2003 as ineligible for the National Register because they were at that time under 50 years of age would need to be reexamined to determine their eligibility under the standard National Register Criteria, potentially resulting in a large number of historic buildings that could be affected by project operations. Establishing and implementing,

in consultation with the SHPOs, a schedule and methodology for re-evaluating buildings and structures as they reach 50 years of age would ensure that resources found eligible for the National Register in future years of the license term would be identified and subsequently managed in accordance with a finalized HPMP.

Traditional Cultural Properties and Sacred Sites, including Rock Art

The Hells Canyon Project area has been used by Native populations since prehistoric times, and their modern day descendants continue to do so today. Places and elements (including but not necessarily limited to archaeological sites and rock art) that tribes consider part of their traditional culture and history may be affected in various ways by project operation, depending on the kind of resource and source or agent of the effect. In subsection *Prehistoric and Historic Archaeological Resources* above, we discuss the effects of proposed and alternative operations on archaeological resources, including prehistoric sites and rock art that Native Americans also value as TCPs. In section 3.7.2.5, we analyze proposed measures for increasing upland and riparian habitats, both of which support indigenous species that Native Americans have traditionally used as food, medicine, or raw material for tools and household implements.

Archaeological surveys commissioned by Idaho Power in association with project relicensing have noted the presence of lichen on rock art in the project area. The biodeterioration of rock by lichen is a recognized natural phenomenon and the subject of continuing study worldwide. Air pollution (including nitrogen and sulfur deposition) can cause changes in lichen chemistry and lichen communities that have raised questions about whether such changes may affect the integrity of rock art on which such lichen communities are found. The Forest Service has expressed concern that elevated levels of ammonia and sulfur oxides attributable to the project are causing an increase in lichen on rock art in the Hells Canyon area.

Our Analysis

Hoelsher and Meyers (2003) note that nutrient processing within the Hells Canyon reservoirs (particularly in Brownlee reservoir) causes an increase in ammonia levels in discharges downstream of Hells Canyon dam. The absence of oxygen (anoxia) in near bottom waters causes the release of ammonia and can lead to an increased activity of anaerobic bacteria (i.e., bacteria that use energy sources other than oxygen, such as sulfur). The accumulation of ammonia occurs because water stagnates in the lower portion of the reservoir where much of the ammonia formation occurs. Idaho Power proposes an aeration system to supplement DO in the reservoirs (see section 3.5.2.2, *Dissolved Oxygen*). Aeration could eliminate anoxic conditions in portions of the reservoir, potentially increasing the pH and reducing the production and accumulation of ammonia in those areas. As a result, discharges from Brownlee and Hells Canyon Reservoirs could have higher pH levels and lower ammonia concentrations. However, the relationship between ammonia originating in the project reservoirs and atmospheric conditions affecting lichen communities in ways that could cause damage to rock art has not been adequately demonstrated. Monitoring the condition of all National Register-eligible archaeological sites and rock art in the APE would provide a continuous stream of data about resource conditions and provide a basis for Idaho Power to develop further treatments for sites and rock images affected by project operations. We analyze measures for treatment of archaeological sites and TCPs, including rock art, in section 3.9.2.2 below

3.9.2.2 Site Treatment

A first step in treatment of cultural resources is assessment of their existing condition and periodic monitoring thereafter to determine whether the condition of a given resource has changed, and if so, why. Monitoring may indicate that project operations do, or are likely to, adversely affect the condition of a resource. In that case, the next step is to develop and implement treatments to repair damage where possible, and prevent further deterioration or loss. Such treatments take into consideration the type and significance of the resource as well as the agent and extent of the effect. For historic

buildings and structures, repairs or prevention of conditions causing adverse effects may be appropriate. For archaeological sites and TCPs, stabilization, fencing or barriers to access, and redirection of activities away from resource locations are examples of common treatments. Resources that are stabilized remain in place, protected by vegetative or other coverings from further harm.

Monitoring

Idaho Power proposes to develop and implement a program of regular monitoring and assessment of historic properties within the APE to annually monitor site conditions and determine the need for further treatment. To this end, Idaho Power proposes to monitor the conditions of selected eligible archaeological sites in the APEs of the project's three reservoirs, as well as the known burial site at Oxbow reservoir. In the APE below Hells Canyon dam, Idaho Power proposes an initial 3-year program, at the end of which the condition of historic properties sites in this portion of the APE would have been verified and, as necessary, updated. Idaho Power would use results of this initial program to determine appropriate schedules for monitoring over the next 3 years. This pattern would continue throughout the license term, with the monitoring program being reviewed and revised as needed every 3 years.

In FS-25, the Forest Service specifies that Idaho Power's HPMP should provide for periodic monitoring of all identified historic properties, including TCPs, within the APE, with special protocols for photographic documentation of selected rock images determined in consultation with the Forest Service. In Interior-5, BLM specifies that 13 known sites on BLM land in the APE should be included in the initial monitoring cycle.

The Umatilla Tribes and the Forest Service recommend that Idaho Power monitor the condition of TCPs, including rock art. For rock art, the Umatilla Tribes recommend scheduling visitations during periods of lowest water levels, and recording each rock art site under at least two different lighting conditions out of four lighting scenarios based on position of the sun at various times of the day. The tribes further recommend that a special Rock Image Panel Supplement form be appended to each existing site form, and that all information on physical characteristics and condition be updated or revised as needed. The Umatilla Tribes also recommend that Idaho Power develop a framework for monitoring TCPs in consultation with the tribes.

The Nez Perce Tribe's recommendation that all known historic properties in the APE be monitored to identify project-related effects is similar to Idaho Power's alternative Forest Service condition. The tribe also recommends that estimates of monitoring costs over the term of the license be increased to $10 million or justified at another level based on a reasonable method and scope.

The Idaho State Historical Society recommends that the monitoring program include confirmation of information on the archaeological site records Idaho Power submitted in association with relicensing, and that Idaho Power ensure that its cost estimates for monitoring are sufficient to cover this additional work.

Our Analysis

Not all archaeological sites may ultimately require monitoring with the same frequency, and changing circumstances may require adjustment in the frequency of monitoring at any given site over time. Because Idaho Power's archaeological field investigations were conducted more than 6 years ago (from 1997 to 2000), and because many of the archaeologists' site condition assessments were based on single visits, an initial 3-year program during which the conditions of all National Register listed and eligible sites in the APE were verified and updated (as proposed by Idaho Power and consistent with FS-25 and Interior-5) and existing site data were corrected or brought up to current conditions (as recommended by the Idaho Historical Society) would provide an informed starting point for the program. It would also provide the opportunity to rectify inconsistencies in assessment of effects that inadvertently resulted from differing approaches on the part of the two archaeological consultants contracted by Idaho

Power for its relicensing effort. Review of the program and its findings every 3 years, as proposed by Idaho Power, would provide Idaho Power with an opportunity to make any necessary adjustments to monitoring methods and frequencies.

Because resources may be significant under more than one National Register criterion, proper treatment of such resources may require consideration of measures other than those commonly employed for resources significant only for their information potential (Criterion D). Thus, employing monitoring methodologies that take key characteristics of a resource type and its significance into account, as recommended by the Umatilla Tribes, would enhance assessment of the resource's condition and inform Idaho Power's consideration of any necessary additional treatments. Because rock images frequently occur in association with Native American archaeological sites, a single overall monitoring program, appropriately designed to address a range of feature characteristics in a manner consistent with FS-25, would be more time-and cost-effective than separate monitoring efforts, and would ensure consistency of approach and analysis.

The Nez Perce Tribe has recommended that the estimate for monitoring be increased to $10 million (based on an estimate of $333,000 per year for 30 years), or adequately justified alternative amounts. The Idaho Historical Society's recommendation includes no basis for what the Idaho Historical Society would consider sufficient. Because of the long time frame, potential for changes in circumstances, and possibility that new monitoring methods may be developed and implemented over time, the total cost of monitoring hundreds of resources over multiple decades cannot realistically be determined.

Stabilization

Idaho Power proposes to stabilize seven archaeological sites on Brownlee reservoir that are affected by project operations. Idaho Power has also proposed to stabilize approximately 20 sites between Hells Canyon dam and the confluence with the Salmon River that show evidence of active erosion potentially attributable to project operation. Fifteen of the sites, all in Oregon, have already been selected; others remain to be determined. Consistent with a provision of FS-25 and provisions of Interior-5, Idaho Power proposes to coordinate with the appropriate SHPO, land management agency (or other landowner), and tribes to develop stabilization measures appropriate to each individual site as the need arises.

The Umatilla Tribes recommend that stabilized sites be maintained in perpetuity. The Idaho State Historical Society recommends that the list of sites for initial stabilization below Hells Canyon dam be finalized, and also that Idaho Power establish a fund to support archaeological testing to determine appropriate stabilization measures. The Nez Perce Tribe recommends that Idaho Power stabilize more sites than currently proposed.

Our Analysis

Neither Idaho Power's application nor its draft HPMP describes the criteria it used to select sites below Hells Canyon dam for stabilization. However, field notes from site visits conducted in 2005 by archaeologists from Idaho Power, the Forest Service, and both SHPOs, and filed with the Commission by Idaho Power (Baker, 2005a,b), indicate two major factors considered in Idaho Power's initial list of sites to be stabilized below Hells Canyon dam: (1) the site's location with respect to the 30,000 cfs level plus (2) evidence of active erosion. Decisions regarding stabilization need to be based on clearly articulated, measurable criteria to ensure that sites most in need of stabilization as a result of project operations will be identified and treated in a timely manner. Including such criteria in the final HPMP would help all concerned parties understand how Idaho Power is identifying sites for the initial stabilization efforts. Such criteria would also offer a sound basis for determining thresholds for stabilization in the future. Over the license term, periodic monitoring of all eligible sites in the APE would ensure that if project-

related effects to other sites are identified, appropriate treatments could be developed and implemented in consultation with the tribes, agencies and SHPOs, as proposed by Idaho Power and specified in Forest Service 4(e) condition no. 25. While stabilization in place is a generally preferred treatment, the passage of time and changing circumstances during the license term could render stabilization measures ineffective. In such cases, it may not be possible to continue stabilization over the full term of the license, and other measures may be necessary.

Because stabilization is resource-specific, a variety of methods, including subsurface testing, may be used to determine the most appropriate way to stabilize a site. The costs of such subsurface testing would thus be included in the suite of actions taken to develop each stabilization plan. Establishment of a separate fund to support archaeological testing, as recommended by the Idaho State Historical Society, would therefore appear to offer no additional resource protection..

Mitigation

Idaho Power proposes to conduct data recovery at four archaeological sites on Brownlee reservoir because the sites lie partly below the usual reservoir level and Idaho Power therefore does not believe that stabilization in place would be effective. Two of the proposed sites are on BLM land, and Interior-5 specified these two sites for data recovery.

The Umatilla Tribes' recommendation that Idaho Power develop plans to mitigate effects to sites within 3 years is similar to Idaho Power's proposed timetable for monitoring and treatment. The Umatilla Tribes also recommend recognition of the fact that some sites may possess significance apart from their potential to yield scientific information.

Our Analysis

Idaho Power's proposed Data Recovery Plan recognizes that four archaeological sites on Brownlee reservoir, including the two on BLM land, are experiencing active erosion resulting from project operations. Idaho Power's proposed data recovery would be a beneficial step to take in this instance, where stabilization is not possible, and would be consistent with the provisions of Interior-5. As a result of annual monitoring over any new license term, other sites requiring further treatment (stabilization or other measures, including data recovery) may be identified, and in those instances Idaho Power's draft HPMP provides for consultation with the agencies, tribes, and SHPOs regarding appropriate treatments. Such consultation would ensure, as recommended by the Umatilla Tribes, that each site's significance and important characteristics are accorded the greatest consideration in the treatment plan.

3.9.2.3 Cultural Resources Interpretation

Protection of cultural resources can take many forms. One of them is interpretation, the main objectives of which are to increase public knowledge and appreciation of cultural resources and to enhance public awareness about threats to such resources. Idaho Power proposes to create, install and maintain 14 informational kiosks at various locations throughout the project. Six would focus on the Native American presence and land use in the project area. Four would describe aspects of European-American occupation, and four would cover the Asian-American experience. Idaho Power also proposes to provide financial assistance in the form of grants to local communities and organizations to support museum collections acquisition, display and curation, and for other public information and outreach projects focusing on the European-American and Asian-American presence in the Hells Canyon area.

The Idaho State Historical Society recommends that Idaho Power provide funding to student and professional/academic researchers to support study of archaeological materials recovered during previous investigations in the project area that have not been analyzed or formally reported on. The Idaho State Historical Society, the Forest Service and the Nez Perce Tribe recommend that Idaho Power update the

1984 National Register nomination for the Hells Canyon Archaeological District, to incorporate the numerous additional sites identified during the relicensing surveys. The Burns Paiute, Shoshone-Bannock, and Shoshone-Paiute Tribes recommend that Idaho Power build, operate and maintain a cultural center that would provide information, educational programs, and curation facilities to enhance public awareness of the area's Native American cultural traditions and resources

Our Analysis

Under the Advisory Council's regulations implementing section 106 of NHPA, the Commission, in consultation with other parties, is required to identify historic properties that may be affected by project operations; determine whether project operations would or could adversely affect historic properties; and resolve adverse effects through avoidance, minimization and/or mitigation. Programs and activities that most directly benefit historic properties enhance compliance with these priorities.

Informational/interpretive kiosks proposed by Idaho Power, placed in appropriate locations in the landscape, would be an effective way to introduce visitors to the cultural history and resources of the Hells Canyon area. They also could potentially contribute to resource protection by noting legal penalties for vandalism and looting, and by making visitors aware of activities that could inadvertently damage or destroy resources.

Actively engaging area communities in programs related to the historical, archaeological, and cultural values of the project and its resources could enhance public appreciation of the significance and fragility of these resources. Idaho Power's proposed grant program for local communities and organizations, if carefully targeted and administered, could be an effective way to achieve this objective. Establishment of a similar carefully targeted program or programs for the tribes would encourage cultural resource interpretation from the Native American perspective (see also section 3.9.2.4, *Support for Native American Programs*). This approach would have closer nexus to the project and project resources than Idaho Power's building and operating a cultural center as the tribes recommend.

The Commission requires applicants and licensees to conduct cultural resources surveys to accepted professional standards and to dispose of any artifacts in accordance with applicable laws, regulations and standards. Analysis and interpretation of archaeological materials removed from their original locations in the project during previous investigations by other parties, as recommended by the Idaho State Historical Society, could potentially enhance the state of knowledge concerning the cultural history of the project area. However, there is no regulatory basis for requiring Idaho Power to fund or support studies beyond those necessary to identify historic properties and appropriately resolve project-related adverse effects. Updating the 1984 National Register nomination for the Hells Canyon Archaeological District, as recommended by the Idaho State Historical Society, the Forest Service, and the Nez Perce Tribe, would increase the number of sites included in the National Register as contributing elements of the listed district. However, there is no regulatory basis for requiring Idaho Power to nominate resources to the National Register. Furthermore, nominating resources would not afford those resources any greater protection than would be required under any new license.

3.9.2.4 Support for Native American Programs

Encouraging broad-based participation in management efforts builds and sustains informed constituencies that can support management goals and contribute ideas and expertise toward effective treatment of cultural resources. In this section, we analyze a variety of proposals and recommendations regarding Native American participation in cultural resources management in the project area.

Participation, Education, and Training

In consultation with each of the tribes, Idaho Power proposes to provide support for tribal programs and tribal participation in resource management in the project. Specifically, Idaho Power

proposes to: fund costs of tribal staff time and travel costs associated with tribal-related implementation of environmental measures; support educational development programs, including scholarship/training; and support ongoing and future cultural enhancement projects in consultation with each tribe. Idaho Power proposes to allocate $1 million in support of each tribe (total $6 million) over the term of the license.

The tribes have made recommendations similar to those proposed by Idaho Power. The Burns Paiute, Shoshone-Paiute, and Shoshone-Bannock Tribes have recommended generally that Idaho Power support tribal participation in natural and cultural resource management of the Snake River and its tributaries. The Umatilla Tribes recommend that Idaho Power provide $1 million to the tribes to facilitate consultation and coordination on matters pertaining to cultural resources. The Burns Paiute Tribe recommends establishment and continued funding of a tribal education scholarship fund that would be administered by the tribe, and also recommends that Idaho Power provide annual funding to support the tribe's participation in cultural resources management in the project.

The Shoshone-Paiute Tribes recommends that the funding measures for each tribe be increased to $10 million. The Nez Perce Tribe recommends that Idaho Power grant each tribe its share of the funds in a lump sum at the beginning of the license term, for the tribe to use for license-related programs.

Our Analysis

Informed participation by individuals and groups for whom project-area resources are of both historic and ongoing cultural importance could contribute significantly to management and protection of such resources. Reimbursement of travel costs would directly foster participation by those otherwise unable to attend meetings or programs associated with cultural resource management at the project. Educational and training opportunities specifically designed to equip interested persons with technical knowledge and skills necessary for active participation in design and implementation of project-related protection and enhancement efforts would support cultural resource management goals. As we discuss in section 3.9.2.3 above, a grant program to support the tribes' interpretation of their cultural heritage in the Hells Canyon area would enhance appreciation of the area's Native American cultural resources. Any such programs would need to be closely managed to ensure that their objectives are realized.

Ethnographic and Oral History Studies

Ethnographic and oral history studies compile and elicit from living Native Americans information about the culture of, and resources important to, the nation's indigenous peoples. The Shoshone-Paiute, Nez Perce, Burns Paiute, and Shoshone-Bannock Tribes have made generally similar recommendations that Idaho Power provide funding to undertake, expand, or complete ethnographic and oral histories of these tribes.

Our Analysis

As part of relicensing activities, Idaho Power funded a Hells Canyon-area ethnographic overview as well as oral history studies for each of the tribes. Oral histories from the Warm Springs Tribes, Umatilla Tribes, and Burns Paiute Tribe were included as technical report appendices in the draft and final license applications, and Idaho Power filed the Nez Perce Tribe's oral history in February 2007.

Idaho Power's funding of the ethnography and oral history studies offered the tribes the opportunity to identify TCPs and to provide information that Idaho Power could use in its management and protection of resources and places in the project that are of importance in the area's Native American cultural traditions. Completion of oral history studies by Shoshone-Paiute and Shoshone-Bannock Tribes, as well as appropriate dissemination of the Nez Perce Tribe's oral history study, would complement the studies by the other tribes, and would contribute additional information toward effective and appropriate management of TCPs and sacred sites in the project area. Tribal participation in resource management

planning could provide opportunities for the tribes that have contributed oral history studies to refine and expand information from the studies in a continuing manner over the license term, to the benefit of the tribes and of Idaho Power's management efforts. We also note that revision of the HPMP consistent with Forest Service 4(e) condition no.25 would provide strategies for adaptive management and processes for determining when and under what circumstances additional cultural resource studies may be required.

Employment of Native Americans

The Nez Perce Tribe recommends that Idaho Power seek to employ qualified tribal members in all contracts and work performed under the license. In section 5.2, *Comprehensive Development,* under *Tribal Participation, Education, and Training*, we discuss the issue of agency jurisdiction over employment decisions.

Other Tribal Recommendations

The Umatilla Tribes recommend that Idaho Power develop a plan to increase access to tribal fishing sites in the APE. The Nez Perce and Burns Paiute Tribes recommend that Idaho Power establish a fund to acquire additional upland and riparian lands that would provide substitute fishing and wildlife harvesting opportunities for the tribes. The Burns Paiute Tribe also recommends establishment of a cooperative management area for the Snake River and its tributaries.

Our Analysis

In Native American communities with hunting-gathering traditions, food procurement sites are often integral elements of culture history, and may as such be considered potential TCPs. Continued or renewed use of locations such as traditional fishing sites, as recommended by the Umatilla Tribes, could support tribal efforts to maintain cultural traditions. In its draft HPMP, Idaho Power states that it will endeavor to provide access to TCPs identified within the APE where it is practical and safe to do so. Providing tribes with access to sacred sites and TCPs (which may include tribal fishing sites, locations of culturally significant plants, as well as other locations) is also specified as an action to be undertaken under Standard Procedure 1 of the draft HPMP.

The Nez Perce and Burns Paiute Tribes state that their recommendations arise from an insufficiency of aquatic and terrestrial resources available to the tribes. Idaho Power proposes to acquire, enhance and manage additional upland and riparian habitat as mitigation for anticipated impacts of project operations on wildlife. Lands acquired under this proposal would likely support terrestrial species of traditional cultural importance to the tribes. Additionally, such lands could potentially contain historic properties that could benefit from protective habitat management, as long as their presence was taken into account in any habitat restoration efforts involving ground disturbance. We analyze these land acquisition proposals in more detail in section 3.7.2.5, *Upland and Riparian Habitat Acquisition.* Additionally, in section 3.6.2 we analyze measures to improve the condition of aquatic resources that would benefit species of cultural importance to the tribes.

3.9.2.5 Management of Cultural Resources

The Commission typically requires applicants to prepare and submit a draft HPMP with their license applications. An HPMP contains measures, strategies and procedures for resource management and protection, and for resolving known or potential project-related adverse effects to historic properties over the term of the license. In previous sections, we have discussed measures proposed by Idaho Power or recommended by agencies and tribes with respect to treatment and interpretation of cultural resources and Native American participation in the process, all of which are integral components of an HPMP. In this section, we analyze other historic property management measures recommended by agencies and tribes.

Expansion of Area of Potential Effect

The Umatilla Tribes recommend that the APE be expanded to the confluence of the Snake and Clearwater rivers, and that the added land be surveyed for cultural resources. The Nez Perce Tribe recommends that the APE extend beyond the confluence of the Snake and Salmon rivers to the upper limit of the next downstream reservoir, near Asotin, Washington. The Idaho State Historical Society recommends that archaeological surveys be conducted along the reach of the Snake River between the Salmon and Grande Ronde rivers. The Oregon SHPO also recommends that the APE be extended downstream of the Salmon River. The Shoshone-Paiute Tribes recommends that the APE, and therefore the provisions of the HPMP, include all lands between the confluence of the Snake and Salmon rivers upstream to Shoshone Falls.

Our Analysis

In section 3.9.1.1, we describe Idaho Power's proposed APE and in section 3.9.2.1, we analyze the nature and extent of potential effects to archaeological resources from proposed and alternative project operations. As indicated in the latter section, flows from the Salmon, Grande Ronde and other tributaries below the Salmon River significantly attenuate water level fluctuations arising at Hells Canyon dam. While we note that geomorphologists do not appear to have yet developed a solid scientific methodology for distinguishing between project and natural flows in a riverine environment, the recommendations of the tribes, Oregon SHPO and the Idaho State Historical Society to expand the APE do not provide an empirical basis for attributing erosional impacts to cultural resources below the Salmon River to project operations.

Regarding the Shoshone-Paiute Tribes' recommendation to expand the APE upstream to Shoshone Falls, we note that there are a number of other hydroelectric projects above the Hells Canyon Project, each of which has a unique APE that represents the geographic extent to which actions under that project's license, whether operations, recreational enhancements, natural resource enhancements or other actions, could potentially affect historic properties. Each licensed project is also required to manage any historic properties within its APE in a manner consistent with section 106 of NHPA. Extension of the Hells Canyon Project's APE to Shoshone Falls, therefore, would not afford historic properties upstream of this project any greater protection than they now receive.

We do note, however, that changing circumstances, or emergence of new information, may make it necessary to revise an APE over time. Including provision for review, and as appropriate, revision, of the HPMP (including as necessary the APE) in Idaho Power's final HPMP would ensure that this possibility could be addressed should the need arise.

Cultural Resources Technical Subcommittee

The Idaho State Historical Society and the Umatilla, Nez Perce, Shoshone-Paiute, and Burns Paiute Tribes recommend formation of a standing organization (variously called a task force, advisory committee, or work group) specifically concerned with implementation of the HPMP for the project.

Our Analysis

A cultural resources technical subcommittee composed of representatives from all the tribes, land management agencies, other landowners, and SHPOs would give these directly concerned parties a voice in the management and protection of cultural resources in the project over the license term. There are many kinds of cultural resources in the project area; and committee members' contributions of knowledge and recommendations would inform Idaho Power's decision-making, and would facilitate Idaho Power's adaptation, as necessary, of the HPMP to address the changing circumstances inevitable over the period of any new license.

Law Enforcement

The Burns Paiute, Umatilla, and Shoshone-Paiute Tribes recommend that Idaho Power provide law enforcement as a measure to protect cultural resources from vandalism and looting. In *Comprehensive Development* under *Law Enforcement and Fire Protection*, we discuss the issue of agency jurisdiction over law enforcement.

Sensitivity Training

The Umatilla Tribes recommend that Idaho Power conduct periodic training sessions to enhance staff understanding of cultural resources and their importance to the tribes.

Our Analysis

In its draft HPMP, Idaho Power proposes to develop a company-wide education program, particularly for departments involved in construction and other potentially ground-disturbing activities. Such a program would appropriately include discussion of the different kinds and significance of cultural resources in the project area, as a way of enhancing employees' understanding of issues that would influence planning and implementation of project-related activities.

Re-survey of the APE

The Umatilla Tribes recommend that Idaho Power re-survey the APE every 10 years to identify cultural resources beyond those identified to date. In its condition no. 25, the Forest Service specifies that Idaho Power's HPMP include provisions for determining when and under what circumstances new survey, or resurvey of previously examined areas, may be required.

Our Analysis

We acknowledge that field conditions, methodologies, technology, and interpretations change over time, and may change over the term of a license. However, we do not see material benefit in arbitrarily re-surveying the entire APE every 10 years. Including provisions in Idaho Power's HPMP for determining the need for new survey or resurvey would ensure that these issues would be appropriately taken into account in the management of cultural resources over the license term.

Curation of Archaeological Materials

The Umatilla Tribes recommend that artifacts recovered in the APE as a result of project operations be reburied on site or curated at a federally recognized repository.

Our Analysis

Under federal law, disposition of archaeological materials recovered on federal land is the responsibility of the land-managing agency. Although Idaho Power has not indicated how it would treat archaeological materials recovered from state, county and private land, including such a provision in the final HPMP would ensure that such artifacts are disposed of, in consultation with the SHPOs and tribes, in a manner consistent with the federal standards specified in 36 CFR 79.

Treatment of Paleontological Resources

BLM recommends that Idaho Power evaluate, and then protect or mitigate, scientifically important paleontological resources discovered in the course of project operations.

Our Analysis

Idaho Power's draft HPMP provides for development and implementation of site-specific treatment plans for newly-discovered paleontological resources in consultation with BLM and in accordance with BLM's Paleontological Resources Manual. This would ensure that these resources are protected in the event of inadvertent discovery.

Revise and Finalize the HPMP

The tribes and Idaho State Historical Society recommend and Interior and the Forest Service specify (Interior-5, FS-25) that Idaho Power revise, finalize, and implement the HPMP.

Our Analysis

Finalizing the HPMP to include measures recommended in the Staff Alternative (see section 5.2, *Comprehensive Development*), followed by implementation, would ensure that historic properties are protected over the license term.[97] Prior to issuing a new license, the Commission would execute a programmatic agreement (PA) with the SHPOs and Advisory Council to implement the HPMP. Idaho Power, the tribes, the Forest Service, and BLM would be invited to participate in the PA as concurring parties.

3.9.2.6 Effects of Other Measures on Cultural Resources

Sediment Transport Measures

Implementation of measures to restore sandbars through sand augmentation, as specified in Forest Service 4(e) condition no. 4, would help maintain some current beaches and, most importantly, provide a buffer against terrace erosion. Because archaeological sites (and some TCPs) are frequently located on river terraces, sandbar restoration would contribute to protection not only of terraces but of any archaeological deposits that may be present. Maintenance and enhancement of beaches may also afford protection to sites on terraces at the water's edge.

Aquatic Resource Measures

Idaho Power's proposals to make improvements to anadromous fish hatchery facilities involve construction of holding ponds and other features. Such construction is likely to involve ground disturbance that could affect archaeological sites or TCPs if any exist at the hatchery locations. If these locations have not been surveyed to identify cultural resources, such survey would ensure that cultural resources were identified early in the planning process for the hatchery improvements. If these locations have been surveyed and no sites have been identified, Idaho Power's proposed hatchery improvements would be unlikely to affect historic properties.

Measures to improve the condition of aquatic resources (see section 3.6, *Aquatic Resources*, and relevant portions of section 3.8, *Threatened and Endangered Species*) could also benefit tribal fisheries and culturally important aquatic species.

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[97] The Commission is requiring Idaho Power to finalize the HPMP prior to issuance of a new license. The final HPMP must address the issues outlined in section 5.2.6 of this final EIS. The final HPMP would be attached to the final PA.

Terrestrial Resource Measures

Idaho Power proposes to acquire more than 20,000 acres of upland and riparian habitat to mitigate effects of project operations on wildlife. Idaho Power also proposes to enhance habitat on four Snake River islands and adjacent to the reservoirs. Habitat restoration measures could involve ground disturbance at locations containing significant archaeological sites or TCPs. However, we note that habitat restoration measures resulting in stabilization of ground surfaces could beneficially affect archaeological sites at such locations because the sites would be less subject to erosion or deflation. We also note that any lands acquired by Idaho Power under the license would automatically come under the provisions of the HPMP regarding treatment of any historic properties that may exist on such lands.

Measures to protect and enhance terrestrial resources, within the current project area and on any land acquired under mitigation proposals, could benefit terrestrial resources that are important to the tribes.

Recreation Measures

Idaho Power proposes a long list of actions to develop and/or enhance recreational sites, including dispersed sites. Agencies have also recommended or specified recreational improvements. Development or enhancement activities involving ground disturbance could potentially affect archaeological sites or TCPs if any exist at the recreational site locations. In its draft HPMP, Idaho Power has indicated that archaeological monitoring during construction would ensure that previously unknown resources would not be inadvertently destroyed, and that steps could then be taken to avoid adverse effects from recreational site development. However, we note that human access is perhaps the greatest cause of adverse effects on cultural resources in the APE, particularly given the resources' general high degree of visibility. Recreation enhancements are therefore expected to increase threats to cultural resources and require greater protective and management efforts on the part of both Idaho Power and agencies supporting such enhancements.

Project Boundary Revision

Exclusion of lands from the licensed project, as proposed by Idaho Power, would remove that land from the Commission's jurisdiction. However, the lands proposed for exclusion are federal lands managed by BLM and the Forest Service, and as a result they would continue to be subject to the protective and management requirements of NHPA. Exclusion of the approximately 3,800 acres of federal land from the project, as proposed by Idaho Power, would therefore have no effect on historic properties, should any be located on that land.

3.9.3 Unavoidable Adverse Effects

Execution of the PA and implementation of an HPMP over the term of a new license would ensure proper management of significant cultural resources within the APE of the Hells Canyon Project and also provide for resolution of any project-related adverse effects.

3.10 RECREATION RESOURCES

3.10.1 Affected Environment

3.10.1.1 Regional Recreational Setting

Recreational resources in the project vicinity are extensive and provide for a wide variety of outdoor activities. Lands adjacent to the upstream end of the project and surrounding Brownlee and Oxbow reservoirs are primarily publicly owned and managed by BLM or state agencies. These lands provide free public access to the mountains and rivers surrounding the upper and middle project area and are used, among other things, for hiking, hunting, snowmobiling, and off-road vehicle use.

The Forest Service manages the majority of land adjacent to the project around Hells Canyon reservoir. Much of the land west of the reservoir is included in the Hells Canyon Wilderness and is managed as part of the Wallowa-Whitman National Forest to provide non-motorized public recreational opportunities. Although much of this land is remote and relatively inaccessible, some visitors use informal trails and outfitter/horse-pack trails to support hunting and hiking trips into the wilderness area (Claycomb and Brown, 2003).

The Hells Canyon National Recreation Area (HCNRA) includes more than 650,000 acres of land adjacent to the downstream end of the Hells Canyon reservoir and dam. The HCNRA includes the free-flowing portion of the Snake River corridor from the downstream end of the Hells Canyon Project downstream approximately 71 miles. The HCNRA includes portions of the Nez Perce, Payette, and Wallowa-Whitman National Forests with the Wallowa-Whitman National Forest managing recreational use of the HCNRA, including boating in the HCNRA portion of the Snake River (Sorensen, 2003).

Recreational opportunities at the HCNRA are extensive and diverse, but the primary attractions are whitewater boating and associated fishing and camping on the free-flowing portion of the Snake River downstream of Hells Canyon dam (Brown, 2003c). Whitewater boating opportunities range from riffles and Class I rapids at the downstream end of the HCNRA to technical Class III and IV rapids in the upper reaches of the canyon. The unique whitewater opportunities located in an isolated canyon attract private and commercial kayakers, rafters, and power boaters. Rafters and kayakers typically launch at the Hells Canyon Visitors Center, approximately 1 mile downstream of the Hells Canyon dam, and take out at Pittsburg Landing (33 miles downstream) or Lewiston (114 miles downstream). Private and commercial powerboat trips are typically staged from Lewiston or Pittsburg Landing, running up the river a few miles or all the way to Hells Canyon dam and returning to the launch area.

The Snake River through Hells Canyon (downstream of the project) has a long navigational history, with attempts to run the rapids as early as the 1890s and commercial outfitting beginning in the 1950s. Regular operation of commercial boating trips through all rapids in the canyon is a relatively recent event, associated with the development of powerful jet boats capable of climbing rapids at low to moderate flows and navigating technical downstream routes through the rapids. Idaho Power estimates between 40,000 and 50,000 boaters used the river annually in the HCNRA in the 1990s, with seasonal and annual variation linked to flow (Brown, 2003c). Commercial power boaters were the majority of HCNRA boaters in the years included in the survey (table 76).

Table 76. Number of registered boaters entering the HCNRA through Hells Canyon Creek, Pittsburg Landing, Dug Bar, and Cache Creek portals combined, by year. (Source: Brown, 2003c, as modified by staff)

Type of Boater	1992	1993	1994	1995	1996	1997	1998	1999
Commercial Power	27,169	30,275	28,831	30,443	29,000	29,275	29,405	31,113

Type of Boater	1992	1993	1994	1995	1996	1997	1998	1999
Private Power	11,820	11,490	12,941	12,268	11,056	10,068	10,647	10,509
Private Float	3,798	3,241	4,727	3,321	2,857	2,133	2,754	2,448
Commercial Float	2,058	4,783	4,592	5,618	5,696	1,885	3,930	2,216
Total	44,845	49,789	51,091	51,650	48,609	43,361	46,736	46,286

In addition to providing boating opportunities, the HCNRA has about 925 miles of trails that provide outstanding opportunities for hunting, fishing, backpacking, horseback riding, mountain biking, photography, and many other recreational pursuits. Two important hiking and horse pack trails parallel the Snake River through Hells Canyon downstream of the project: on the Idaho side, the Snake River National Recreation Trail runs approximately 30 miles from Pittsburg Landing to Butler Bar, and on the Oregon side, the Snake River Trail parallels the river for about 45 miles from Dug Bar to Battle Creek. Both trails allow visitors to explore several side-trail loops from the river up the canyon to higher elevation bench and summit trails.

3.10.1.2 Recreational Facilities within the Project Boundary

Numerous recreational facilities are located within the project boundary, including 24 formal or semi-formal public-access sites that have some level of recreational infrastructure ranging from minor to substantial;[98] 4 private marinas and camping areas; and at least 123 undeveloped, dispersed, or informal sites (figure 115). These sites within the project boundary are owned and managed by a variety of entities, including Idaho Power; state, federal, or county government agencies; and private companies.

The formal public recreational sites provide a wide range of opportunities and public access to the project. As shown in table 77, 8 of the 24 sites are fully developed, with management presence during the peak-use season of May 1 through September 31. These sites also have received substantial capital investment in site-specific infrastructure that supports a wide range of recreational uses. All of these parks provide some level of barrier-free access and include boat launch and dock facilities, permanent toilets, potable water, and picnic areas. Some include fish cleaning facilities, tent and RV camping pads, rental cabins, dump stations, electricity hook-ups, and/or showers, among other things. Camping fees at these 8 sites range from $5 to $35 per night.

The other 16 formal public recreational sites have minimal improvements, with a lower level of development that supports lower intensity recreational use. These sites typically have gravel rather than paved boat ramps, simple vault or portable toilets, no potable water, and limited signage and management presence. Within this group, sites that allow camping do not necessarily have designated camping areas or fire rings, electricity or other infrastructure; instead, campers typically disperse into user-defined areas.

Idaho Power owns and manages nine formal recreational areas within the project boundary and manages two additional sites located on BLM lands within the boundary (Hall and Bird, 2003). At these sites, Idaho Power provides management staff; posts park rules and regulations; provides public telephones; and develops and installs informational, historical, and interpretive signs. Most of the public parks in the project are open from March 1 through September 31, but Idaho Power keeps its parks open year-round, with limited amenities and reduced rates available during the off-season.

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[98] Idaho Power (2003a) included the 11 public access sites in its inventory of dispersed sites. Because these sites have some level of infrastructure and management presence, we categorize these sites as formal recreational areas.

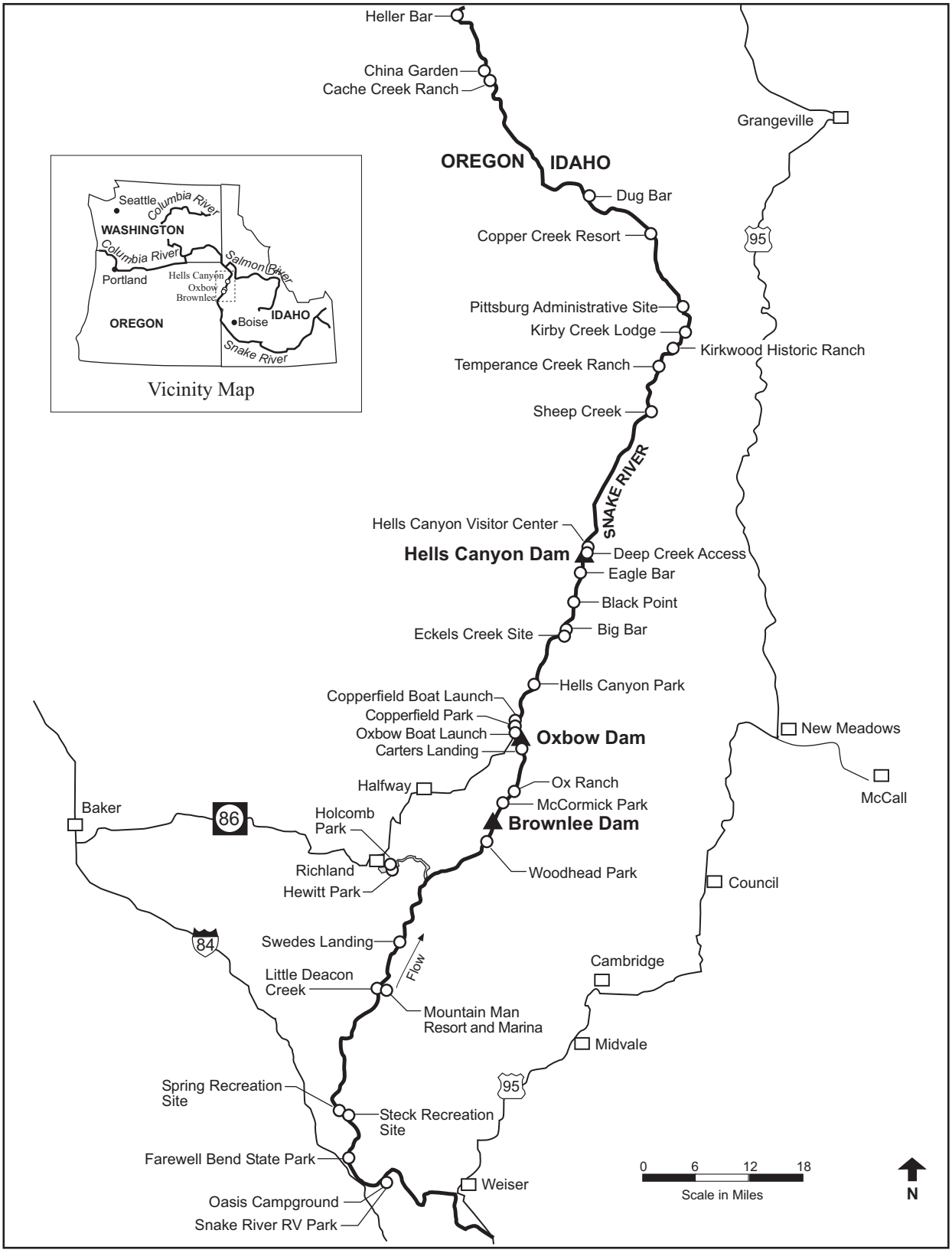

Figure 115. Hells Canyon Project recreational sites. (Source: Idaho Power Company, 2003a, as modified by staff)

Table 77. Formal and semi-formal public recreational facilities within the Hells Canyon Project boundary. (Source: Idaho Power, 2003a; Moore and Brown, 2003, as summarized by staff)

Park	Ownership	Reservoir	State	Camping	Picnic Area	Potable Water	Toilets	Showers	Electricity	Dump Stations	Boat Ramp	Location (RM)
Eagle Bar	Forest Service	Hells Canyon	ID	Yes (informal)	No	No	No	No	No	No	Yes (unimproved)	249.5
Black Point overlook	Forest Service	Hells Canyon	ID	No	No	No	No	No	No	No	No	252.7
Big Bar	Forest Service	Hells Canyon	ID	Yes (informal)	No	No	Yes	No	No	No	Yes (unimproved)	256.2
Eckels Creek	Forest Service	Hells Canyon	ID	Yes (informal)	No	No	No	No	No	No	No	256.8
Copper Creek (Hells Canyon Trailhead)	BLM	Hells Canyon	OR	Yes (informal)	No	No	Yes	No	No	No	No	260.3
Hells Canyon Park[a]	Idaho Power	Hells Canyon	ID	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	264
Bob Creek	BLM	Hells Canyon	OR	Yes (informal)	No	No	Yes	No	No	No	Yes (unimproved)	265.9
Airstrip A	Owned and managed by BLM	Hells Canyon	OR	Yes (informal)	Yes	No	Yes	No	No	No	Yes (unimproved)	
Airstrip B	Idaho Power	Hells Canyon	OR	Yes (informal)	Yes	No	Yes	No	No	No	Yes (unimproved)	265.9
Westfall	BLM	Hells Canyon	OR	Yes (informal)	Yes	No	Yes	No	No	No	Yes (unimproved)	267.3
Copperfield boat launch	Idaho Power	Hells Canyon	OR	No	No	No	Yes	No	No	No	Yes	269
Copperfield Park[a]	Idaho Power	Hells Canyon	OR	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	270
Oxbow boat launch	BLM (managed by Idaho Power)	Oxbow	OR	No	No	No	Yes	No	No	No	Yes	276

Park	Ownership	Reservoir	State	Camping	Picnic Area	Potable Water	Toilets	Showers	Electricity	Dump Stations	Boat Ramp	Location (RM)
Carters Landing	BLM (managed by Idaho Power)	Oxbow	OR	Yes	Yes	Yes	Yes	No	No	No	Yes (unimproved)	281
Old Carters Landing	Idaho Power	Oxbow	OR	Yes (informal)	Yes	No	Yes	No	No	No	Yes (unimproved)	281,4
McCormick Park[a]	Idaho Power	Oxbow	ID	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	284
McCormick Overflow	Idaho Power	Oxbow	ID	Yes	No	No	Yes	No	No	No	Yes	284
Woodhead Park[a]	Idaho Power	Brownlee	ID	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	288
Hewitt and Holcomb Parks[1]	Baker County	Brownlee (Power River)	OR	Yes	Yes	Yes	Yes	No	Yes	No	Yes	7.5
Swedes Landing	BLM	Brownlee	OR	Yes (informal)	No	No	Yes	No	No	No	Yes (unimproved)	304
Hibbards Landing	Idaho Power	Brownlee	OR	Yes (informal)	No	No	Yes	No	No	No	Yes (unimproved)	318
Spring recreation site[a]	BLM	Brownlee	OR	Yes	Yes	Yes	Yes	No	No	No	Yes	327
Steck recreation site[a]	BLM	Brownlee	ID	Yes	Yes	Yes	Yes	No	No	Yes	Yes	327
Farewell Bend State Park[a]	State of Oregon	Brownlee	ID	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	334
Oasis	BLM	Brownlee		Yes (informal)	No	No	Yes	No	No	No	Yes	340

[a] Fully developed public recreational site, with numerous permanent facilities, daily management presence during primary recreational season, and user fees.

Undeveloped, dispersed, and informal recreational sites have no facilities but, nonetheless, show a clear indication of recreational use (Hall and Bird, 2003). Of the 123 such sites within the project boundary, 62 are at Brownlee reservoir, 29 are at Oxbow reservoir, and 41 are at Hells Canyon reservoir. In addition, Idaho Power identified 7 dispersed sites in the Hells Canyon dam tailwater area that are within the project boundary.

In general, undeveloped, dispersed, and informal recreational sites are user-created recreational areas, typically including access trails, boat-in and drive-in camping areas, and campfire rings. The average density of recreational areas across all three reservoirs is approximate 1 per 0.58 river mile, with a higher concentration of dispersed sites associated with roads and relatively level land, and a lower concentration of dispersed sites in large roadless areas. Although generally minor, most of the dispersed sites show some deterioration or resource damage associated with recreational use (e.g., damage to trees, presence of waste or litter, evidence of campfires, erosion, and damage to shoreline vegetation cover [table 78]).

Table 78. Descriptive statistics of dispersed, undeveloped, and informal recreational sites within the project boundary. (Source: Hall and Bird, 2003, as modified by staff)

Description	Statistic
Total number of sites	139[a]
Total number of used areas	341
Total number of usable areas	470
Average number of used areas per site	2-3
Percent of usable areas touching shoreline	43
Percent of sites with boat access	94
Average density of sites	1 site per 0.58 RM
Percent of sites with observable human waste	58
Percent of sites with observable livestock waste	54
Percent of sites with observable litter	99.9
Percent of sites with fire rings	73

[a] Idaho Power included all recreational sites except the eight fully developed sites within its inventory of dispersed sites. We consider 16 of the dispersed sites with some level of development and management (such as Eagle Bar and Big Bar) as semi-formal sites and include them in table 77. As such, we estimate that there are 123 dispersed sites within the project boundary.

3.10.1.3 Recreational Use within the Project Boundary

Recreational use in the project varies by year and season. During Idaho Power's pre-filing study period (1994–1998 and May 1 through October 31, 2000), Idaho Power found a declining use trend in total annual recreation days (table 79). Total annual recreation days dropped from a high of 484,612 recreation days in 1994 to 204,526 in 1997, a decline of 58 percent. From 1997 to 2000, warm-season recreational use increased slightly from 167,478 to 173,008 recreation days. We discuss the possible reasons for this decline in use, including low water levels and changes in the crappie population, below under *Recreational Trends.*

Table 79. Total annual recreation days by development and season. (Source: Idaho Power, 2003a, as modified by staff)

Reservoir	Season	1994	1995	1996	1997	1998	2000
Brownlee	Warm-season	223,139	162,356	137,397	106,643	93,733	102,665
	Winter	86,440	29,874	12,419	26,095	--	--
Oxbow	Warm-season	22,755	18,362	25,417	18,620	16,160	20,385
	Winter	8,734	4,382	5,171	3,015	--	--
Hells Canyon	Warm-season	118,250	94,525	60,500	42,215	38,605	49,958
	Winter	25,294	17,551	8,545	7,938	--	--
Total		484,612	327,050	249,449	204,526	148,498	173,008

Note: -- – not reported by Idaho Power

Approximately 60 percent of total use within the project boundary occurs during warm-season months (May through September) at Brownlee reservoir, a percentage that has remained relatively constant over Idaho Power's study period, despite a significant decrease in total recreational use. During the study period, there appears to have been a relative increase in use at Oxbow reservoir and commensurate decrease in use at Hells Canyon reservoir (table 80).

Table 80. Percent of warm-season recreation days by development. (Source: Idaho Power, 2003a, as modified by staff)

	1994 (%)	1995 (%)	1996 (%)	1997 (%)	1998 (%)	2000 (%)
Brownlee	61.3	59.0	61.5	63.7	63.1	59.3
Oxbow	6.2	6.7	11.4	11.1	10.9	11.8
Hells Canyon	32.4	34.3	27.1	25.2	26.0	28.9

Idaho Power also reported recreational use data for the project in hours of use by zone,[99] a metric that is more sensitive to identifying recreational use patterns than the common metric of recreation days (Idaho Power, 2003a, section E5.2.1.2). The decline in recreational use was primarily associated with Zone 2, which includes most of the developed recreational sites at Brownlee, Oxbow, and Hells Canyon reservoirs, and Zone 4, which includes the recreational sites on the Powder River (figure 116). Recreational use of Zone 2 declined from a high of more than 703,000 hours in 1994 to a low of 115,000 hours in 1996 and rebounded to about 594,000 in 2000. In contrast, recreational use of the Powder River

[99] Because of the size of the project and the variation in topography, access, type of use, and ownership of adjacent lands within the Hells Canyon Project, Idaho Power divided the complex into six management zones as follows: Zone1 from Hells Canyon Visitors Center (RM 247) to Copper Creek (RM 260); Zone 2 from the upstream end of Zone 1 to the south side of the mouth of Brownlee Creek on Brownlee reservoir (RM 288.4); Zone 3 from the upstream end of Zone 2 to Swedes Landing (RM 303.7); Zone 4 is the Powder River arm from the Snake River (RM 0) upstream to the upper end of the reservoir pool (RM 9); Zone 5 from the upstream end of Zone 3 (RM 303.7) to the Burnt River (RM 328); and Zone 6 from the upstream end of Zone5 upstream to the transmission line crossing of Brownlee reservoir just upstream of Porter Island (RM 343). Zone 2 includes both the largest area and the primary recreational sites on Brownlee, Oxbow, and Hells Canyon reservoirs.

arm declined from a high of 413,000 hours in 1994 to less than 100,000 hours by 2000. Recreational use in the other zones remained fairly constant throughout this period.

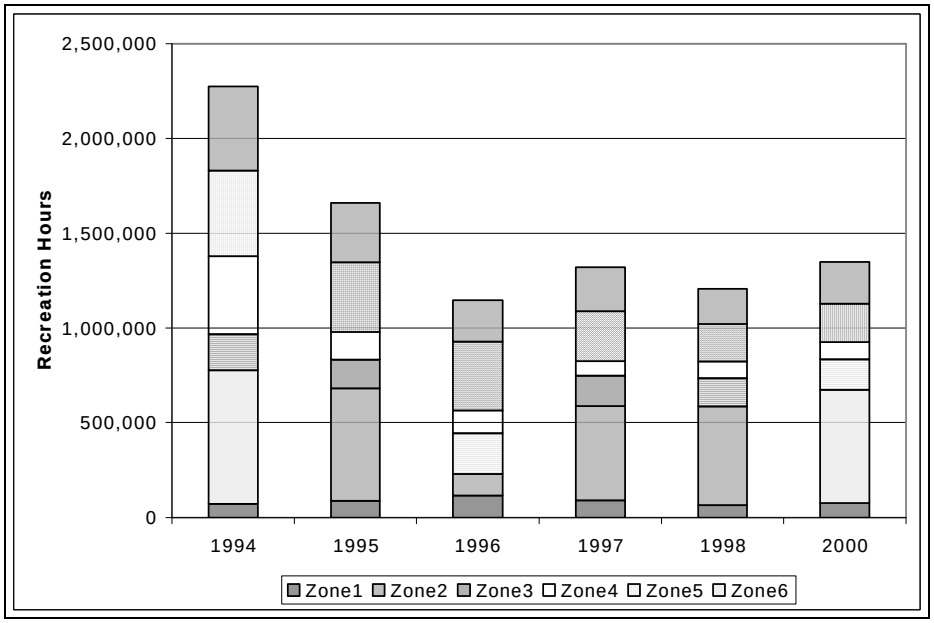

Figure 116. Hours of recreational use by year and zone. (Source: Idaho Power, 2003a, as modified by staff).

Idaho Power found that recreational use decreased over the study period at all developed sites on Brownlee reservoir except at Woodhead Park (Idaho Power, 2003a, section E.5.2.2.2). Woodhead has a number of attributes that may explain this trend: (1) it is one of the largest parks in the project and provides a wide variety of recreational opportunities, (2) it is near all three project reservoirs, providing a convenient location from which to base daytrips to different areas within the project; and (3) it is one of a few sites on Brownlee reservoir with boat ramps of sufficient length to access the water during deep drawdown of the reservoir.

Idaho Power found that more than 75 percent of visitors to the project stay overnight at the developed parks (Idaho Power, 2003a, section E.5.2.2.2). Although the majority of visitors to the Hells Canyon tailrace are reported as day users, Idaho Power indicates that these users could be boaters entering the HCNRA or project visitors staying in other parts of the project.

Despite the recent decline in recreational use of the project area, Idaho Power anticipates substantial future growth in recreational use. Although not quantified, Idaho Power bases its assumption of increased use on anticipated population growth of neighboring and regional counties; nation-wide changes in preference for certain types of recreational use, with anticipated growth in camping, hiking, and water-related activities; and proposed improvements to the project recreational facilities. In addition, Idaho Power points out that if the crappie population rebounds as a result of low water years, it is likely that the project would experience another recreational use bubble related to angling success (see section 3.10.2.1 for more information about the relationship between the crappie fishery and recreational use trends).

Site Capacity

Idaho Power studied the ability of the public recreational sites to meet demand by estimating capacity and use for tent and RV services at the eight formal sites. During the May through September warm season, the average use at all sites is well below the total capacity (table 81). For the most part, site

Table 81. Physical capacity of project sites developed for RVs and tents. (Source: Moore and Brown, 2003, as summarized by staff)

			RV (weekday/weekend)			Tent (weekday/weekend)		
Park	**Ownership**	**Reservoir**	**Capacity**	**Mean Use**	**Max. Use**	**Capacity**	**Mean Use**	**Max. Use**
Hells Canyon Park	Idaho Power	Hells Canyon	24	8.3/10	24/40	15	5.1/8.4	55/60
Copperfield Park	Idaho Power	Hells Canyon	62	24.2/25.3	60/50	10	6.3/9.2	24/39
McCormick Park	Idaho Power	Oxbow	34	6.7/7.9	39/26	8	3.4/4.8	19/26
Woodhead Park	Idaho Power	Brownlee	124	19.2/32.5	94/91	15	5.18/12.3	40/64
Hewitt and Holcomb Parks	Baker County	Brownlee (Powder River)	35	5.2/4.7	21/27	15	1.3/1.8	20/16
Spring recreation site	BLM	Brownlee	34	3.6/4.7	14/19	10	0.8/1.5	5/12
Steck recreation site	BLM	Brownlee	45	3.2/6.4	19/36	5	1.6/4.7	11/23
Farewell Bend State Park	State of Oregon	Brownlee	138	20.9/29.6	71/93	4	5.7/14.1	33/83
Idaho Power developments	Idaho Power	HCC	244	58.4/75.7	155/147	48	19.3/34.7	80/159
Non-Idaho Power developments	Other	HCC	252	24.5/36.2	156/42	34	5.3/14.3	42/112

Notes: BLM – Bureau of Land Management
HCC – Hells Canyon Complex

capacity for RVs is rarely met, even during peak-use periods, and average weekend demand is generally well within site capacity. In contrast, demand for tenting facilities during peak-use days exceeds capacity at all of the eight developed sites, with use often exceeding capacity by several hundred percent. Average use of tenting facilities on weekends is generally near capacity at most sites.

Nonetheless, despite the appearance that some of the developed recreational sites may reach capacity during peak-use periods, survey results suggest that capacity concerns are not displacing visitors to the informal sites (Whittaker and Shelby, 2003a). Results from Idaho Power's year 2000 mail survey indicate that less than 0.05 percent of all respondents reported being displaced to other sites as a result of full parks.

3.10.1.4 Recreational Activities

The project provides a wide variety of recreational opportunities. However, as observed by Idaho Power, most visitors come to the project for angling and other water-based activities (figure 117). Together, lounging (primarily associated with relaxing along the project shoreline), boat angling, and bank angling make up approximately 80 percent of warm-season recreational use. Although cold-season recreational use represents only about 30 percent of total recreational use, these same three activities account for nearly 80 percent of cold-season use. Other important warm-season recreational activities include hiking, power boating, picnicking, and water skiing,

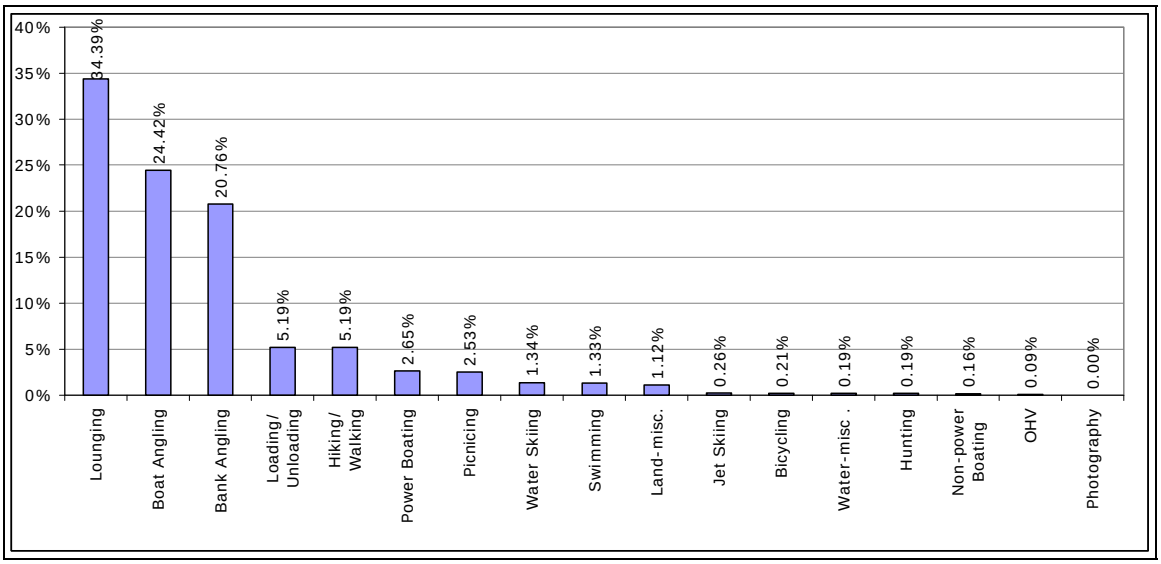

Figure 117. Average percentage of total warm-season hours of recreational use by activity. (Source: Idaho Power, 2003a, as modified by staff)

The decline in recreational use described in the previous section can be seen in the hours of use by activity data. The three primary recreational activities within the project boundary decreased by about 38 percent from 1994 through 2000, with the majority of the decrease associated with boat and bank angling; lounging declined slightly over the same period (figure 118).

In interviews, visitors listed angling as the primary activity and reason for their visit to the project, with approximately three-quarters of all visitors listing fishing among their primary activities, and about 70 percent of visitors listing fishing as their main focus (Whittaker and Shelby, 2003b). Results from the year 2000 mail survey indicate that while most visitors focus on fishing, many visitors do more than just fish; they camp, sightsee, view wildlife, and swim.

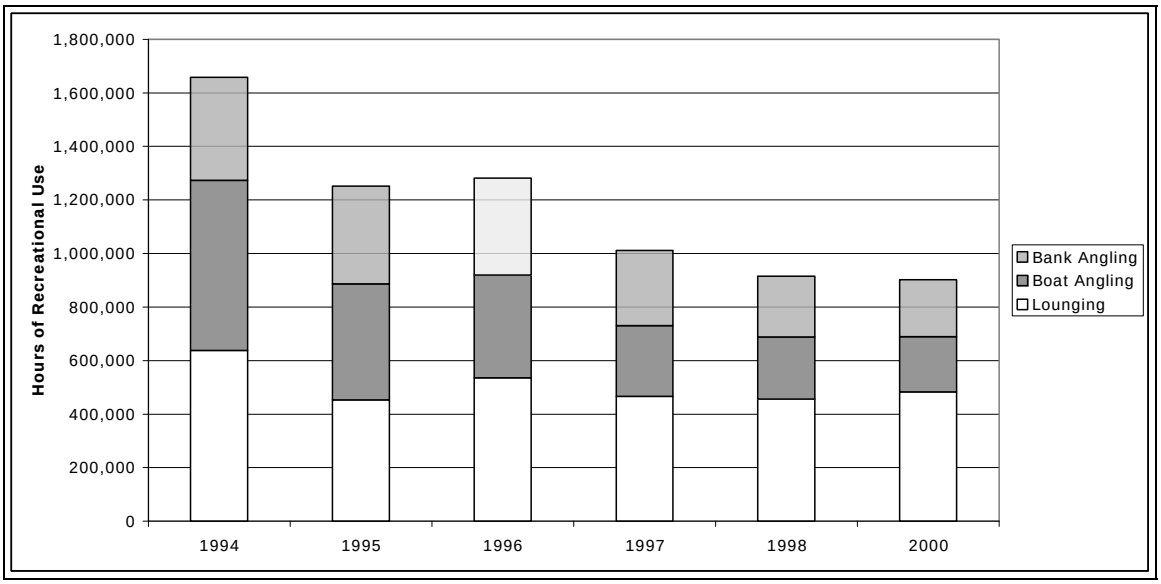

Figure 118. Total hours of warm-season recreational use by primary activity. (Source: Idaho Power, 2003a, as modified by staff)

Recreational activities differ slightly between the reservoirs. Hells Canyon reservoir users were less likely to report fishing as a primary activity than were users at the other reservoirs and a higher percentage of Oxbow reservoir visitors reported fishing as one of their three primary activities.

3.10.1.5 Recreational Visitor Concerns

As part of the onsite interviews and year 2000 mail survey, Idaho Power collected more than 23,000 comments from visitors about their recreational experiences. The questions in the survey were open-ended and the results do not provide a statistically meaningful representation all visitors' attitudes toward project-related issues. In addition, visitor concerns or criticisms of project-related recreational characteristics represent less than 10 percent of all comments received. Nonetheless, the results provide some insight into visitor perceptions of recreational needs at the project. Overall, the majority of all specific comments focused on the level of facility development (28 percent), water levels (14 percent), facility and site maintenance (10 percent), angling (7 percent), and access (6 percent) (table 82).

Table 82. Percentage of comments by major category and reservoir. (Source: Idaho Power, 2003a)

Category	Hells Canyon Tailwater (%)	Hells Canyon Reservoir (%)	Oxbow Tailwater (%)	Oxbow Reservoir (%)	Brownlee Reservoir (%)	All Areas (%)
General Positive	34	28	33	23	19	23
General Negative	4	3	1	2	2	3
Facility Development (Positive)	20	16	14	16	14	15
Facility Development (Negative)	9	17	16	17	10	13
Maintenance (Positive)	10	10	4	7	6	7
Maintenance (Negative)	1	4	1	3	3	3

Category	Hells Canyon Tailwater (%)	Hells Canyon Reservoir (%)	Oxbow Tailwater (%)	Oxbow Reservoir (%)	Brownlee Reservoir (%)	All Areas (%)
Angling (Positive)	1	1	2	2	2	2
Angling (Negative)	2	3	6	4	7	5
Water Levels (Positive)	<1	<1	1	<1	1	1
Water Levels (Negative)	7	4	7	7	20	13
Access (Positive)	1	1	0	0	1	1
Access (Negative)	3	4	4	4	6	5
Visitor Impacts (Litter/Interaction)	3	3	5	3	3	3
Fees	<1	3	<1	5	2	3
Angling Regulations	<1	1	1	2	1	1
Enforcement/regulations	1	2	2	1	1	<1
Commercial Services	1	<1	<1	1	1	1
Hunting	0	<1	0	<1	<1	<1
Agency Evaluations	2	1	0	1	1	1
Total	100	100	100	100	100	100

The majority of comments related to facility development were positive, and negative comments were generally site-specific. The most common facility complaints were associated with a shortage of restrooms (9 percent), shortage of facilities in general (8 percent), and interest in electric or water hookups (4 percent). Findings suggest that there are, or have been, toilet facility problems at Oxbow dam tailrace area and along Hells Canyon reservoir and that many Brownlee reservoir users are interested in more shade.

Reservoir fluctuations appear to be an area of concern for recreational visitors to the project. Approximately 13 percent of all visitors complained about reservoir levels, with the majority of concern expressed about Brownlee reservoir elevations (approximately 20 percent of all comments at Brownlee concerned reservoir fluctuations). At Brownlee reservoir, the most common subcategories of reservoir elevations were "stop fluctuations," specific criticism of low levels, biological issues, and general criticism of levels. Because Brownlee reservoir does not fluctuate significantly each day, Idaho Power indicates that the "stop fluctuation" comments might refer to criticisms of seasonal changes. Less often mentioned comments for Brownlee reservoir were water quality criticisms, the need for more information about levels, and the need to "remove the dams." Specific reservoir level comments at Brownlee reservoir focus on a wide variety of issues, including effects on fishing, use of boat ramps, access to parts of the reservoirs, and the aesthetics of a reservoir drawdown.

The most often mentioned subcategories for reservoir fluctuations at Hells Canyon and Oxbow reservoirs were "stop fluctuations," biological issues, and specific criticisms of low levels. Most of the biological issues focused on effects on fish and fishing. The less often mentioned comments for Hells Canyon and Oxbow reservoirs were the need for more information about levels, general criticisms, water quality criticisms, and the need to "remove the dams." Idaho Power points out that blue-green algae blooms are a common occurrence on project reservoirs in some summers and states that the blooms could be responsible for many of the water quality comments.

3.10.1.6 Boating Use Downstream of the Project

Boaters typically access the HCNRA and register for use of the Snake River downstream of the project at four entry portals, including Cash Creek Ranch, Dug Bar, Pittsburg Landing, and Hells Canyon Creek (Brown, 2003c). Recreational use of the HCNRA typically does not start or finish within the project; however, both private and commercial boaters that use the Hells Canyon Creek portal must pass through the project on project roads along Hells Canyon reservoir, cross Hells Canyon dam, and launch at the Forest Service-managed Visitors Center approximately 1 mile north of the Hells Canyon dam and just outside of the project boundary.

Of the four portals, Cache Creek Ranch consistently registered the most boaters during the study period, varying from a low of 27,842 in 1996 to a high of 30,205 in 1999. The Hells Canyon Creek portal was the second most heavily used access point. During the study period, Idaho Power found that access through the site varied considerably, from a low of 10,714 in 1997 (the highest flow year on record) to a high of 20,369 in 1995 (figure 119). Although boater counts at Pittsburg Landing remained relatively consistent (from a low of 2,234 in 1996 to a high of 2,844 in 1994), they were much lower than those at Cache Creek and Hells Canyon Creek. Dug Bar portal had very few boaters registering each year, varying from 4 in 1996 to a high of 74 in 1999.

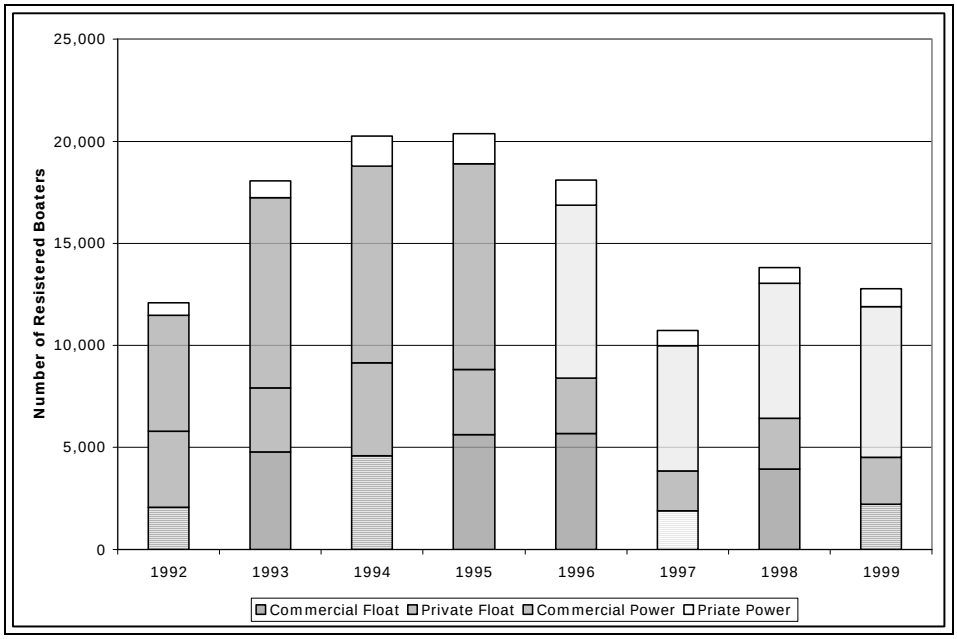

Figure 119. Annual number of boaters by status (commercial or private) and type (float or power) registered as entering the HCNRA through Hells Canyon Creek portal (from Forest Service boater registration database). (Source: Brown, 2003d)

Idaho Power found that most commercial power boaters visit the HCNRA as part of sightseeing tours in boats with capacities of up to 40 people (Brown, 2003d). In comments on the draft EIS, NPPVA states that the larger commercial power vessels are certified to carry 50 to 60 passengers (letter from Alan Odergaard, President, Northwest Professional Power Vessel Association, to the Commission, filed October 31, 2006). Sightseeing tours are typically day trips that stop at historic and cultural sites along the river. A smaller percentage of this group uses commercial outfitters to stage angling or hunting trips. An even smaller number of commercial powerboat customers "drop camp," using the outfitter to transport the group and equipment to campsites in the HCNRA.

Private power boaters consist of both day and overnight users. Private power boaters have the flexibility to travel throughout the HCNRA. Depending on boat size and operator expertise, three large rapids in the upper canyon (Wild Sheep, Granite, and Rush Creek) limit many private power boaters to areas either above or below this stretch. These users participate in a broad range of outdoor activities in the HCNRA, including angling, hunting, camping, hiking, sightseeing, and pleasure boating.

A large majority of commercial float boaters access the river through Hells Canyon Creek portal and stay overnight while floating the river. Some outfitters offer day trips where customers float downstream for all or a portion of a day and are transported back upstream by powerboat. Many commercial float boaters also participate in angling, hiking, swimming, picnicking, and sightseeing while on these trips.

Private float boaters typically access the river through Hells Canyon Creek portal and more than 90 percent of these visitors stay overnight. Generally, private float boaters participate in activities similar to those of commercial float boaters.

Flows

Idaho Power found that releases from the project into the Snake River downstream and outside of the project boundary affect recreational use in the HCNRA in two primary ways (Shelby et. al., 2002). First, different flow levels support specific types of recreational activities and influence the amount, type, and location of recreation use. Second, daily fluctuations can interfere with certain activities and affect the quality of recreational experiences that occur in the HCNRA.

Flow Levels

Idaho Power found that different types of boating opportunities are provided in different parts of the hydrograph (Brown, 2003d). Flows over 30,000 cfs provide challenging trips, of interest primarily to a small number of highly skilled float boaters. Flows between 10,000 and 30,000 cfs provide less challenging trips that are used by both private and commercial power and float boaters. Within that range, float boaters prefer slightly higher flows than those preferred by power boaters. Below about 10,000 cfs, boating trips tend to be more technical for both types of craft.

Overall navigability through the HCNRA tends to be limited by low flows through Granite Creek and Wild Sheep rapids in the upper canyon, particularly for larger powerboats. While the overall whitewater challenge drops at low flows for float boaters, these rapids are still navigable at 5,000 cfs, the lowest flow under current project operations. Experienced powerboat operators are known to take boats about 24 feet long through these rapids at flows as low as 5,500 cfs, and boats up to 40 feet long[100] at flows as low as 6,500 cfs. However, interviews with commercial powerboat operators suggest that the larger boats require flows higher than 7,500 cfs for upstream navigation when fully loaded, and flows between 8,000 or 9,000 cfs for safe downstream navigation when fully loaded. Idaho Power concluded that, depending on the type and size of craft, the minimum navigable flows are between 5,000 and 9,000 cfs and maximum navigable flows range from 30,000 cfs for power boaters to 50,000 cfs for float boaters.

Flow Fluctuations

Idaho Power found that visitor concerns about daily fluctuation of flows appear to be more important than flow changes throughout the year or absolute flow levels for the different types of recreational use in the HCNRA (Shelby et al., 2002). Under current project operations, daily fluctuations can exceed 9,000 cfs in late June, July, August, and the first half of September. In an average water year, the largest daily fluctuations (between about 5,000 to 10,000 cfs) occur during two distinct periods:

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[100] The Forest Service permits powerboats up to 40 feet long in the HCNRA.

(1) winter months before spring runoff, typically December through February, and (2) the midsummer months, after runoff but before stable salmon spawning flows occur in early October. During high runoff periods, typically March through June, fluctuations are smaller because generators are often near capacity and dams are passing spill flows. During periods of low reservoir inflows in late summer, higher fluctuations are also rare because they would compromise the provision of average minimum navigation flows of about 7,000 to 7,500 cfs.

A majority of experienced boaters report that these daily flow fluctuations adversely affect trips in a number of ways, including access to camping areas, beaches, and fishing areas; the use of sites and facilities; trip schedules; and the quality of fishing (table 83). Idaho Power found few substantial differences in fluctuation-related problems encountered between float boaters and power boaters, although slightly more float boaters report access problems (particularly access to camping sites and beaches), as well as problems with the use of sites (particularly the ease of walking along the bank), than power boaters. In contrast, more power boaters reported having to wake up at night to move boats as the water level rises or drops or stay with boats during day stops to avoid having boats stranded during a rapid drop in the water level.

Table 83. Snake River fluctuation-related problems experienced by boaters. (Source: Shelby et. al., 2002).

Float Boaters			Power Boaters		
Comment	**Reported Problems (%)**	**Major Problems (%)**	**Comment**	**Reported Problems (%)**	**Major Problems (%)**
The way they have to tie up boats	97	68	Having to wake up at night to move/check boats	100	70
Where they set up camps	98	53	Effects on steelhead fishing	93	73
Access to camps	94	54	The way they have to tie up boats	93	61
Access to beaches	93	51	Where they set up camps	86	40
Overall fishing quality	89	45	Effects on overall fishing quality	92	55
Having to abandon camps	81	46	Having to stay with boats at stops	81	43

Flow Information

Numerous sources provide Snake River flow information (table 84). Most of these sources include historical and near real-time flow information for gages within the HCNRA. Although real-time and historical information is useful and readily available, Idaho Power found a strong interest by experienced boaters in obtaining daily flow forecasts for the upcoming day or week in order to assist boaters in planning trips (Shelby et. al., 2002).

Table 84. Typical source of flow information for boaters who checked flows before their trip (% using various sources). (Source: Shelby et. al., 2002)

Source of Flow Information	Private Float Boaters	Commercial Float Passengers	Private Power Boaters	Commercial Powerboat Passengers
Idaho Power Phone Line	14	1	16	5

Source of Flow Information	Private Float Boaters	Commercial Float Passengers	Private Power Boaters	Commercial Powerboat Passengers
Idaho Power Internet Site	17	2	7	1
USGS Internet Site	21	3	8	2
Forest Service Phone Line	13	3	4	1
Idaho Water Resources phone line	7	1	3	0.5
Idaho Water Resources Internet Site	14	1	6	0.5
Other (guides, newspaper, Idaho Power staff, other Internet sites, friends, previous experience)	17	18	11	6

3.10.2 Environmental Effects

3.10.2.1 Effects of Project Operations on Recreation Resources

We describe Idaho Power's Proposed Operations in section 2.2.2, *Proposed Project Operations*, and we assess the effects of the proposed operation on reservoir levels and project outflows in section 3.3.2, *Effects of Project Operations on Water Quantity*. In section 3.3.2.2, we identify operation-related recommendations filed by agencies, tribes, and other parties (table 9), and we describe three alternative operational scenarios that we use to assess the effects of the various operation-related recommendations. At our request (AIR OP-1), Idaho Power simulated project operations for these representative scenarios under various hydrologic conditions. Refer to section 3.3.2.2 for additional discussion of the scenarios and the modeling process used for the simulations. We use the results of these simulations to assess the effects of the operation-related recommendations.

In the following sections, we evaluate the effects of Idaho Power's Proposed Operations and of operation-related recommendations received from agencies, tribes and other parties on the following resources: (1) flat-water boating and reservoir access; (2) recreational trends; (3) navigation downstream of Hells Canyon dam; and (4) boating and access downstream of Hells Canyon dam.

Flat-water Boating and Reservoir Access

Flat-water boating use of Brownlee reservoir is affected by seasonal drawdown of the reservoir. As the reservoir drops, the navigable surface area is reduced and some boating ramps become dewatered. Also, when the reservoir is low, the upstream end of the reservoir becomes very shallow, with channels cut by inflow through silt deposits in the lakebed, which can affect navigability.

Our Analysis

Existing conditions and Proposed Operations entail substantial spring and early summer drawdown of Brownlee reservoir to meet flood control requirements and substantial late summer and fall drawdown to meet minimum flow requirements for the Fall Chinook Salmon Recovery Plan downstream of Hells Canyon dam (see section 2.1.2, *Current Project Operations*). Years with high inflow amplify both the timing and magnitude of the drawdown, with full pool elevation reached for a short period during the primary recreational season and deeper drawdown to meet winter storage requirements.

As Brownlee reservoir drops from full pool (2,077-foot contour), recreational opportunities, including navigable surface area, and public access are reduced starting in the upstream end of the reservoir and the Powder River arm. When the reservoir is drawn down about 15 feet below full pool (2,062-foot contour), Cobb Rapids can be exposed, creating a wide cobble riffle that is difficult to

navigate in powerboats. Starting just north of Spring recreation site, about 10 miles of substantial sediment deposits are normally under water. When the reservoir level drops to about 40 or 50 feet below full pool (2,037-foot contour), sediment deposits in the upper 10 miles of the reservoir are exposed and currents begin to cut channels through them. At levels 60 to 70 feet below full pool (2,017-foot contour), these channels present steep-sided walls that rise well above the water surface, limiting public access to the shoreline. At its lowest drawdown of 101 feet[101] (1,076-foot contour), the surface area of the reservoir is about half of the full pool area.

Under existing conditions and Proposed Operations, drawdown of Brownlee reservoir dewaters many of the primary public access boat ramps (table 85). Idaho Power found that from 1994 through September 2001, reservoir levels were within 30 feet of full pool about 74 percent of the days and within 40 feet of full pool about 86 percent of the days. However, the timing of lower reservoir levels exacerbates the problem of public access to the reservoir. In general, flood control and minimum fish flows considerations require that Brownlee be drawn down in April and May and again in mid-July through October. These are prime parts of the reservoir recreation season and Idaho Power found that the lower reservoir levels displace users from some ramps (Idaho, Power, 2003a, section E.5.2.2.2).

Table 85. Elevation of the toe of boat ramps at Brownlee reservoir parks compared to full pool elevation. (Source: Whittaker et. al., 2002).

Park	Elevation of Ramp's Toe	Feet Below Full Pool
Farewell Bend State Park	2,051	−26
Steck Park Ramp	2,062	−15
Steck Park North Ramp	2,040	−37
Spring Recreation Park	2,045	−32
Hewitt Park	2,041	−36
Woodhead Park	2,025	−52
Woodhead Park (gravel launch)	1,976	−101

Compared to existing operations and Proposed Operations, any operations scenario would adversely affect boating access and navigability on Brownlee reservoir if it increased the magnitude of the drawdown, increased the duration of the drawdown, and/or increased the amount of time the reservoir is below full pool during peak use summer months.

Scenario 1 (Reregulating) would not generate any noticeable changes in Brownlee reservoir management compared to existing conditions and Proposed Operations, and there would be no change in flat-water boating at Brownlee reservoir.

Scenario 2 (Flow Augmentation) would have the most substantial adverse effects on flat-water boating opportunities. In all hydrologic year types, the Flow Augmentation Scenario would result in an earlier and more rapid drafting of Brownlee reservoir and in some water years, full pool would not be reached at all during summer months.

Under Scenario 3 (Navigation), flat-water boating opportunities would generally be consistent with existing operations and Proposed Operations, except during low and extremely low water conditions. When inflow is low, Brownlee would be drafted relatively early during spring months to meet navigational flow requirements downstream of Hells Canyon dam, and there would be insufficient inflow

[101] The largest drawdown of Brownlee reservoir since 1994 was 101 feet and is the maximum permissible drawdown under the current license.

to raise Brownlee reservoir back up to full pool. Under this scenario, the navigable surface area of the reservoir would be reduced during most of the primary recreational season.

Recreational Trends Based on Crappie Population Changes

In the early 1990s, the project experienced a significant rise and subsequent decline in recreational use that, by all accounts, appears to stem from a commensurate rise and decline in the crappie population in Brownlee reservoir. During visitor surveys conducted by Idaho Power, some anglers associated the decline in the crappie population with project operations, specifically the mid- to late-summer drawdown of Brownlee reservoir to meet minimum flows for the fall anadromous fish runs.

Our Analysis

Idaho Power reports that creel studies and anecdotal information show that a substantial increase and subsequent decline of the crappie population in Brownlee reservoir began in the late 1980s and extended through 1994 (Brown, 2003a). IDFG and ODFW conducted a creel study at Brownlee reservoir in 1989 and estimated crappie populations at a much higher level than Idaho Power found during its resident fish study (Brown, 2003a). Idaho Power states that the relative boom of the crappie population could have been the result of a series of drought years that allowed juvenile crappie to accumulate rather than be flushed through the project by high flows.

Peak recreational use in the early 1990s at Brownlee reservoir appears to be associated with the beginning of the decline in the crappie population. During the 1994 field season, Idaho Power observed recreational visitors with large crappie catches, some with thousands of crappie fillets packed into freezers retrofitted into motor homes for the primary purpose of handling the catch. By 1995, the crappie fishery was in decline and recreational demand at the project facilities was starting to drop.

Under Proposed Operations, the crappie population would be expected to follow similar patterns of population growth and decline associated with the water year. During extended periods of drought, when Brownlee is held at near full pool through spring and summer months and there is little inflow, it is likely that spawning nests would be preserved because more stable reservoir levels and lower inflow would wash fewer juvenile crappie through the reservoir. As shown in the early 1990s, there is significant recreational demand for crappie angling; a spike in recreational use would likely follow any spike in the crappie population.

Scenario 1 (Reregulating) would not generate any noticeable changes in Brownlee reservoir management compared to existing conditions and Proposed Operations and would not change the crappie population and recreational use trends at Brownlee reservoir.

Scenario 2 (Flow Augmentation) would have the most substantial adverse effects on crappie fishing opportunities. In all hydrologic year types, the Flow Augmentation Scenario would result in an earlier and more rapid drafting of Brownlee reservoir, which would result in difficult spawning conditions and a relatively narrow channel with relatively rapid currents that would be more likely to flush juvenile fish through the project than under existing conditions and Proposed Operations.

Under Scenario 3 (Navigation), crappie fishing opportunities would generally be consistent with existing operations and Proposed Operations except during low and extremely low water conditions. When inflow is low, Brownlee would be drafted relatively early in the spring to meet navigational flow requirements, and there would be insufficient inflow to raise Brownlee reservoir back up to full pool. Currently and under Proposed Operations, when inflow is low or drought conditions exist, Brownlee is held near full pool and the crappie population is likely to increase. However, under similar low inflow conditions, the Navigation Scenario would result in a lower pool elevation in Brownlee reservoir, which would reduce spawning opportunities and increase relative currents through the reservoir with a commensurate reduction in the crappie population.

Navigation Downstream of Hells Canyon Dam

Safe navigation of the Snake River downstream of Hells Canyon dam requires minimum flows sufficient to effectively cover rocks and create navigable channels through important rapids. Historically the Corps has supported 6,500 cfs as the minimum navigable flow for the river. As part of this relicensing, however, and based on an assessment of boating accidents in the canyon at flows below 8,500 cfs, the Corps now recommends that minimum navigable flows are 8,500 cfs downstream of Hells Canyon dam and 11,500 cfs downstream of the mouth of the Salmon River. In their comments on the draft EIS, many parties, including the Corps, the Forest Service, NPPVA, local Chambers of Commerce, and others, indicated their concern for safety and their support for an 8,500-cfs minimum navigation flow.

Our Analysis

Operational scenarios that maintain the Corps-recommended minimum flows for the longest duration would benefit navigation. Flows under Proposed Operations would routinely fall below the 8,500-cfs navigation target at the Hells Canyon dam gage in most water years and would routinely fall below 11,000 cfs downstream of the Salmon River confluence in low water years.

The Navigation Scenario was derived primarily from the Corps recommendation (see measure Corps-3 on Table 9). The Corps has responsibility for protecting navigable waters and expertise in determining safe navigation requirements. The Commission gives serious consideration to the Corps' input in determining appropriate license conditions. Compared to Proposed Operations, the Navigation Scenario would provide substantial benefits for boating, particularly for the larger powerboats, by keeping flows at or above 8,500 cfs more of the time. During low water years, both the total number of days and the magnitude of flows below the minimum recommended flows would be substantially less than under Proposed Operations. In addition, this scenario would also provide boaters with the ability to predict flows when they drop below minimum levels, as outflow from Hells Canyon dam would equal Brownlee reservoir inflows based on the previous 3-day moving average. Providing a systematic approach to minimum flows would improve navigability downstream of Hells Canyon dam by giving predictability to low flows. Boaters could decide whether their specific boat would be capable of running the most difficult rapids in the HCNRA at the predicted flows and could schedule and plan their trips accordingly. Some of the predictability regarding low flows could also be obtained through better communication (see section 3.10.2.8 for our discussion of flow information and coordination.

The Corps compiled incident and accident data showing that flows of 8,500 cfs downstream of Hells Canyon dam and flows of 11,500 cfs below the Salmon River confluence significantly reduce accidents in the river (Corps, 2006). The Corps study indicates that historically, boating accidents are correlated with releases of 7,500 cfs or less, with accidents causing boat sinking as well as lacerations and broken bones. As further evidence of its assessment, the Corps indicates that there were no reported accidents resulting from low flows in 2004 and 2005 when Idaho Power implemented an 8,500-cfs minimum flow.

As discussed in section 3.10.1.6, *Boating Use Downstream of the Project*, float boaters can navigate key rapids at flows as low as 5,000 cfs, while larger (40-foot) power boats, when fully loaded, require flows in the 8,500-cfs range. To provide clearance over rocks for all vessels, and a margin of safety during passage through critical rapids, the Corps' recommended minimum flow of 8,500 cfs appears to enhance navigation and provide a greater margin of safety than Idaho Power's proposed minimum flow of 6,500 cfs, particularly for larger boats.

The Corps assessment focused on minimum flows, which are only one aspect of many that affect safe boating. Other factors include operator skill and experience, boat characteristics, navigational markings, and other environmental factors, none of which were controlled for in the Corps assessment of minimum flows. The data show that accidents occur for a wide variety of watercraft at various flows, although many of the powerboat accidents are associated with lower flows. Given the many factors that

influence boat-related accidents, it may be possible to develop other programs, such as navigational markings, channel modification, and boater safety courses that would improve boater safety in the HCNRA.

In the draft EIS, we concluded that the Flow Augmentation Scenario would improve boating opportunities compared to Proposed Operations because flows would be greater during the month of July and minimum overnight flows would rise accordingly. While true of the 350-kaf flow augmentation scenario, this would be less true of the 237-kaf augmentation flow included in the Staff Alternative in the draft EIS. In comments on the draft EIS, Idaho Power provided the results of additional operational modeling for the 237-kaf flow augmentation regime. The incremental effect of adding the Corps' minimum flow recommendation to the 237-kaf flow augmentation regime would be to reduce the below-target days from 116 to 100 under extremely low water conditions, from 120 to 32 under medium-low water conditions, and from 40 to zero under medium water conditions. Thus, the Navigation Scenario would provide substantially more flows above 8,500 cfs than would be achieved with a 237-kaf flow augmentation regime, and would therefore provide a substantially better boating flow, especially for the larger boats.

As discussed in section 3.10.2.8, *Flow Information and Coordination Downstream of Hells Canyon Dam,* improved communication between Idaho Power and boaters in the HCNRA would help improve safety by providing boaters with sufficient information to allow them to more accurately assess their skills in the context of actual flows.

River Fluctuations and Campsite Access Downstream of Hells Canyon Dam

Daily river level fluctuations downstream of the project can affect access to camping sites. If river levels rise overnight, boats secured near the low water edge can float off moorings and be damaged by rubbing against rocks. Conversely, when flows drop overnight, large boats can get stranded above the waterline and boaters may have to wait for high water to launch boats.

Our Analysis

Experienced rafters and power boaters apply basic standard operating practices for extended boating trips on regulated rivers, such as the Snake River and the Colorado River. These practices include, among other things, protocols for anchoring boats overnight. Anchoring systems are typically designed to be flexible and easily adjusted to accommodate fluctuating river levels, including anchor and stay systems with ropes that can be extended or shortened as needed. Typically, at least one member of the party sleeps on each boat and wakes periodically overnight to adjust the rigging. Although good planning and camping protocols allow most groups to manage diurnal river stage changes, the quality of the river trip would generally improve, boaters' rigging systems could be less complex, and contingency planning for any stranding that may occur would be eased to the degree that river fluctuations are lessened. Under the Proposed Operation, there would be substantial flow fluctuations up to 10,000 cfs per day that would ebb and flood over shoreline areas. Boaters would have to follow standard protocol for safe and efficient camping along the river.

Similar to Proposed Operations, Scenario 3 (Navigation) would allow river flow fluctuations up to 10,000 cfs per day except when minimum navigation flows are reached. At these low flows, the Navigation Scenario would benefit the quality of the boating experience by reducing stage changes.

In contrast, Scenario 1 (Reregulating) and Scenario 2 (Flow Augmentation) would substantially reduce diurnal fluctuations. The stabilized flow regime under Scenario 1 would have the most benefits to boaters camping along the river by reducing the diurnal ebb and flood. The ramping rates would also minimize the hourly change in river levels, which would further improve public access to camping areas.

3.10.2.2 Recreation Plan

The Hells Canyon Project includes some of the most important recreational resources in the region, and acts as a gateway to the upstream end of the nationally significant Hells Canyon whitewater boating run. Public recreational facilities in the project are managed by a number of different organizations, including private companies, counties, and state and federal agencies. Early in the relicensing process, Idaho Power convened the Recreation and Aesthetics Resource Work Group (RARWG).[102] RARWG found that in general the quality of some existing recreational facilities associated with the project is good, with some sites showing deterioration as a result of insufficient capital investment, increased use, and deferred maintenance. RARWG also found that some new recreational facilities are needed to meet project-related demand (Whittaker and Shelby, 2003b). The primary recreational issues identified by RARWG include the need for expansion/revitalization of some existing park facilities, new recreational facilities in some areas, an improved information and education (I&E) program, an improved litter and sanitation program at dispersed sites, and measures to address unforeseen recreational needs over the term of any new license.

To address the recreational issues identified by the RARWG, Idaho Power proposes to implement a Recreation Plan for the project that includes the proposed recreational measures that we describe and analyze below in sections 3.10.2.3 through 3.10.2.10. In this section, we consider the merits of developing a Recreation Plan and the procedural framework necessary to support implementation of the proposed measures. In subsequent sections, we consider specific proposals and recommendations that would be included in the plan, as well as the proposed and recommended related plans (e.g., road management plan, visual resource plan, vegetation management plan).

Idaho Power's proposed Recreation Plan would be designed to achieve the following objectives: (1) promote public safety and increase public awareness of recreational opportunities by providing interpretive, informative, and educational panels and kiosks at developed recreational sites and by providing information through a web site and a toll-free telephone number; (2) promote reasonable health and safety standards through a Litter and Sanitation Plan (see section 3.10.2.4); (3) provide accurate and timely information about water flow and river fluctuations downstream of Hells Canyon dam via the web site, toll-free telephone number, and onsite flow monitors (see section 3.10.2.8); (4) provide accurate and timely information about water flow and reservoir fluctuations at Hells Canyon Project reservoirs via the web site and toll-free telephone number (see section 3.10.2.8); (5) provide safe and reasonable access to recreational areas (see section 3.10.2.3); (6) reduce congestion and conflict among visitors and resources related to recreational activities; (7) provide reasonable and amenable recreational facilities that provide for a range of recreational opportunities (see section 3.10.2.3); (7) reduce effects on cultural, terrestrial, and aquatic resources; (9) provide a forum for the coordination of resources between Idaho Power and law enforcement agencies (see section 3.10.2.9); and (10) provide opportunities to work cooperatively with agencies and other entities to provide adequate and reasonable recreational developments that incorporate desired future conditions (see section 3.10.2.9).

The Forest Service (FS-12) specifies that within 1 year of new license issuance, Idaho Power, in consultation with the Forest Service, would finalize the Hells Canyon Complex Comprehensive Recreation Management Plan (Recreation Plan) and file the plan with the Commission for approval. In addition to specific measures that we discuss below in sections 3.10.2.3 through 3.10.2.10, the recommended Recreation Plan would include an annual implementation schedule, consultation, and

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[102] RARWG consists of the Forest Service, BLM, National Park Service, Idaho Department of Parks and Recreation (IDRP), Idaho Department of Fish and Game, Oregon Department of Parks and Recreation, Oregon Department of Fish and Wildlife, Idaho Rivers United, Oregon State Marine Board, Baker and Wallowa counties (Oregon), and Washington and Adams counties (Idaho).

approval procedures. The Forest Service also specifies that the plan adequately address Forest Service resource concerns and standards of quality (e.g., Meaningful Measures) for the term of any new license.

Interior's modified condition no. 6 specifies that Idaho Power prepare a Comprehensive Recreation Management Plan (CRMP). Specific elements that are included in the CRMP that are not addressed elsewhere in this EIS include: (1) consulting with the recreation workgroup (RRWG); (2) using a decision making structure that involves the RRWG; (3) implementing provisions of the recreation mitigation package according to the Americans with Disabilities Act (ADA); and (4) establishing protocols for consultation with and approval by agencies. In its comments on the draft EIS, Interior indicates that the CRMP would identify, enhance, and sustain an appropriate range of recreation settings and experiences on lands for the public over the entire complex; identify recreation facility needs; and enable Idaho Power to identify and correct public health problems as they arise. The CRMP would also identify how to use visitor contact, resource patrols, public outreach, and interpretation and information efforts to improve voluntary compliance with rules and regulations. Interior also specifies that the CRMP define acceptable operational and maintenance standards for all recreational facilities and improvements, and define monitoring and data collection standards used to determine facility conditions, resource conflicts, public safety issues, levels of use, needs for new or expanded facilities, and levels of public satisfaction with recreation experiences. Interior justifies the scope of this recommendation by stating that future management of the project should be planned and managed as one unit, irrespective of ownership.

BPT-19 recommends that Idaho Power prepare an Integrated Comprehensive Recreational Plan, subject to approval by the federal agencies and the Burns Paiute Tribe. As recommended, the plan appears to be generally consistent with Idaho Power's proposal and would include measures to provide interpretive signage for education and information that would be developed in consultation and with approval of the tribes. BPT-19 also recommends that the Tribe have the authority to review and approve the selection of all contractor(s) and sub-contractor(s), and, whenever possible, that tribal preference would be exercised to develop and increase competencies and capacities of the tribe.

Our Analysis

Idaho Power currently manages recreational facilities through a Recreation Use Plan that was required by the Commission in Article 38 of the original license. During the past 20 years, Idaho Power has updated and revised the plan to accommodate improvements at the applicant-owned recreational sites. In addition to implementing measures in the Recreation Use Plan, Idaho Power has also worked closely with various resource agencies to assist in funding and implementing recreational site improvements throughout the project area, including major capital improvements at some sites, such as Holcomb and Hewitt parks.

The proposed Recreation Plan would replace the old plan and substantially increase and formalize Idaho Power's responsibilities to provide and maintain recreational resources throughout the project area, including those formal and dispersed recreational sites managed by others that provide public access to the project. The plan would provide a framework for Idaho Power to implement the recreational site improvements (discussed in section 3.10.2.3, *Recreational Site Improvements*) and coordinate management of recreational resources with the many land managers that have jurisdiction over project lands, and monitor recreational use and needs over the term of any new license. These measures would provide substantial improvements to management and delivery of recreational resources and would substantially expand recreational opportunities within the project.

The proposed plan reflects the unique character and management responsibilities of public recreational sites around the project. The plan would recognize that, while Idaho Power has no legal authority to redevelop public access sites owned or managed by others, it does have some responsibility to ensure reasonable public access to project lands and waters for that portion of the site that is within the

project boundary. The assistance and funding included in the plan would improve delivery of recreational services by streamlining implementation of the improvement measures, minimizing jurisdictional conflicts between the Commission and the various land management agencies, and providing a mechanism for earmarking Idaho Power funds to specific project-related improvements.

Although the Forest Service recommends many additions to specific components of Idaho Power's proposal, the Forest Service recommendation for the administrative components of the Recreation Plan is generally consistent with Idaho Power's proposal. Including a discussion of how Idaho Power would meet Meaningful Measures in any license issued would help ensure that the proposed Recreation Plan addresses Forest Service standards for any improvements constructed on Forest Service-managed lands. This part of the plan would help balance Forest Service conditions against recreational needs in other parts of the project.

The CRMP that Interior (Interior-6) and the Burns Paiute Tribe recommend is also similar to Idaho Power's proposed Recreation Plan. Some of Interior's specifications for standards and procedures that would be outlined in the Recreation Plan would benefit recreational opportunities by establishing procedures for communication and consultation with other land managers. Interior's specification to establish a RRWG would help ensure that appropriate consultation occurs as the plan is being developed and implemented without including too many stakeholders in a manner that slows planning and delivery of the plan. Similarly, Interior's specification to establish protocols for consultation with agencies would ensure that Interior and other agencies have reasonable opportunities to provide input into the finalization and implementation of the plan. Interior's specification to include a discussion of ADA in the proposed Recreation Plan would help ensure that an appropriate level of barrier-free access is achieved and maintained for the term of any new license.

There is no indication that recreational resources would benefit from Interior's specification that the plan include a decision-making structure that involves all stakeholders and the Burns Paiute Tribe's recommendation that the tribe have review and approval authority over the selection of all contractor(s). Idaho Power's proposed plan would include consultation with agencies and stakeholders prior to implementing the measure, which would be the appropriate time for Interior and/or the Burns Paiute Tribe to comment on the plan. Additionally, we note that as the licensee, it is Idaho Power, and not any other party, that the Commission holds responsible for implementing the terms of any new license

In conclusion, a number of the recommended measures would improve planning and delivery of the proposed Recreation Plan. Idaho Power provides little detail about how the plan would be prepared, how consultation with agencies and stakeholders would be handled, what standards for construction and O&M would be met for different properties, and how Idaho Power would implement measures across the many jurisdictional boundaries within the project area. In addition to those measures discussed in the application, it would improve recreational resource management if the Recreation Plan included standards for construction that meet the disparate agency requirements; measures to comply with ADA standards; a description of how Idaho Power would plan, design, and construct new facilities (including a detailed description of each measure to the conceptual design level); and a description of how Idaho Power would comply with various federal and state standards for site development, help define appropriate procedures for implementing the plan, and help ensure that adequate standards are met for all recreational improvements over the term of any license issued. Also, finalizing the proposed plan in consultation with the primary land managers, including the Forest Service, BLM, IDPR, IDFG, ODFW, OPRD, and the Oregon and Idaho counties around the Hells Canyon Project, would help to ensure consistency between proposed and recommended measures.

3.10.2.3 Recreation Site Improvements

Recreational sites provide the primary public access to the Hells Canyon Project. Recreational use associated with the project increased and subsequently dropped in the early 1990s with slow but

steady growth through 2002. Many new facilities were constructed in the early 1990s to meet visitor demand and Idaho Power's recreational use study shows that most of these developments have been underused at the current level of use (table 81). However, even with existing rates of growth in recreational use, project-related recreational facilities may reach capacity and displace recreational visitors over the term of any new license. As visitor demographics and use patterns change over the term of any new license, recreational amenities at these sites may no longer serve the type of recreational uses that visitors expect.

As part of the proposed Recreation Plan (section 3.10.2.2), Idaho Power proposes to improve many recreational sites and upgrade some informal recreational facilities to provide an improved level of service. These proposed measures are summarized in table 86. It is our understanding, from comparing the proposed project boundary in exhibit G of the license application with the description of the proposed improvements, that all of the proposed improvements summarized in table 86 would be within the project boundary.

Idaho Power developed the proposal over many years in consultation with the RARWG. All of the public comment concerning recreational facilities was from RARWG members and the majority of comments recommend implementing Idaho Power's proposed site improvements. Agency comments and recommendations regarding Idaho Power's proposal are listed in table 86, as well as additional recommended measures. Each agency recommendation that differs from Idaho Power's proposal is discussed in subsections below.

Our Analysis

Existing recreational facilities within the project include 24 formal or semi-formal public-access sites that have some level of recreational infrastructure ranging from minor to substantial; 4 private marinas and camping areas; and at least 123 undeveloped, dispersed, or informal sites (figure 115). These facilities provide the primary public access to project lands and waters. The infrastructure at many of the existing recreational facilities is degraded from deferred maintenance, and some of the facilities are not able to support the desired level or type of recreational use during peak-use periods. Although most recreational visitors interviewed expressed a high level of satisfaction with the condition of the sites, they also noted their desire for improvements, such as improved public access when the reservoirs are low, additional facilities along the Oregon shoreline of Brownlee reservoir and at Hells Canyon reservoir, and site improvements throughout the project (Whittaker and Shelby, 2003b).

Idaho Power's proposal to enhance, expand and formalize the sites listed in table 86 would substantially improve public access in the project area. Idaho Power's proposed improvements to recreational facilities within the project boundary would be site-specific, derived from a recreational needs assessment, prepared in consultation with stakeholders, and targeted at either improvements to existing facilities or development of informal facilities. In addition, the proposal considers recreational needs from a geographical perspective and recommends site improvement measures based on the overall need in a given project reach. This approach would help to ensure that certain areas of the project or certain facilities are not over-capitalized and that other areas receive appropriate improvements to meet existing and projected needs.

The proposed improvements and expansions to the semi-formal sites would include expanding camping facilities and formalizing uses at Swedes Landing, Carters Landing, Westfall, Bob Creek, Airstrip A&B, Copper Creek, Eckels Creek, Big Bar and Eagle Bar. Historically, these sites have received substantial overnight and day use by campers and boaters visiting the project. The recreational studies indicate that some basic infrastructure is needed to support recreational activities, such as improved toilet facilities; defined camping, driving and parking areas; designated day-use facilities; and improved maintenance (Whittaker and Shelby, 2003b). Idaho Power's proposal would address these needs by expanding and formalizing recreational opportunities at these semi-formal sites and would help

Table 86. Proposed and recommended recreational facility improvement measures. (Source: Idaho Power, 2003a, as modified by staff)

Site	Idaho Power Proposal	Agency Conditions and Recommendations
Oasis		Interior-16: Within 2 years of new license issuance, develop an enhancement plan for the Oasis site that would include provisions that would, among others, address the need for and feasibility of enhanced restrooms, parking, vehicle control, day use activities, foot trail, and signage. Interior states that recreational use of the site is primarily project-related.
Steck recreation site		Interior-12: Develop an enhancement plan for the Steck recreation site within 1 year of new license issuance. The plan would include provisions that would, among others, address the need for and feasibility of adding communication capabilities for emergency and other necessary purposes to meet the needs based on site requirements; separate day-use facilities with shade structures, tables, cement pads, and grills; and an additional public information kiosk.
Weiser Dunes		Interior 27: Idaho Power, in coordination with BLM, would conduct a recreation user study at Weiser Sand Dunes to determine levels and types of recreation use and the relationship between use at the project and Weiser Dunes. Idaho Power would then cooperate with BLM to develop a Recreation Plan for the site. Idaho Power's level of participation in designing and implementing the plan would be proportional to the amount of recreation assigned to the project. Assessments of additional site needs, including facilities, O&M, enhancements and mitigations would be conducted through the Adaptive Management Plan.
Farewell Bend State Park		OPRD-3 and -4: Develop and implement a maintenance plan that would address and remove sediment buildup around docks and in-reservoir pumps. OPRD indicates that the sediment buildup results from project operations of Brownlee reservoir and that the buildup reduces lake access from the docks and adversely affects the performance of the park's irrigation pumps.
Jennifer's Alluvial Fan		Interior-13: Develop and implement an enhancement plan within 2 years of new license issuance that would include installing toilet facilities, limiting the further spread of vehicle damage and noxious weeds, repairing and preventing further erosion damage at the entry/exit point of the site, and providing an information kiosk and map.

Site	Idaho Power Proposal	Agency Conditions and Recommendations
Spring	Prepare a site plan for Spring recreational site to enhance existing recreational facilities and improve boat ramp access to Brownlee reservoir to be completed within year 4 of the new license.	Interior-11: Develop a site plan that would include: (1) redesigning vehicle circulation and relocate portions of the interior road; (2) increasing parking capacity for day use boat trailer parking; (3) defining camping sites and adding electric and water hookups where appropriate; (4) improving tent camping areas, including parking and ADA toilets; (5) surfacing new and existing roads and parking areas with asphalt; (6) developing overflow parking; (7) retrofit the existing boat launch and boat ramp to be ADA accessible; (8) designing access from boat ramps to boarding docks with accessible grade according to OSMB ADA design; (9) replacing boat dock system to minimize ongoing maintenance and to better accommodate reservoir drawdowns and refill; (10) improving fish cleaning station to minimize ongoing maintenance, reduce offensive odors, and meet DEQ septic requirements; (11) retrofitting the water system throughout site and developing an irrigation system for vegetation; (12) upgrading one RV space for a campground host, including shade and septic system; and (13) landscaping the site to maximize shade and reduce dust and installing shade structures where appropriate. Idaho Power would assume the responsibility associated with the O&M of existing and new facilities at this site for the life of the new license.
Swedes Landing	Prepare a site plan for Swedes Landing to be completed within year 4 of the new license.	Interior-10: If a new low-water boat ramp and associated campground are not developed at Private Dude's Cove within 2 years of license issuance, develop an enhancement plan for Swedes Landing site that would include enhanced campsites with kitchen areas, improved ADA accessibility, enhancement of riparian area and rehabilitation, replacement of existing toilets, replacement of jersey barriers with more aesthetic barrier, boating facilities, and shade shelters. If a new boat ramp and campground are developed within 2 years at Private Dude's Cove, prepare and implement a plan at Swede's Landing to address riparian habitat restoration, public safety and control, and site vegetation. ODFW-83: Develop a low-water boat launch on the Oregon side of Brownlee reservoir at or near Swedes Landing. OPRD-9: Increase and improve low water access to project reservoirs.
Low-Water Boat Launch	Develop and implement a site plan for a low-water boat launch at or near Swedes Landing to be completed within year 3 of the new license.	Interior-18. If, within 1 year of license issuance, Idaho Power has not constructed a Low-Water Boat at Private Dude's Cove and if Interior-10 has not been implemented, then within the second year after license issuance, Idaho Power would file a Low-Water Boat Launch Plan that would include provisions to find a suitable location at or near Swedes Landing, developing a site plan, and implementing the site plan for a low-water boat launch.

Site	Idaho Power Proposal	Agency Conditions and Recommendations
Hewitt and Holcomb parks	Develop and implement a site plan for Hewitt and Holcomb parks to improve site condition and provide cultural and natural resource protection. Start consultation with Baker County and begin implementation within year 1. Additional measures would be implemented as appropriate through the RAMP.	ODFW-79: Develop and implement a site plan for enhancement of Hewitt and Holcomb parks.
McCormick Park	Reconstruct McCormick Park to meet current standards of services, benefit recreation, improve public access, and protect cultural and natural resources to be completed within year 5 of the new license.	
Carters Landing and Oxbow boat launch	Implement a site plan for Carters Landing and Old Carters Landing recreational sites to be completed within year 3 of the new license. Implement a site plan for Oxbow boat launch to be completed within year 3 of the new license.	Interior-15: Develop and implement enhancement plans for Carter's Landing and Oxbow boat launch. The plan for Carter's Landing would include provisions to enhance campsites with kitchen areas, improve ADA accessibility, and add boat moorage and shade shelters. The plan for Oxbow boat launch would include an improved boat ramp, boarding floats, improved ADA accessibility, and enhanced parking.
Copperfield boat launch	Enhance Copperfield boat launch area to improve day-use site conditions. Start implementing improvements in year 3 of the new license.	
Westfall, Bob Creek and Airstrip A, B, and C	Develop and implement site plans for Westfall, Bob Creek sections A, B, and C, and Airstrip A&B dispersed recreational site to be completed within year 3 of the new license.	Interior-9: Develop an enhancement plan for Airstrip, Bob Creek Section C, and Westfall within 10 years of new license issuance. The plan would include, but not be limited to, improved ADA accessibility, boat moorage, and one camp host site for all 3 sites. The provision of potable water would be evaluated and implemented if feasible. ODFW-80: Develop site plans for Westfall dispersed recreation site, Bob Creek sections A, B and C dispersed recreation site and Development of Airstrip A and B dispersed recreation site.
Hells Canyon Park	Reconstruct Hells Canyon Park within year 5 of the new license.	ODFW-80: Consult with state and federal agencies regarding proposed changes to Hells Canyon Park.

Site	Idaho Power Proposal	Agency Conditions and Recommendations
Copper Creek	Develop and implement a site plan for the Copper Creek dispersed recreation site to benefit recreation and provide cultural and natural resource protection to be completed within year 3 of the new license.	Interior-17: Develop an enhancement plan for Copper Creek within 2 years of new license issuance. Development would be consistent with section 106 of NHPA and the requirements for NEPA. Depending on findings of these evaluations, the plan may include provisions for a road system serving designated campsites with picnic shelters and fire rings, trailhead parking, equestrian staging area, boat moorage, and mitigations for soil erosion around the point near the mouth of Copper Creek. Enhancement design would mitigate effects on terrestrial and aquatic resources, i.e., trampling and removal of vegetation, shoreline erosion, and soil compaction.
Eckels Creek	Develop site plan and enhance Eckels Creek dispersed recreation site to benefit recreation and provide cultural and natural resource protection to be completed within year 3 of the new license.	FS-15: Implement the site plan proposed in the draft Recreation Plan (Idaho Power, 2003a), for the Eckels Creek dispersed recreation site within 3 years of new license issuance.
Big Bar	Develop site plan for Big Bar recreation site in coordination with the Forest Service consistent with the Settlement Agreement. The plan would include specific facility enhancements at Section C, as well as possible future expansion on other sections of the Big Bar as part of the adaptive management measures in the RMP. Big Bar Section C campground would be developed to level "3", or moderate site modification with design of improvements generally based on use of native materials, with about 15 to 20 campsites and support facilities.	FS-13: The modified condition is based on the Settlement Agreement between Idaho Power and the Forest Service and is consistent with Idaho Power's proposal.
Eagle Bar	Enhance Eagle Bar dispersed recreation site and improve boat ramp access to Hells Canyon reservoir to be completed by end of year 3 of the new license.	FS-14: Within 3 years of new license issuance, Idaho Power would implement the site plan proposed in the draft Recreation Plan (Idaho Power, 2003a) for Eagle Bar.
Deep Creek Stairway	Complete a condition and safety inspection of Deep Creek Stairway/Trail #218 within 1 year of new license issuance consistent with the Settlement Agreement. Upon completion of the inspection, Idaho Power would coordinate with the Forest Service and IDFG to address any mutually agreed upon deficiencies found in the inspection. Idaho Power would also develop an O&M Plan and implementation schedule for the site.	FS-16: The modified condition is based on the Settlement Agreement between Idaho Power and the Forest Service and is consistent with Idaho Power's proposal.

Site	Idaho Power Proposal	Agency Conditions and Recommendations
Hells Canyon Road pull-outs	Idaho Power proposes to grade and conduct litter patrols at informal pull-outs and parking areas along Hells Canyon Road.	FS-17: Develop, improve, and maintain parking and signage at Allison Creek, Kinney Creek, Eckels Creek, and Deep Creek parking lots. The Forest Service states that all of these facilities are used to provide public access to project lands and waters and that the facilities require improvements to meet the existing demand for recreational activities at those sites.
Hells Canyon Creek launch		FS-21: Prepare a plan for the launch that would include (1) adding potable water and grey water disposal; (2) leading a cooperative effort to provide a sanitary cleaning systems; (3) addressing safety issues at the boat launch that may include modifying the existing ramp;(4) repairing the footing on the ramp at the launch site; (5)maintaining the existing level of Licensee staffing; and (6) conducting 100% of the O&M for the road, parking area, vault toilets, and ramps associated with the launch.
Heller Bar		Interior-28: Develop a Heller Bar plan and implement facility upgrades Heller Bar within 5 years of new license issuance. The plan would include: (1) a new two-lane concrete boat ramp with concrete aprons for gear preparation along each lane to accommodate motorized boaters, and (2) a separate take-out facility for non-motorized boating traffic just downstream of the confluence of the Grande Ronde River, including graded access for boat trailers, a ramp designed to accommodate two parties with loading and unloading areas, and designed to be useable during average low water levels.
Angler Access downstream of the project		IDFG-8: Develop improved public angler access near IDFG-managed fish hatcheries on the Little Salmon River and Salmon River downstream and outside of the project boundary. IDFG points out that prior to construction of the Hells Canyon Project, access to adult anadromous resources in the Snake River provided significant fishing opportunities. IDFG states that hatchery fish are the key mitigation factor for the loss of anadromous fish species relative to the project; therefore, it is reasonable for Idaho Power to help facilitate societal use and access to that resource.
Boat moorages	Idaho Power proposes to develop boat moorages as part of the proposed Recreation Plan on Oxbow and Brownlee reservoirs	Interior-8: Develop a Project Boat Moorage Plan that would include a minimum of one moorage at Westfall, Bob Creek Section C, airstrip, and Copper Creek on Hells Canyon reservoir and Oxbow boat launch and Carter's Landing on Oxbow reservoir. OPRD-10 and -11: Install moorages for recreational watercraft. Include moorages for shore access and composting toilets in site development.

Site	Idaho Power Proposal	Agency Conditions and Recommendations
Idaho Dispersed Sites		Interior-14: Develop and implement a plan for Site No. 2 Below Hells Canyon Bridge to include a 5-vehicle gravel parking lot, a barrier to limit vehicle damage to adjacent uplands, and a portable toilet. Develop and implement a Litter and Sanitation Plan for Site No. 2 Below Hells Canyon Bridge and other dispersed sites, including Williamson Creek and Boat-in Camping Area No. 2, consistent with Interior-7.

Notes:
ADA – Americans with Disabilities Act
BLM – Bureau of Land Management
IDFG – Idaho Department of Fish and Game
NEPA – National Environmental Policy Act
NHPA – National Historic Preservation Act
ODFW – Oregon Department of Fish and Wildlife
O&M – operation and maintenance
OPRD – Oregon Parks and Recreation Department
RV – recreational vehicle

to delineate appropriate recreational uses for various activities. Also, a number of the formal recreational sites, including Hewitt, Holcomb, Woodhead, McCormick, and Hells Canyon parks, are at or near capacity during peak-use periods. Improving the semi-formal sites by installing basic infrastructure would provide other opportunities within the project area to accommodate visitors displaced from full campgrounds.

Project operations limit public access to Brownlee reservoir when the reservoir is low. Currently, only Woodhead Park has a boat ramp that can access water when the reservoir is drawn to 101 feet below full pool. Woodhead Park is difficult for many Oregon residents to reach, given the topography of the area. The proposal to develop low water launch sites, particularly at the site near Swedes Landing, would improve recreational opportunities for visitors arriving from the Oregon side of Brownlee reservoir by providing access when the reservoir is low.

When we compare Idaho Power's proposed site improvements with agency recommendations for those sites, we note minor differences, such as the location of potable water taps and the number of campsites. These differences could be resolved through the consultation process during both finalization of the proposed Recreation Plan and implementation of site improvement measures.

Overall, Idaho Power's proposed measures listed in table 86 above and as detailed in the license application (Idaho Power, 2003a) would increase recreational opportunities by providing new facilities and would enhance visitors' recreational experiences by improving existing conditions. These measures represent a substantial improvement over existing conditions and would provide additional capacity in an area where existing project recreational facilities would continue to receive heavy recreational use, particularly on some weekends and holidays.

Oasis

Recreational use of Oasis appears to be project related. The site is the most southern recreational site within the project boundary that provides access to project lands and waters. This area is within the backwater influence of Brownlee reservoir, which explains why it is within the project boundary. Unlike the more remote sites within the project, Oasis is near Interstate 84 and is easily accessible by road from Weiser and other nearby population centers. Oasis receives continuous but small amounts of recreational use throughout the year, with spikes during early summer months that appear to be associated with full pool in Brownlee reservoir (Idaho Power, 2003a; Brown, 2003a). Although we acknowledge that the type and character of recreational use at Oasis differs from other sites within the project, this seems logical given its location within the project at the upstream end of Brownlee reservoir and the more riverine setting.

The condition of Oasis is informal, with a restroom, parking area, and gravel boat ramp. Interior-16 calls for site improvements to meet existing and future needs. However, it is unclear from the recreational use data to what extent improvements are needed. Oregon manages Farewell Bend State Park, just downstream of Oasis, at a very high level of development, so developed site recreation experiences are available in the vicinity. Relatively informal recreational sites provide a unique experience, and improvements may conflict with visitors' expectations for the site. Nonetheless, developing a plan for an initial round of Oasis site improvements that would define and contain parking and formalize areas for other recreational uses, and, if needed, installing improved toilets, would improve the site condition without developing the site beyond what is needed to meet demand. Any future recreational needs could be addressed through the RAMP discussed in section 3.10.2.9.

Weiser Dunes

As summarized in table 86, Interior-27 calls for Idaho Power to develop a Recreation Plan for the Weiser Dunes. The sand dunes are approximately 100 acres on BLM land located across the Snake River

from Farewell Bend State Park, approximately 15 miles from Weiser and 5 miles upstream from Steck Recreation Site (Duneguide, 2006). Interior states that recreational use of the dunes is

> . . . strongly influenced by the Project area surrounding the reservoir, and as a consequence it is receiving increased recreational use and demand from a regional population. BLM acknowledges that some level of OHV use at Weiser Dunes from nearby local communities would have inevitably occurred without the impoundment of Brownlee Reservoir. However the development of the reservoir appears to have created a regional attraction that draws substantial use from larger urban communities outside the local area and accounts for much of the current and anticipated growth in recreational OHV use at Weiser Dunes (letter from Interior to the Commission dated January 26, 2006, pg 100).

There is little recreational use information about the site on the record that shows any relationship to project uses. No jet-skis, boat trailers or other water-related equipment was observed on vehicles in the parking lot and no shoreline angling was observed at the site during Idaho Power's recreation study (Brown, 2003d).

The property is not within the project boundary, is not associated with project-related camping or boating facilities, and is separated from the project boundary by a railroad track. There is no reasonable way for OHV users to access the property from Brownlee reservoir. As suggested by Interior, some visitors to the dunes may camp at Steck Recreation Site; however, if this is the case, it would appear the project is absorbing some level of use induced by proximity to the dunes, not the other way round. It is also possible that visitors to Steck Recreation Site, in addition to bringing boats and other water-related recreational equipment may also bring OHV equipment and all of the necessary gear to support that activity as well. The degree to which this may occur is not known.

Steck Recreation Site

As summarized in table 86, Interior-12 specifies that Idaho Power develop an enhancement plan for the Steck recreation site within 1 year of new license issuance. As shown in table 81, however, recreational use of the site does not appear to meet the existing day-use or overnight capacity. Facilities at the site have substantial capacity to meet current use. Thus, Interior's specification to develop an enhancement plan for Steck recreation site in anticipation of future recreational use does not appear to be needed at this time. It is likely that growing future use would degrade the existing facilities and ultimately require expansion and upgrades. Idaho Power's proposal to include Steck recreation site in the RAMP (see section 3.10.2.9) would allow Idaho Power and BLM to address future recreational requirements, including expansion of the site if needed, over the term of any new license issued.

Interior's specification for a communication system at Steck Park would improve safety along Brownlee reservoir by allowing visitors to contact emergency services or police. The project area is remote and communication throughout the area is difficult. Cellular phone reception is intermittent to non-existent around much of Brownlee reservoir, and evacuations could take many hours to arrange. However, the specification does not take into account many other potential systems that could improve communication in a more holistic manner. For example, it may be more efficient and provide much greater coverage to install a repeater, a cellular tower, or a radio tower at a location that would maximize coverage in the project area. As part of the I&E portion of the Recreation Plan (see section 3.10.2.5), Idaho Power could also study and consider the need for maps that show communication coverage areas. Considering the need for improved communication systems in the proposed Recreation Plan would allow Idaho Power to study the need for and implement the most practical and cost-effective communication measures throughout the project area rather than at individual sites. This approach may be more effective at addressing communication needs within the project area than installing a single landline at Steck recreation site.

Farewell Bend State Park

As summarized in table 86, OPRD's recommendation that Idaho Power remove sediment buildup around docks and in-reservoir pumps recognizes that sediment buildup at Farewell Bend State Park is project related. During the spring freshet, deposition of sediments in the river generally occurs where inflow meets the backwater from Brownlee reservoir. Farewell Bend State Park is located near the upstream end of Brownlee reservoir; when the reservoir is full, backwater in front of the park is relatively wide, with slow moving currents. Depending on the elevation of the reservoir, deposition occurs throughout the entire upstream end of Brownlee reservoir, as evidenced by the many feet of sand and silt that can be seen during seasonal reservoir drawdown. When the reservoir is near full, deposition occurs in the vicinity of Farewell Bend State Park. Given the nexus between sediment buildup and project operations, developing a plan to remove the sediments in a systematic manner would improve public access to the reservoir, improve aesthetics of the docks, and address project-related effects on the park's irrigation pumps.

Project operations appear to be the primary contributor to shoreline erosion and slope undercutting at Farewell Bend State Park. OPRD conducted and filed with its comment letter an erosion study for the site that found seasonal fluctuations of Brownlee reservoir and boat wave action cause erosion along almost 80 percent of the park shoreline. The report also suggests that, without stabilization treatments, the shoreline would continue to erode until the toe of the slope is at or just above the high water mark. OPRD estimates that without protection measures, bank stabilization would be achieved at a point approximately 120 feet inland from the current bank with a loss of about 4 acres of the park. Including measures to harden and protect the shoreline as part of the final Recreation Plan would help reduce project-related losses of recreational land and infrastructure, help protect riparian habitats from further degradation, and improve aesthetic characteristics of the site.

Jennifer's Alluvial Fan

As summarized in table 86, Interior's specified enhancement plan for Jennifer's Alluvial Fan would improve recreational opportunities at the site. Currently, the informal site is about 6 acres with no facilities, and it is used for project-related camping and fishing activities. Interior indicates that recreational use of the area has created problems with litter, disposal of human waste, vehicle damage to shoreline areas, and erosion damage at the entry/exit point of the site. Developing and implementing a site plan that includes basic infrastructure, such as toilet facilities, vehicular barriers, signage and regular maintenance, would help improve the site condition and would help protect the surrounding area from prohibited recreational activities.

Hells Canyon Road Pull-outs and Parking Areas

As summarized in table 86, the Allison Creek, Kinney Creek, Eckels Creek, and Deep Creek parking lots, which the Forest Service specifies be developed and improved, are relatively informal pull-offs along the project road that parallels Hells Canyon reservoir within the project boundary. The pull-offs are located near the creeks and provide public access to the reservoir and creeks. Developing and improving these sites would enhance the quality of the sites and potentially allow them to accommodate additional use. However, simply maintaining these sites under the Recreation Plan as proposed by Idaho Power would ensure reasonable informal access. If any modifications are needed at Eckels Creek and Allison Creek parking areas, these pull-outs could be included in the proposed site plans for Eckels Creek and Big Bar, respectively. Ongoing O&M of the pull-out areas could also be addressed through the proposed Road Management Plan. These areas are known for their important riparian areas; including these pull-outs in the proposed I&E plan (section 3.10.2.5) would help ensure consistency of educational and interpretive materials throughout the project area and describe site-specific acceptable and prohibited uses.

Boat Ramps on Hells Canyon Reservoir

Idaho Power proposes to continue to operate the Hells Canyon reservoir within a 5-foot maximum daily drawdown. However, as proposed, Idaho Power would allow for an additional 5-foot drawdown under atypical conditions. Atypical conditions, as defined by Idaho Power, are conditions when Idaho Power determines that operation of the project (which operation may occur automatically or manually) is needed to: (1) protect the performance, integrity, reliability, or stability of Idaho Power's electrical system or any electrical system with which it is interconnected; (2) compensate for any unscheduled loss of generation; (3) provide generation during severe weather or extreme market conditions; (4) inspect, maintain, repair, replace, or improve Idaho Power's electrical systems or facilities related to the project; (5) prevent injury to people or damage to property; or (6) assist in search-and-rescue activities. This proposal could affect recreational access to the reservoir because most of the existing facilities have been developed to provide access at a maximum 5-foot drawdown.

Forest Service condition no. 19 calls for Idaho Power to manage reservoir levels to minimize impacts on recreation resources during the summer. Maximum drawdown during the recreation season is currently limited to 5 feet from full pool elevation. If, based on operational modifications ordered by the Commission or system emergencies, the reservoir is drawn down for protracted periods below 5 feet from full pool elevation, FS-19 specifies that Idaho Power reconstruct or modify boat launching facilities to provide access to the reservoir.

In its comments on the draft EIS, the Forest Service clarified the purpose and scope of the condition, indicating that the major premise behind FS-19 is to provide access to Hells Canyon reservoir when water conditions are low as a result of operational conditions ordered by the Commission, system emergencies, or other situations that could cause the reservoir to be drawn down for protracted periods below the current 5-feet drawdown limit. This condition would require Idaho Power to reconstruct or modify launching facilities to provide access to the Hells Canyon reservoir during these times to avoid stranding of boating recreationists. FS-19 would not require operational changes at either Brownlee or Hells Canyon reservoirs, instead it requires construction of additional access facilities at Hells Canyon reservoir to provide continued access to that reservoir when drawdown is greater than 5 feet.

Our Analysis

There is little information on the record describing the length of boat ramps at recreational sites along Hells Canyon reservoir. However, it is likely that most of the sites were developed consistent with current project operations, suggesting that some of the existing ramps would not allow access to the reservoir during atypical days under proposed operations. Idaho Power indicates that proposed operations would rarely extend below the normal drawdown of 5 feet. Nonetheless, there is nothing in Idaho Power's proposal that would ensure that drawdown does not adversely affect boating on the reservoir.

FS-19 would help ensure that reasonable public access to Hells Canyon reservoir continues from Big Bar and Eagle Bar. These are the only Forest Service-managed sites on Hells Canyon reservoir, but they are important public access sites to the reservoir. Proposed changes to these sites (see table 86) would further improve the quality of the sites and may increase recreational demand for access to the reservoir from these sites. FS-19 would ensure that boat ramps are extended to support public access if proposed project operations interfere with reasonable use. The condition does not define "prolonged" drawdown. Defining the conditions under which Idaho Power would extend boat ramps as part of the proposed Recreation Plan, which would be prepared in consultation with the Forest Service and other resource agencies, would clarify what would constitute an adverse level of impact on boat access from project operations.

Other boat ramps could also be affected by proposed operations. Assessing the need for extending public boat ramps at Hells Canyon reservoir as part of the proposed Recreation Plan would help ensure that atypical conditions do not adversely affect boating. A systematic evaluation of existing boat

ramps, based on the elevation at the bottom of each primary boat ramp, the amount of time that boat access would be limited under atypical conditions, and whether extending the boat ramp is needed to support public access to the reservoir, would help ensure reasonable public boat access to the reservoir for the term of any new license.

Deep Creek Stairway

Recreational use of the Deep Creek Stairway appears to be project related. The stairway descends from the Hells Canyon dam parking area to the mouth of Deep Creek, dropping approximately 350 vertical feet on a combination of 250 steps and short stretches of trail. The stairway starts within the project boundary and exits the project at a point approximately half way down the stairway. Deep Creek is approximately 0.1 mile downstream of the dam and just outside of the project boundary. The Forest Service states that prior to the construction of the stairway, visitors (primarily fishermen) traversed a steep, narrow, and dangerous path along the canyon to access the fishing hole at the mouth of Deep Creek. The stairway and trail is currently operated and managed by the Forest Service with the intent to provide public recreational and, possibly, maintenance access to the base of the Hells Canyon dam on the Idaho side of the river. The trail provides the only public access to the Idaho side of the Hells Canyon dam tailrace area. Given the contemporary and historical demand for access to the Deep Creek confluence and tailrace area, and the project's role in providing public access from the Hells Canyon dam to the tailrace area, we find that recreational use of the stairway and trail from the dam to the Deep Creek confluence is project related.

Idaho Power's proposal and Forest Service modified condition no. 16 to complete a condition and safety inspection of Deep Creek Stairway and trail and correct any deficiencies found during the inspection would address recreational needs at the site. Given the trail's close connection to the project and angling access to the base of the Hells Canyon dam, operating and maintaining the facility as part of the project would ensure public access for the term of any new license issued. In addition, including the stairway and trail in the project boundary would ensure that reasonable public access to the tailrace and Deep Creek area would be maintained for the term of any new license.

Hells Canyon Creek Launch

Idaho Power states that most of the use at Hells Canyon Creek launch area is related to the HCNRA, which would attract substantial use even without the project. Although we acknowledge that most of the use of the launch area is associated with boating downstream of the project, we find that recreational use of the launch is associated with the project. The launch site is the only area for boaters, and the primary area for anglers, to access the Snake River immediately downstream of the project. The project represents a substantial barrier to accessing the Snake River; given the national significance of the boating run downstream of the project, the launch site represents minimal and reasonable access to the Snake River downstream of the project.

As described in table 86, the Forest Service (FS-21) specifies site enhancements at the launch area, as well as development of a potable water system in the launch vicinity. Given the remote location of the Hells Canyon Creek launch area, providing potable water at the site or nearby would improve the quality of the site and provide important infrastructure necessary to safely and efficiently stage trips into the HCNRA. The benefits of similar systems can be seen at other major river portals in the region, such as the Middle Fork and Main Salmon River launch areas.

The Forest Service (FS-21) also specifies improvement of the primary public access at the launch area, as well as sanitation, safety, and public outreach. Overall, the specified measures recognize the responsibility of the licensee to provide reasonable access to the project and the river downstream of the project.

Because of the importance of the launch area and its relationship to the project, including the Hells Canyon Creek Visitors Center and boat launch area in the proposed Recreation Plan would allow Idaho Power and the Forest Service to cooperatively plan and implement appropriate recreational improvements to the site. Also, including this area within the project boundary would ensure that the site continues to provide safe public access for boaters to the river downstream of the dam, as well as appropriate facilities to provide reasonable access for powerboats and float boats.

Dispersed Sites

Interior-14 specifying site improvement measures for Site No. 2 Below Hells Canyon Bridge and a litter and sanitation program for dispersed sites, including Site No. 2 Below Hells Canyon Bridge, Williamson Creek, and Boat-in Camping Area No. 2, would improve the conditions of these sites and would be consistent with Interior-7 and with Idaho Power's proposed RAMP (section 3.10.2.9) and its proposed Litter and Sanitation Plan (section 3.10.2.4).

Heller Bar

Heller Bar is one of a number of primary access sites to the HCNRA well downstream and outside of the project boundary (RM 168). Heller Bar is used as one of a number of downstream takeout areas. Although the recommended measures may improve site conditions at Heller Bar, there is no indication that recreational use of the site is project related or that project operations adversely affects the site.

Angler Access Downstream of the Project

IDFG's recommendations to improve public angler access near IDFG-managed fish hatcheries on the Little Salmon River and Salmon River do not appear to be project related. We find that IDFG's recommendation mixes the issues of hatchery mitigation for the loss of anadromous fish species and societal use and access to hatchery fish. Although the hatchery program addresses a project-related effect on aquatic resources (see section 3.6.2.12), the project provides substantial recreational opportunities within and adjacent to the project boundary. The effects of project development and operations on pre-project recreational opportunities have been addressed by the current license and Idaho Power's provision of reasonable public access to project lands and waters. These existing facilities and opportunities for flat-water recreation would not exist without the project and recreational use statistics indicate that there is substantial demand for these recreational resources. Idaho Power proposes additional recreational measures to be included in any new license that would improve project-related recreational opportunities. As recommended by IDFG, the angler access sites would be well downstream and outside of the project boundary with no clear nexus to the project's recreational resources. In addition, numerous opportunities are available to access the free-flowing portions of the Snake and Salmon rivers, and the project has no demonstrated adverse effects on these access sites.

3.10.2.4 Litter and Sanitation Plan

The project provides recreational opportunities for many thousands of visitors from the region. However, in part because of this intense use, Idaho Power and RRAWG identified litter and human waste problems along the project shorelines, which can create public health and safety impacts and aesthetic impacts, and can detract from recreational experiences (Whittaker and Shelby, 2003b).

Idaho Power proposes to continue the current litter and sanitation program at dispersed and impromptu sites within the project boundary. Currently, Idaho Power maintains some trash receptacles at dispersed sites and places portable toilets at some highly used dispersed sites at all three project reservoirs. Idaho Power proposes to continue to fund the existing Litter and Sanitation Plan. Idaho Power also proposes to enhance the existing Litter and Sanitation Plan for the project by providing

additional portable and vault toilets at appropriate dispersed recreational sites and by implementing a biannual litter pickup program throughout the project area. Idaho Power would develop the plan in consultation with the appropriate agencies and entities and would implement the Litter and Sanitation Plan for the term of any new license.

Interior-7 specifies that Idaho Power develop and implement a Litter and Sanitation Plan for the project that would include supplying dumpsters with appropriate frequency in appropriate locations near lands administered by BLM along the Homestead, Oxbow, and Snake River roads; installation of permanent vault toilets at appropriate dispersed recreation sites; providing at least one floating restroom on Brownlee and Oxbow reservoirs; and implementing a routine litter pickup program that is adequate to mitigate the litter problem. Parameters to determine appropriate locations for dumpsters and vault toilets, as well as adequacy of the litter program, would be identified within the recommended plan. O&M for this plan would be the responsibility of Idaho Power (discussed further in section 3.10.2.7, *Operation and Maintenance of Forest Service and BLM Sites*). Interior also specifies that Idaho Power continue existing actions regarding litter and sanitation measures consistent with its proposal and implement the litter and sanitation provisions of the Baker County Settlement Agreement, dated October 3, 2003.

OSMB-5 calls for Idaho Power to develop waste disposal measures that would include human waste disposal in its Litter and Sanitation Planning. OSMB recommends installation of boat toilet dump stations in the project area based on the fact that many smaller boats now carry portable toilets that require dump stations to be serviced. OSMB also recommends installation and maintenance of one floating toilet on Brownlee reservoir between Morgan Creek and Hibbards Landing. OSMB encourages Idaho Power to work with the Marine Board to solicit federal Clean Vessel Act funds to assist with installation and purchase of floating toilets and waste disposal systems.

ODFW-77 suggests that Idaho Power continue and enhance its Litter and Sanitation Plan within 1 year of new license issuance, similar to Idaho Power's proposal. ODFW recommends that the plan be developed in consultation with appropriate state and federal agencies and entities and the recreation stakeholder group.[103] Under ODFW's recommendation, Idaho Power would fund, operate, and maintain the Litter and Sanitation Plan and its improvements with regular monitoring of the litter and sanitation situation for the term of a new license.

As part of FS-21, the Forest Service specifies that within 1 year of new license issuance, Idaho Power design, construct and maintain a gray water disposal system and a sanitary cleaning system, comparable in design to SCAT cleaning devices, capable of cleaning portable human waste carry out systems within the Hells Canyon reservoir area. The Forest Service indicates that recreational use associated with the Hells Canyon Creek area is project-related; therefore, it is Idaho Power's responsibility to construct and maintain such a system.

Our Analysis

Idaho Power's litter and sanitation proposal would substantially improve existing conditions throughout the project area. Idaho Power and stakeholders identified litter and sanitation as an important recreational issue that affects both the quality of the recreational experience and the environmental attributes of the dispersed sites. As proposed, Idaho Power would continue to operate and maintain trash receptacles at important sites and would expand the program to include installation and maintenance of toilets at some more important recreational sites, as well as implement a bi-annual litter pickup program throughout the project area. Including these proposed measures in any new license issued for the project would substantially improve the condition of the dispersed sites, improve health and sanitation for

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[103] ODFW recommended formation of this group as part of the Recreation Adaptive Management Plan discussed in section 3.10.2.9.

visitors, and potentially reduce some of the impacts from visitors on sensitive environmental resources around these sites.

Idaho Power has not identified all of the sites where toilet facilities and trash receptacles would be installed. In response to agency comments on the license application, Idaho Power indicates that the plan would include biannual litter pickup at Kevin's Alluvial Fan and Weiser Sand Dunes, Jennifer's Alluvial Fan, Snake River boat launch, and Oasis. Idaho Power indicates that Jennifer's Alluvial Fan and Snake River boat launch may also be included in the sanitation part of this measure if they are selected through ongoing consultation for portable toilet locations. Although the full details of the proposal are unclear at this time, Idaho Power would prepare the details of the Litter and Sanitation Plan in consultation with RRWG, allowing agencies to recommend the appropriate location for these facilities.

Interior's specified Litter and Sanitation Plan (Interior-7) is similar to Idaho Power's proposal. Interior calls for the installation of vault toilets on the grounds that they are more aesthetically pleasing and cost less to operate. Interior also specifies the installation of dumpsters in areas along Brownlee and Oxbow reservoirs. Both of these specifications would achieve similar goals for improved sanitation. To the degree that these specifications may differ from Idaho Power's proposal, resolution about the type of sanitation and trash facilities and the location of these facilities could be appropriately addressed through the consultation process and filed for Commission approval as part of the plan.

Interior's specification for the construction and maintenance of floating restrooms on Brownlee and Oxbow reservoirs (Interior-7) and OSMB's recommendation for a similar facility on Brownlee reservoir may provide additional recreational benefits for some boaters at the project. In some areas of the project reservoirs, particularly the middle portion of Brownlee and the northern portion of Hells Canyon reservoirs, convenient boater access to restrooms does not exist, which may result in boaters using waters and/or shoreline areas for their restroom needs. However, there is little indication on the record that floating restrooms are needed. Currently, numerous developed recreational sites with boat ramps along all reservoirs provide sufficient shoreline restroom facilities. Idaho Power's proposal includes additional shoreline toilet facilities through the Litter and Sanitation Plan, which should improve public access to these facilities, especially in the more remote areas of the project reservoirs. Boaters could access the existing and proposed facilities with relatively short travel times.

Although it is not entirely clear from the record, we assume that these agency recommendations are associated with Idaho Power's proposal to install moorings for overnight camping. If the final locations of the mooring sites are associated with shoreline facilities, the recommended floating restrooms do not appear to be needed. If the location of the moorings is more than 1 mile from a developed public access site, then floating restrooms may provide an appropriate level of service. Developing these details in the proposed Litter and Sanitation Plan, in consultation with the RRWG, would help ensure that an appropriate level of service is provided to meet recreational needs without overdeveloping the resource.

There is no indication on the record that OSMB's recommendation to develop a dump station for boat holding tanks at the upstream end of the project is needed. Although developing a dump station in the project area may be convenient for some visitors, public access through primary roads varies significantly throughout the project area. For example, boaters accessing Brownlee may approach and leave the project from Oregon or Idaho on roads accessed from the north or south. There is no one obvious portal on which to locate a dump station that would be convenient for most visitors. Boaters and RV campers have options to pump holding tanks along major highways throughout the region, and there is no indication in the public record to suggest that these regional facilities are insufficient to meet project-related visitor demand for such services.

One exception to our analysis is noted above with respect to the Forest Service specification that Idaho Power design, construct and maintain a gray water and sanitary cleaning system capable of cleaning portable human waste carry out systems within the Hells Canyon reservoir area. Recreational use associated with the Hells Canyon Creek area is project-related because the property, which is just outside

of the project boundary, is the only area for boaters and anglers to access the Snake River immediately downstream of the project. The area is very remote and is accessible only along one project road. The specified sanitation measures would provide infrastructure to support reasonable public access to trips into the HCNRA. Many float boaters return to the Hells Canyon launch area by powerboat so that they do not have to arrange a vehicle shuttle (Brown, 2003c). Consistent with HCNRA regulations, most rafters that float the river collect human waste in ammunition boxes or other containers that can be conveniently stowed in float boats. However, safely disposing of human waste and sanitizing these types of containers is difficult for private boaters. Given the remote location of the Hells Canyon Creek put-in/take-out, construction of the Forest Service-specified human waste disposal system would improve sanitation and disposal of human waste. The benefits of similar systems can be seen at other major rivers portals in the region, such as those on the Middle Fork and Main Salmon rivers.

3.10.2.5 Information and Education

Idaho Power proposes to develop an Information and Education Plan that includes: (1) review and selection of appropriate themes; (2) review and selection of appropriate interpretive media to be used; (3) development of a web site and toll-free phone number accessing pertinent recreation-related information; and (4) review and selection of prioritized sites where the interpretive media would be located. Through these efforts, Idaho Power would then implement the plan in consultation with the appropriate agencies and entities, and operate and maintain I&E facilities and amenities resulting from the plan.

Both Interior-24 and ODFW-78 call for Idaho Power to develop and implement an Information and Education Plan consistent with Idaho Power's proposal.

OSMB-6 calls for Idaho Power to provide education and outreach materials at all boating access points designed to prevent the introduction and/or spread of invasive species, including zebra mussels, hydrilla, mud snails, and other non-native, aquatic species that pose a serious threat to western waterways. Under this recommendation, Idaho Power would monitor for introduction of these species and participate in state and federal planning efforts to prevent introduction or respond if an introduction occurs.

NMFS-20 recommends that Idaho Power design and construct an anadromous fish interpretive display at a location near Brownlee dam. The purpose of the display would be to instruct the public with respect to: (1) the biology and geographical ranges of anadromous fish species that historically migrated past the project; (2) the importance of anadromous fish to Native American Indian Tribes; (3) the factors contributing to the loss of these species (with graphical and geographical depictions of these losses over time); and (4) measures that Idaho Power is taking to protect and restore anadromous fish resources or their habitat.

Our Analysis

The proposed Information and Education Plan would promote protection and preservation of cultural, natural, and historical resources by providing educational and interpretation materials at primary recreational sites. The plan would also provide consistency of information and education materials between recreational sites, which would help give recreational users the sense of coherent management throughout the project area. As described by Idaho Power, the plan does not specify the location or type of materials that would be developed. Including this information in the plan, as well as operational and maintenance activities and any scheduled updates to the information and education materials, would help ensure that the plan can be successfully managed over the term of any new license.

OSMB recommends including information on aquatic invasive species in the proposed Information and Education Plan. Invasive aquatic species can adversely affect recreational and commercial uses of waterways and damage aquatic ecosystems by overwhelming native plant and fish populations and altering species composition throughout a waterway. Introduction of invasive species to

the Hells Canyon Project could also threaten downstream areas as well as fish and habitat restoration efforts throughout the basin. The project draws recreational boaters from throughout the region, which increases the risk of introducing aquatic invasive species. Including this recommended measure in the Information and Education Plan would help inform visitors about the incremental role individual boaters play in spreading non-native species. Information and education materials about invasive species would also help to provide basic information about the potential harm these plants and animals could cause to important aquatic resources within the project area.

As discussed in section 3.7.2.8, *Special Status Wildlife*, Interior identified concerns about protection of special status bats and reptiles. In our analysis, we found that recreational activity could cause disturbance to these species and their habitat, and that educating visitors by including information about them in the Information and Education Plan could reduce the potential for adverse effects.

Implementing the NMFS recommendation to develop anadromous fish information and education materials at Brownlee dam would provide important information about the effects that hydroelectricity development has on migratory fish runs. Idaho Power contributes substantial resources annually toward the improvement of anadromous fish runs, without which certain populations of salmon would be further stressed. Including in the Information and Education Plan information about the role hydroelectric projects, as well as other human activities, play in bringing about the loss of anadromous fish runs, and the efforts underway to improve and protect these runs within the context of modern energy demands, would help place this issue in a contemporary context.

3.10.2.6 Trails

Trails provide important recreational and hunting access to the federal lands adjacent to the project. Although many other types of recreational uses are declining on a national level, demand for trail-related activities, such as walking, hiking, and biking tends, to be increasing. Of the numerous recreational and hiking trails that provide access to public lands managed by federal agencies near the project, many begin along project roads or at project-related recreational sites.

Idaho Power does not propose any specific measures for trails outside the project boundary. However, as part of the Litter and Sanitation Plan (discussed in section 3.10.2.4, *Sanitation and Litter Management*), as well as proposed improvement measures at Eagle Bar and Copper Creek dispersed recreation sites, Idaho Power proposes measures to improve O&M at trailhead sparking areas along Hells Canyon reservoir. In Idaho Power (2003a), Idaho Power states that funding for trail improvements and maintenance should remain the responsibility of the Forest Service because use of the trails is not primarily project related.

The Forest Service (FS-20) specifies that, within 1 year of new license issuance, Idaho Power perform trail maintenance of Forest Service trails accessed from the Hells Canyon reservoir and Hells Canyon Creek launch site. In Oregon, these trails would include Hells Canyon Trail (#1890), Bench Trail (#1884), McGraw Trail (#1879), and Stud Creek Trail (#1781). In Idaho, these trails would include Eckels Creek Trail (#223), Allison Creek Trail (#514), Midslope Contour Trail (#222), Kinney Creek Trail (#221), and Deep Creek Trail (#219). The condition also specifies that within one year Idaho Power would develop a plan to address future management of the Hells Canyon Reservoir Trail and within 5 years would develop a plan to address future management of the McGraw Creek Trail (#1879A). The Forest Service states that the primary use of these trails is by Hells Canyon Project visitors, who come to the area for other recreational activities, but who frequently use Forest Service trails during their visit. The Forest Service states that these visitors are attracted to Forest Service-managed trails because of their proximity to the project, the lack of opportunities on Idaho Power's lands, and the general increasing population base that is projected to influence use of the project area in the future.

ODFW-84 recommends that Idaho Power improve access to the Stud Creek Trail.

Interior-3 specifies that, as part of an integrated travel and access management plan for BLM-administered lands affected by the project, Idaho Power develop and implement a plan for non-motorized use of trails connecting recreation sites along the Oregon side of Hells Canyon reservoir and conduct a feasibility study for developing a trail system along the Hells Canyon, Brownlee, and Oxbow reservoirs connecting Farewell Bend State Park to the HCNRA. Interior states that a well-maintained trail system would accommodate increased use as well as prevent unregulated use, and thus protect natural and cultural resources.

Our Analysis

Recreational use within the project boundary is primarily associated with the project reservoirs, including boating, fishing and camping. With the exception of a few specific trails within the project boundary, little evidence on the record suggests that use of hiking trails that originate at the project are project related. Further, Idaho Power indicates that the Forest Service overstates the proportion of project-induced users that hike and does not consider other information that suggests most reservoir users are not seeking longer trail hiking opportunities. In its February, 27, 2006 filing, Idaho Power states that its new analysis of trailhead surveys collected from 1998 through 2002 offers additional information about the proportion of trail users who probably should not be categorized as project-induced because their primary purpose was hiking upland trails that would have been available with or without the project.

Although Idaho Power's recreational study shows that walking and hiking are secondary uses in the project area, there is little indication of where this walking and hiking occurs. Idaho Power found that less than 2 percent of all visitors to the area use Forest Service trails as their primary destination (Whittaker and Shelby, 2003b). The Forest Service states that 22 percent of all visitors surveyed reported using these trails during their visit to the Hells Canyon Project, but we cannot confirm this number from materials on the record. Whittaker and Shelby (2003b) state:

> Over one-quarter of all visitors reported walking, while 7% reported hiking. This suggests that most reservoir users do not travel along the reservoirs by foot, but if they do so, it is to explore the immediate vicinity rather than travel long distances. Fewer than 1% reported traveling by horse. Hells Canyon reservoir users were more likely to walk and hike than other users. Taken together, these results suggest greater visitor interest in short trails than in longer ones (although the lack of longer trails may also offer a partial explanation for these results).

Although there is good indication that visitors walk and hike in the project area, it is likely that walking and hiking mean different things to different visitors. Some visitors may report hiking while exploring a reservoir shoreline, walking along project roads, or walking around some of the larger recreational sites.

Based on the data in the record and our visits to the project, we cannot assume that this use is on Forest Service-managed trails. Instead, we assume that some percentage of project visitors hike on Forest Service lands as secondary activities. Likewise, some percentage of visitors to the area are attracted principally by hiking, hunting, horseback riding, or boating opportunities on Forest Service lands and secondarily use project resources. As such, project and Forest Service recreational resources probably induce secondary use on other resource areas, similar to what happens in other complex recreational areas.

As part of its proposal and settlement with the Forest Service, Idaho Power would maintain and improve the principal pullouts and trailheads within the project boundary that provide hiking access. The trails covered by FS-20 begin at the project boundary in these areas, but extend well beyond the project. Idaho Power's commitment to improve and maintain these areas includes the project-related uses of these areas, such as sightseeing, resting, picnicking, swimming, and hiking. Some of these uses may include hiking or other activities on Forest Service lands. It appears that the proposed and specified measures

would fulfill Idaho Power's responsibility to protect environmental resources associated with access points to Forest Service trails.

Based on the information on the record, we do not find a clear nexus between project operations and recreational use of Forest Service-managed trails, including Stud Creek Trail, outside of the project boundary. Idaho Power appears to address the primary project-related effects on trails originating within the Hells Canyon Project by proposing to maintain pull-out and parking areas along Hells Canyon Road and improving sanitation and increasing litter patrols throughout the project.

With respect to Interior's modified condition specifying development and implementation of a new trail system (Interior-3), Idaho Power found in its studies related to project relicensing (Johnson, 2003) that creating a trail system may negatively affect wildlife and other natural resources, and recommended against expansion of access for recreational use where possible. In addition, Idaho Power states that the RARWG in its pre-application meetings did not discuss the concept of creating a trail system, which Idaho Power suggests is an indication that the group did not believe that a new trail or trails were needed in this area. While a trail system could improve recreational opportunities along Brownlee and Oxbow reservoirs, based on the record, Interior has not established a clear need for the recommended trail system to provide reasonable public access to the project.

3.10.2.7 Operation and Maintenance at Forest Service and BLM Sites

Long-term O&M of project recreational facilities would ensure that the quality of the recreational sites is maintained for the term of any new license. Under the current license, Idaho Power has kept its recreational facilities in good operating condition and has amended the current Recreation Use Plan with new capital improvements at its recreational sites. Idaho Power has also assisted some of the other land managers with sites adjacent to the project by providing litter patrol and maintenance at some dispersed sites and contributing funds toward capital improvements. However, some formal sites and many of the informal sites have deferred maintenance needs or receive minimal ongoing services.

Idaho Power proposes to continue O&M of its parks and recreation facilities and to perform O&M at Idaho Power-enhanced BLM and Forest Service reservoir-related recreational sites. In addition, as part of its settlement with the Forest Service (October 26, 2006), Idaho Power proposes to perform O&M necessary to meet USDA Forest Service Standards, Meaningful Measures, as amended, over the term of any new license for Eagle Bar, Eckels Creek, Big Bar, parking areas along the Hells Canyon reservoir, Black Point Viewpoint, and dispersed areas on National Forest System lands within the project boundary pursuant to the Recreation Plan. This proposal is consistent with FS-18 that calls for O&M on Forest Service-managed lands.

The Forest Service (FS-21) specifies that, among other things, Idaho Power perform 100 percent of O&M necessary to maintain the Forest Service-specified improvements at the Hells Canyon launch, and 50 percent of the remaining O&M needs at the launch. Idaho Power's alternative to the Forest Service 4(e) condition regarding the Hells Canyon launch area would require Idaho Power to maintain much of the access road, parking areas, vault toilets, and ramps associated with the launch.

OPRD-8 recommends that Idaho Power fund the O&M and monitoring efforts found within the Recreation Plan and is generally consistent with Idaho Power's proposal.

Our Analysis

Idaho Power's proposal to fund O&M at its recreational sites and those BLM and Forest Service sites as part of the license would provide substantial benefits over existing conditions by formalizing O&M at most of the primary recreation sites within the project boundary. Although Idaho Power's recreation sites are generally maintained in very good condition, many of the other public facilities that provide access to the project, including some of those managed by federal agencies, have not received

consistent O&M funding. As discussed in section 3.10.2.3, *Recreation Site Improvements*, Idaho Power proposes substantial recreational improvements to many federally managed recreational sites within the project boundary. A license requirement for Idaho Power to pay O&M costs for these facilities would ensure that the facilities are adequately maintained for the license term and would be consistent with the settlement between Idaho Power and the Forest Service on condition no. 18.

3.10.2.8 Flow Information and Coordination Downstream of Hells Canyon Dam

Boating in the HCNRA downstream of the Hells Canyon Project is a recreational resource of national significance. Flows downstream of the project are affected by project operations, and change in stage can affect the navigability of certain rapids. In order for private and commercial boaters to plan and run trips in the HCNRA, a reasonable level of historical, near real-time, and projected flow information is needed.

Idaho Power proposes to continue to operate and maintain monitors to provide flow information about river flows downstream of Hells Canyon dam. Idaho Power currently publishes outflows from Hells Canyon dam via satellite transfer. The data are displayed graphically on the Internet in daily outflows for the previous 7 days, hourly outflows for the previous 24 hours, and projected hourly outflows for the next 24 hours. Idaho Power's toll-free flow phone line provides projected flows for up to 4 days. The gages are located at Hells Canyon Creek recreation site, Oregon; Pittsburg Landing, Idaho; Cache Creek Administrative Site (Forest Service), Oregon; Hells Gate Marina, Lewiston, Idaho; Heller Bar, Washington; and the Forest Service Clarkston Office, Washington.

No agency or stakeholder has specified the need for different flow information. However, as part of its comments on the draft EIS, NPPVA states that a significant need exists for accurate, reliable, and timely flow information. As part of its filing, NPPVA highlighted numerous times when the current Internet site reported flows there were different from those that were experienced on the river.

Our Analysis

Boating opportunities exist under all water conditions downstream of the project and, to a large degree, the regulated outflow of the project stabilizes the hydrograph, creating generally predictable flows and boating opportunities. Idaho Power voluntarily provides historical, near real-time, and planned project flow information at numerous points over more than 100 miles of free-flowing river downstream of the project. Boaters have benefited from Idaho Power's publication of this information by having detailed information from which to plan and stage river trips.

Minimum flows are of primary concern to boaters. Certain rapids, including Granite Creek and Wild Sheep rapids in the upper canyon, are not navigable by some boats, particularly large powerboats, at low water. Unless unforeseen problems occur, Idaho Power's proposal with the proposed forecast would allow power boaters to plan trip details, such as when to launch, where to camp, and when to run certain rapids, up to 4 days in advance of entering the canyon.

Overall, Idaho Power's Internet site and flow phone provide substantial information at sufficient detail to safely plan and stage trips downstream of the project. However, as noted by NPPVA in its comments on the draft EIS, there are discrepancies between the actual flow and the flows posted on Idaho Power's Internet site. Idaho Power is not currently under any license obligation to maintain accuracy on the Internet site, as illustrated in NPPVA's letter. In a letter to the Corps dated June 26, 2007, and filed with the Commission on July 3, 2007, Idaho Power outlined a number of measures that it is currently pursuing with respect to improved flow information, including: (1) emphasizing the importance of the Hells Canyon discharge information that is posted at the six flow monitor sites; (2) ensuring the accuracy of information posted on Idaho Power's website and 1-800 phone number; (3) providing timely and accurate press releases; (4) providing a common data source for the flow monitors, web site, and 1-800 number to ensure that accurate and timely information is provided via all three media and that the

information is consistent among the three media; (5) continuing to evaluate the feasibility of developing a text messaging system that would send the current Hells Canyon discharge each hour to a list of subscribers with satellite phones that could be reached on the river; and (6) evaluating the feasibility of installing additional stream flow gaging facilities on the river or important tributaries so that boaters would have access to additional real time information regarding measured flows, in addition to the information already provided on dam releases.

Developing a plan to ensure that boaters have the most relevant flow information for various sections of the river would contribute to improved safety, especially for large powerboats during periods of low flow. Any plan for distributing timely flow information would require close coordination and consultation with the Corps and NPPVA. Such a plan may include forecasts of flows at key locations, taking into account the lag-time associated with releases made at Hells Canyon dam. Although flows would drop under 8,500 cfs under any operating scenario that did not include the Corps' recommended 8,500-cfs minimum flow, boaters would have a better idea when such lower flows might occur and, in the context of their experience and skills, could plan for the best time and route through difficult sections of the river.

3.10.2.9 Adaptive Management

Idaho Power proposes to develop a RAMP within 3 years of new license issuance to ensure the adequacy of the proposed Recreation Plan (section 3.10.2.2), as well as to identify and address recreation management, measures, and facility needs for the project over the term of any new license. Idaho Power would use recreational monitoring as the basis for evaluating and recommending any changes to the Recreation Plan that may be needed. Proposed monitoring would include annual informal onsite observations and traffic counters, as well as a more detailed recreational survey of social indicators and general recreational use every 6 years. Idaho Power would prepare summary reports for stakeholders annually and a comprehensive report every 6 years in coordination with FERC Form 80 (Licensed Hydropower Development Recreation Report) filing. Idaho Power states that the plan would provide a way to ascertain the appropriate level of recreation development or management in relation to the use of recreation sites and other measures, while protecting other resource values. Consultation with agencies and entities would occur in coordination with FERC Form 80 filing.

The Forest Service (FS-12) specifies that Idaho Power develop a Recreation Management Plan (discussed in section 3.10.2.2, *Recreation Plan*) that would include adaptive management measures. The Forest Service specification would require Idaho Power to: (1) develop a comprehensive recreation monitoring plan that includes evaluation of recreation use, preferences and trends; (2) report recreational use information to the Forest Service and other interested entities as it becomes available, including annual reporting of use occurring at Idaho Power's fee parks; (3) coordinate with the Forest Service to establish trigger points that indicate a need for additional development or improvements at sites identified in the Recreation Plan; and (4) provide for appropriate expansion of existing recreational facilities or development of new project related recreation facilities and for other recreational opportunities on Forest Service lands commensurately with project related use pursuant to the Recreation Plan. The Forest Service also specifies that Idaho Power conduct visitor satisfaction surveys every 6 years to monitor crowding and changing reservoir setting conditions. Details of the survey content and implementation would be coordinated with the Forest Service and other applicable entities to ensure that the level of detail and applicability of information would be consistent with previous surveys and analysis. When practical, these surveys would duplicate the survey protocols developed by Whittaker and Shelby (2003b) and presented in Whittaker and Shelby (2003a).

OSMB-4 recommends that Idaho Power fund, develop and implement a RAMP in consultation with a recreation stakeholder group to establish the procedures to accommodate the recreational boating needs within the project. Specific items that would be addressed include: (1) increasing low water access to provide better seasonal access to project reservoirs, and (2) developing moorages of adequate size and

design for recreational watercraft to facilitate full use of the project waters. Under this recommendation, Idaho Power would complete a boat moorage and access facility needs assessment that would provide Oregon boaters fair and equitable access and services compared to Idaho-based facilities. Moorages would include shore access whenever possible and if not available, composting toilets would be included in site development to address sanitation issues.

OPRD, as part of OPRD-4 through -7, recommends a number of measures to be included in the RAMP, including: (1) formation of a recreational stakeholder group within 4 months of new license issuance to assist with the development and implementation of the RAMP; (2) Idaho Power funding, development and implementation of a RAMP in consultation with the recreation stakeholder group to ensure adequacy of the Recreation Plan and to identify and address recreation measures for the project over the life of any new license; and (3) a method to share information between Idaho Power and the recreation stakeholder group about recreation decisions, adaptive management, protocols for annual meetings, trigger points, and comprehensive recreation monitoring. The only recommended measures that appear to differ from Idaho Power's proposal is the 4-month initiation of consultation and the recommendation to include trigger points in the plan.

ODFW-1 states that Idaho Power should develop and implement a RAMP in consultation with a recreation stakeholder group. ODFW recommends that Idaho Power form the stakeholder group within four months of new license issuance, implement the RAMP within 3 years of new license issuance, and maintain the plan through the life of the new license. Under this recommendation, Idaho Power would fund all agreed-upon construction, O&M, and monitoring efforts associated with this license condition.

Interior-31 calls for development of a Recreation/Aesthetics Resource Workgroup to facilitate communication and consultation between Idaho Power and BLM and to develop recommendations regarding recreation and aesthetic resource management goals and objectives. The workgroup would include representatives from the BLM; Forest Service; State Park agencies; County Park representatives; tribal governments; NGOs, who have an expressed interest in the RRWG; and Idaho Power. Among other issues, the workgroup would convene to address: (1) development of the Recreation Plan; (2) Idaho Power's implementation of recreation and aesthetic conditions; (3) planning according NEPA that is necessary to implement the recreation conditions on Federal administered lands; (4) scope, design, and conduct of studies and monitoring procedures required by the recreational conditions; (5) study and monitoring results pertinent to the implementation of the recreational conditions; (6) modifying the recreational conditions based on input from monitoring, (7) land acquisition and selection criteria, required by the recreational conditions, (8) funding; (9) issues identified during any monitoring; (10) updating programs or plans; and (11) annual reporting for the recreational conditions.

Interior-29 calls for Idaho Power to develop and implement a Recreation Land Acquisition and Management Program for acquisition, management, implementation, monitoring, and adaptation of acquired recreation lands as mitigation for recreation resources affected by the continuing operation of the project. The primary goal of the program would be to provide water-based recreational opportunities for the public. Priority areas to acquire lands would include low gradient lands contiguous to project reservoirs. Acquisition of recreation lands would occur within the second decade after license issuance and would include provision for acquiring 42 acres of land suited for public recreational purposes, specifically targeting land in the vicinity of Home, Hibbard, and KFAN (dispersed recreation sites). Within 2 years of acquisition, Idaho Power would plan and implement enhancements for recreational purposes.

Our Analysis

Idaho Power's proposed RAMP would provide a framework for studying, planning, and modifying the proposed Recreation Plan if or when recreational needs have been established through monitoring and consultation. The Hells Canyon Project is complex, includes large geographical areas,

crosses numerous jurisdictional boundaries, and provides a wide variety of recreational opportunities. In this context, planning for change in regional growth and change in recreational use patterns for the full term of any license issued is especially difficult. As proposed, the RAMP would provide a flexible tool that could accommodate changing use over time.

Idaho Power's consultation list includes the primary recreational managers in the project area and would provide a substantial level of coordination without overwhelming or slowing down the consultation process. As proposed, the RRWG would meet every 6 years in advance of filing the FERC Form 80. This schedule would allow the RRWG to study the recreational monitoring results and evaluate any recommended recreational improvements in the context of actual recreational use patterns. Interior's consultation recommendation is generally consistent with Idaho Power's proposal.

The Forest Service specification that Idaho Power provide annual reports to RRWG of recreational use at Idaho Power's recreation sites as they become available does not appear to improve the consultation process or provide additional protection to recreational resources. No information on the record indicates that more frequent surveys or more frequent reporting are needed to meet recreational needs, and other measures included in the proposed RAMP would provide timely consultation over the term of any new license.

Although the Forest Service and OPRD recommend the establishment of trigger points in the RAMP, neither agency provides supporting evidence on how such triggers would improve or protect recreational resources or indicates what the triggers should be. As understood by staff, the recommendation would require Idaho Power to establish quantitative triggers for recreational use for each established and dispersed recreational site in order for triggers to be effective. Even if reasonable triggers could be established, triggers would become prescriptive rather than responsive to site-specific recreational needs over time. As proposed, Idaho Power's RAMP would collect appropriate recreational use data at a sufficient level of detail to consider new recreational needs that arise. The consultation component would allow the Forest Service, ODRP, and other agencies to make recommendations about both the scope of the recreational studies and the type of measures needed, if any, to address recreational concerns, improve recreational opportunities, and protect recreational experiences.

The Forest Service specification to conduct detailed recreational user surveys consistent with the protocol established by Whittaker and Shelby (2003b) for ongoing monitoring does not appear to be warranted. Although much of the recreational use data collected during the pre-licensing period were important for understanding recreational issues at the project, the Forest Service has not indicated why this level of effort would be needed every 6 years. Reservoir level studies, creel surveys, recreational site inventories, and mail surveys are not likely to change in any substantial way every 6 years. Nonetheless, establishing details about a minimum level of recreational use monitoring as part of the RAMP and providing opportunities to expand the monitoring if certain issues arise would help ensure that adequate information is collected that would provide a basis for proposing any new recreational measures.

In some cases, annual consultation, as recommended by OPRD and ODFW, may provide marginal improvements to Idaho Power's ability to implement the RAMP. This would become apparent if there is a sudden change that would demand a rapid response from management agencies within the project area. However, changes in recreational use patterns tend to develop over a number of years or decades rather than from year to year. In that light, the benefits of annual consultation may be outweighed by the inefficiency of a larger bureaucracy on top of monitoring and implementation measures. Nonetheless, including a contingency in the RAMP that would elicit consultation between the 6-year filing of FERC Form 80 would help protect and preserve recreational opportunities if a relatively rapid recreational pattern becomes apparent in the proposed annual monitoring data. Also, it would be beneficial to establish consultation procedures associated with developing use studies, as well as preparing and filing reports every 6 years, that would ensure that agencies have reasonable input into study protocols and have time to consider data and make recommendations based on the data.

OSMB's recommendation to address low-water access and develop additional moorages does not appear to be needed as a specific item in the RAMP. Idaho Power has proposed to develop a low-water put-in on the Oregon side of Brownlee reservoir, and it appears likely that this measure would be sufficient to satisfy identified low-water access needs. Idaho Power's proposed RAMP would require reports and recommendations that result from the ongoing monitoring prepared in consultation with agencies every 6 years. OSMB would have monitoring data from which to make reasonable recommendations at that time and, if needed, could raise the issue of additional put-ins and moorages.

Interior's recommendation to develop a plan for acquiring new recreational lands does would not provide substantial new recreational opportunities. Idaho Power owns important recreational and project-related lands within the project boundary that provide reasonable public access to project waters. In addition, public lands boarder all of the project reservoirs and provide many hundreds of acres of informal recreational access to project waters, as well as numerous formal recreational sites. These facilities appear to be sufficient to provide reasonable public access to the project for the term of any new license.

3.10.2.10 Hells Canyon Visitors Center Staffing

The Hells Canyon Visitors Center is a heavily used facility that provides interpretive and educational materials to both HCNRA and project visitors. As a project-related portal to the Snake River downstream of the project, it is important that staffing be maintained at an adequate level to meet visitor demand.

Idaho Power proposes to continue its Memorandum of Understanding (MOU) with the Forest Service regarding staffing the Hells Canyon Visitors Center. This measure would provide staffing resources to assist the Forest Service in operating the Hells Canyon Visitors Center.

As part of FS-21, the Forest Service specifies that Idaho Power maintain the existing level of Idaho Power staffing (as referenced in MOU No. 99-MU-11061600-556 with Modification No. 001) at the Hells Canyon Creek launch site and Visitors Center for the term of any new license. Idaho Power's alternative 4(e) measure is generally consistent with the Forest Service specification but clarifies consultation and the scope of the capital improvements.

Our Analysis

Idaho Power voluntarily entered the MOU with the Forest Service to help meet staffing needs at the Hells Canyon Visitors Center. The Visitors Center is an important public use site for distributing educational information about the HCNRA and regulatory information about the Hells Canyon Project, as well as information about natural resources, human history, boating etiquette, and recreational facilities and opportunities in the area. The proposed continuance of the MOU would help maintain an appropriate level of staffing to meet recreational needs at the Visitors Center and launch.

3.10.2.11 Warmwater Fisheries Management Plan

Idaho Power has an existing Warmwater Fisheries Management Plan. Interior-32 includes elements of Idaho Power's existing plan plus a strategy for managing reservoir elevations so as to protect and enhance recreational fisheries. Specific elements of the plan would include a description of timing and reservoir elevation requirements for spawning and maintenance of centrarchid fish species populations; a description of the relationship between the timing of reservoir level fluctuations and the ability to access and launch boats at existing Idaho Power boat ramps; an analysis of options for reservoir level management to minimize effects on the warmwater fisheries while meeting flow releases downstream that support the anadromous fish and lamprey populations; and an adaptive management component that would satisfy the reservoir elevation requirements in the Baker County Settlement Agreement as well as fulfill the needs of the warmwater fisheries.

Our Analysis

Interior's recommendation for a new Warmwater Fisheries Management Plan does not appear to offer any improvements for recreational resources. As part of the license application, and as we discuss in section 3.10.2.1, *Effects of Project Operations*, operation of the project is expected to continue to limit public boating access at Brownlee reservoir during some periods. However, Idaho Power's proposal to develop a second deepwater boat launch on the Oregon side of the reservoir would improve public access over existing conditions.

In the same section, we also note that the crappie fishery appears to be influenced by inflow and the water year rather than project operations. Idaho Power is required to meet flood storage requirements as well as stable flows during fall months to meet fall Chinook salmon spawning requirements. During high-inflow years, these operational constraints require deep fluctuations of Brownlee reservoir and relatively rapid flow through the reservoir, both of which may adversely affect the warmwater fishery by limiting spawning areas and flushing young-of-year through the reservoir. During low-inflow years, less water flows through the project, which allows Idaho Power to maintain Brownlee at a higher elevation, and may keep the year-class of fish from being flushed from the reservoir. Given the project's flood storage and the outflow requirements, it does not appear that the recommended fisheries plan would benefit recreational angling opportunities.

3.10.2.12 Effects of Other Measures on Recreation

Sediment Transport

Implementation of measures to restore 14 acres of sandbars through sand augmentation, as specified in Forest Service 4(e) condition no. 4, would help maintain some current beaches and would provide a buffer against continued beach erosion. Because beaches provide locations for boat landing, swimming, and camping, the sand augmentation measure would benefit recreational users. Although the barges needed to deliver the sediment could interfere with recreational boat traffic, we conclude that any such effect would be minimal.

Aquatic Resource Measures

Numerous proposed and recommended aquatic resource measures would work in combination to improve recreational resources by improving the quality of the flat-water and riverine recreational fishery. The proposed improvements to the Fish Hatchery Plan would likely improve the quantity of anadromous fish returning to the project, and the tributary habitat enhancement program should provide some improvements to the quality of the trout fisheries that exists in those streams.

As discussed in section 3.10.2.1, *Project Operations on Recreation Resources*, the recommended Flow Augmentation Scenario to improve aquatic resource downstream of the project would potentially keep Brownlee reservoir below full pool for longer periods than existing conditions. While Idaho Power's low-water boat launch proposal would allow recreational use of the reservoir and provide access when the reservoir is low, the flow augmentation program could reduce the total navigable surface area during some water years.

Terrestrial Resource Measures

The proposed and recommended terrestrial resource measures would improve recreational resources by increasing the abundance and diversity of wildlife in the project area. Viewing and hunting wildlife in the project area represents important recreational opportunities that visitors are interested in pursuing (Moore and Brown, 2003; Claycomb and Brown, 2003). Terrestrial resource measures, including the proposal to acquire thousands of acres of upland and riparian habitats, have the potential to

introduce wildlife to parts of the project where habitats are currently degraded, improving opportunities for wildlife viewing and hunting.

A major component of the proposed and recommended noxious weed program is to remove these weeds from dispersed recreational areas. To the degree that these measures are effective, they would help improve the quality and comfort of many of the dispersed sites.

Cultural Resource Measures

The proposed and recommended cultural resource measures would improve recreational opportunities in the project by enhancing public access sites with Euro and Native American education and interpretation information. Providing cultural resource materials at recreational sites would provide visitors with a historical and cultural context for their experience.

Land Use and Aesthetic Resource Measures

The proposed and recommended land use and aesthetic measures would improve recreational resources by enhancing the aesthetic character of the area, reducing contrasts between project facilities and natural environments and streamlining implementation of environmental resource plans. The proposed and recommended HCRMP would also help define appropriate and prohibited uses on lands throughout the project area, which would help reduce conflicts between recreational activities and between recreation and other land uses.

3.10.3 Cumulative Effects

The proposed and recommended recreational measures would contribute to a beneficial effect on recreational opportunities at the project. A primary goal of the proposed and recommended measures is to improve the recreational experience and manage recreational resources in a manner that does not conflict with other land uses. The proposed and recommended improvements to facilities and the proposed management measures would achieve these goals by reducing user conflicts, distributing visitors more evenly throughout the recreational season and expanding recreational opportunities to meet recreational demand for the term of any new license issued.

The cumulative effect of increased recreational use associated with both growing recreational demand and new recreational opportunities would create new recreational opportunities for regional visitors. Given the extent of land within the project boundary and the number of high quality dispersed recreational sites, it is unlikely that increased recreational use would be exceed the capacity of the project and be displaced to surrounding areas beyond the project boundary. However, as recreational demand for boating and camping opportunities at the project increases over time, some visitors may be displaced to dispersed sites along project reservoirs. Although individually minor, the cumulative effect of increased used of the dispersed sites may adversely affect wildlife and recreational values of these sites. The proposed site stabilization measures, the biannual litter management program, and RAMP should help Idaho Power and stakeholders preserve the recreational and wildlife attributes of these sites as demand increases. Overall, we believe that the proposed site improvements and improved management strategies within and adjacent to the project would offset any cumulative adverse effects of increased dispersed recreational use.

3.10.4 Unavoidable Adverse Effects

None.

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3.11 AESTHETICS

3.11.1 Affected Environment

Project area vistas are dominated by the waters of the three reservoirs and the landscape of rolling hills and steep canyon walls that surround the project. The gorge cut by the Snake River to form Hells Canyon is the deepest river canyon in North America, and as such it provides spectacular visual effects (Sullivan et al., 2001).

As part of its relicensing process, Idaho Power conducted a study of the aesthetic environment within the study area (Sullivan et al., 2001). The study used protocols developed by BLM and the Forest Service to assess visual resources. Sullivan et al. (2001) used the BLM's Visual Resource Management System (VRM) to describe areas of predominantly BLM lands, which also included state, county, private and a small amount of Forest Service lands (VRM study area). They used the Forest Service Scenery Management System (SMS) on areas of predominantly Forest Service lands, which also included limited state and privately owned lands (SMS study area).

The VRM and SMS visual management systems establish visual quality objectives as metrics against which introduced elements such as project facilities and operations can be compared to determine whether they comply with the stated visual quality objective. The BLM's VRM system uses a Visual Contrast Rating to determine the visual condition of a landscape. The Forest Service SMS system relies on an assessment of landscape character and scenic integrity to determine the visual and aesthetic condition of a landscape (Sullivan et al., 2001). Both systems establish specific viewpoints from which the landscape is observed and evaluated. In its study, Idaho Power evaluated only sites from which project facilities, operations, or their effects were visible.

Using these systems, Idaho Power found that 24 of the 27 viewpoints with views of project facilities or operational effects within the VRM study area exceeded the acceptable level of contrast allowed to maintain the visual quality objective. Visual contrasts found in the VRM study area include the appearance of power-generation facilities and substations, reservoir drawdown, vegetation alteration, and hardscape elements at recreational facilities. The facilities that were visible from the viewpoints, including Brownlee and Oxbow dams, powerhouses, substations, access roads, and reservoirs, dominated views and created strong to moderate degrees of contrast in form, line, color, and/or texture.

Within the SMS study area, Idaho Power found that the recommended desired landscape character was not achieved at 30 of 33 viewpoints and the recommended desired scenic integrity was not achieved at 22 of the 33 viewpoints; these two indicators comprise the two parts of the SMS visual quality objective.[104] Visual contrasts found in the SMS study area were the same as those found in the VRM study area with the addition of transmission line 945, river water-level fluctuations, and the loss of sandy beaches. The same types of facilities as those identified in the VRM study area created strong to moderate deviations in form, line, color and texture from the landscape in the SMS study area.

Unless otherwise stated, we use information from the Idaho Power license application's *Report on Land Management and Aesthetics* to describe aesthetic conditions within and adjacent to the project (Idaho Power, 2003a, exhibit E.6).

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[104] Idaho Power study results found that 35 of 47 viewpoints in the VRM study area, 41 of 44 viewpoints for the recommended desired landscape character in the SMS study area, and 33 of 44 viewpoints for the recommended desired scenic integrity also in the SMS study area did not comply with visual quality objectives. Some of these viewpoints include in their view transmission lines that are no longer considered to be project facilities. Those viewpoints are not considered in this analysis unless other project features are visible from the viewpoint.

3.11.1.1 Brownlee Development

The visual character around Brownlee reservoir is characterized by rolling sage and grass covered hills that are steeper as the canyon narrows at the downstream end of the reservoir. The lower two-thirds of the reservoir where the terrain is steeper is mostly void of forest vegetation with the exception of small pockets of riparian vegetation on the shoreline. Pockets of taller cottonwoods are found along small creeks and tributaries. While little sign of human presence exists along this 14,000-acre, 58-mile-long reservoir, Brownlee reservoir is, nonetheless, the most developed of the three reservoirs. Residential developments and docks are found along flat areas of the shoreline, and lead to developed parks and a rural community near the Powder River Arm.

Brownlee reservoir elevations vary substantially from season to season. During periods of drawdown, a large, light-colored ring, called the "drawdown zone," is visible around the reservoir margin. The drawdown zone normally ranges from 20 to 70 vertical feet in the spring and 10 to 70 feet in the fall, but can be as large as 101 feet. Compared to the surrounding countryside, the drawdown zone provides weak contrasts in form and line, strong contrast in color, and moderate contrast in texture (Sullivan et al., 2001).

Deviations from native vegetation, including weed species colonization caused by drawdowns and exotic plants incorporated into facilities and parks, create visual contrasts on Brownlee reservoir. While the contrasts created by weed species colonization are weak in form, line, color and texture, those caused by exotic plants (e.g., irrigated and mowed lawn) incorporated into Idaho Power facilities are strong to moderate in form and line, moderate in color, and weak in texture (Sullivan et al., 2001). Hardscape elements at recreational facilities, such as site furnishings, parking areas, boat ramps, roads, picnic shelters and toilet facilities, are most apparent at developed recreational sites and some dispersed recreational sites, especially at Woodhead and Hells Canyon Parks. These elements generally create strong contrasts in form, line and color, and moderate contrasts in texture (Sullivan et al., 2001). Idaho Power notes that maintaining the full-pool elevation in the reservoirs would eliminate both visual contrasts created by the drawdown effect and undesirable vegetation in the drawdown zone.

From certain viewpoints, project facilities including Brownlee dam, powerhouse, access roads and appurtenant facilities including substations, typically dominate views in localized areas. From the upstream side of the dam, either from the road or the reservoir, the view of the dam and other facilities is subordinate to the landscape and reservoir, since it is mostly hidden from view by the reservoir. Project facilities are much more visible from the downstream side of the dam, including Oxbow Bridge, where they create strong to moderate degrees of contrast in form, line, color and texture. The dam is silhouetted against the skyline, becoming a focal point. The Brownlee cage, a wire frame that passes over the road from the rock wall on one side of the road to a metal grated wall on the other side of the road, protects project facilities from falling rocks along the Brownlee-Oxbow Road. It is constructed of steel beams, wire mesh and support cables. Although the cage dominates the viewshed only for short periods when viewers pass under it in a car, it contributes to the strong contrast caused by project facilities. Non-project transmission structures and the Idaho 71 road cut similarly dominate the viewshed at some points (Sullivan et al., 2001).

3.11.1.2 Oxbow Development

The canyon walls of the 1,400-acre Oxbow reservoir are characterized by steep rock cliffs, basalt outcroppings and talus slopes. The shoreline is well vegetated with shrubs and trees. Human development is limited in this area by the steeper slopes, but signs of human use are visible where small pockets of level land occur. The landscape and reservoir dominate the view through most of the reservoir's 12-mile length.

The narrow reservoir fluctuates less than 5 feet per day, so the drawdown zone is small and the visual effect is minimal. The drawdown effect typically results in weak contrast in form, line and texture,

and moderate contrast in color. Most of the development along Oxbow reservoir, including Idaho Power facilities, occurs on the Oregon side of the reservoir. The Brownlee-Oxbow Road, owned and maintained by Idaho Power, runs the length of the reservoir on the Oregon side, creating a high contrast (Sullivan et al., 2001).

Power-generating facilities of the Oxbow development create strong to moderate degrees of contrast in form, line, color and texture; however, this development is difficult to see from public roads. Upstream views of the development are primarily dominated by the landscape and the reservoir, but the dam can be seen from the lower 1-mile of the road. The closer visitors get to the dam, the more it contrasts with the surrounding landscape and dominates the viewshed. From downstream, the dam structure is contained by rocky outcroppings at the apex of the oxbow bend in the river and does not dominate the landscape from primary viewpoints. The area immediately below the dam is mostly denuded of vegetation and is crossed by a gravel service road. The spillway, road and parking area create high contrast (Sullivan et al., 2001). The bypassed reach, which runs for approximately 2.5 miles, is shallow and has little current.

3.11.1.3 Hells Canyon Development

The Hells Canyon reservoir covers 2,300 acres in its 25 mile length. It is bordered by vertical cliffs of rock and talus slopes, forming a narrow canyon whose shoreline has the most shrub and tree coverage of the three reservoirs. Little development other than small residential communities and Hells Canyon Park exist along this reach. As with Oxbow reservoir, the drawdown effect at Hells Canyon reservoir is minimal since the reservoir normally fluctuates 2 to 3 vertical feet per day, with a maximum of 5 feet. However, the drawdown effect in Hells Canyon reservoir does create a white- to buff-colored band that causes weak contrasts in form, line and texture, and a moderate contrast in color (Sullivan et al., 2001).

Alterations to vegetation caused by project facilities and operations along the reservoir, including irrigated lawns and ornamental landscaping at areas such as Hells Canyon Park and Kirkwood Ranch, result in contrasts in color and form that deviate from the natural landscape (Sullivan et al., 2001). However, Idaho Power reports that many users of these areas find the shade trees and green lawns to be a favorable feature in the summer heat of Hells Canyon. Heavy recreational use of the HCNRA has caused trampling of vegetation at many sites (6 acres total). Hardscape elements often found at developed recreational sites such as Hells Canyon Park and Dug Bar Landing contrast from the scenic integrity and are not consistent with the historical context of the landscape. Docks, structures and buildings, for example, have reflective materials and contrast in color with the surrounding landscape. Other features located in the Hells Canyon reservoir and Snake River vicinity, including handrails, fencing, Jersey barriers, signs, and some parking areas, cause strong contrasts in form, line and color, and moderate contrasts in texture (Sullivan et al., 2001).

Applying the Forest Service SMS system to the Hells Canyon reservoir and Snake River reach, Idaho Power found that both project[105] and non-project transmission structures, power-generation facilities, reservoir drawdown effects, river water-level fluctuations, alterations to vegetation, hardscape elements and structures, and the loss of sandy beaches create contrasts that are similar to those defined using the BLM's VRM system at the Brownlee and Oxbow developments. Sullivan et al. (2001) found that transmission towers and lines dominated the views, especially the non-project transmission line 907 along Wallowa Mountain Loop Road, a designated Scenic Byway.

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[105] Transmission line 945, the only project-related transmission line, is found in two of the SMS viewpoints where it creates inconsistencies in form, line, color, and texture with the desired landscape.

Viewed from the upstream side, the Hells Canyon dam tends to blend with the surrounding landscape since the dam is mostly concealed by the reservoir; however, when the dam is approached from the north (downstream) side, the dam and facilities create strong to moderate contrasts in form, line, color and texture (Sullivan et al., 2001). From the downstream side, the facilities dominate the scene, and the smooth, massive, gray concrete dam structure is visually inconsistent with the jagged slopes that form the dam embankments. The approach to the dam is not aesthetically pleasing and does not give any indication that is serves as the entrance to the deepest gorge in North America and the HCNRA (Sullivan et al., 2001). The Hells Canyon Visitor Information Center, which is owned and managed by the Forest Service and is associated with the Hells Canyon Boat Launch, presents only small inconsistencies with the surrounding landscape. Kiosks and stairs blend in, and the view is focused on the landscape rather than the structures. Some inconsistencies occur, however, such as the dock and counter-weight structures, the poor condition of signs, and dominant weeds (Sullivan et al., 2001).

3.11.1.4 Snake River Downstream of Hells Canyon Dam

The Snake River downstream of Hells Canyon dam, which is outside of the project boundary but inside the study area defined by Idaho Power, continues as a narrow and vertical basalt canyon for 17 miles, at which point it broadens as the rock cliffs transition to steep, grass covered hills. The aesthetic character of the Snake River downstream of Hells Canyon dam remains largely uncompromised because the area is part of the HCNRA. The major cause of aesthetic inconsistencies with the landscape is visitor use and the associated trampled vegetation, denuded sites, compacted soils, and erosion. However, the scenery remains the focal point for viewers.

River level fluctuations along this reach can result in a prominent white- to buff-colored band varying in width from inches to several feet along the river's edge. The absence of sandy beaches is also notable (Sullivan et al., 2001).

3.11.2 Environmental Effects

3.11.2.1 Effects of Project Operations on Aesthetics

We describe Idaho Power's proposed operations in section 2.2.2, *Proposed Project Operations*, and we assess the effects of the proposed operation on reservoir levels and project outflows in section 3.3.2, *Effects of Proposed Operations on Water Quantity*. In section 3.3.2.2, we identify operation-related recommendations filed by agencies, tribes and other parties (table 9), and we describe three alternative operational scenarios that we use to assess the effects of the various operation-related recommendations. At our request (AIR OP-1), Idaho Power simulated project operations for these representative scenarios under various hydrologic conditions. Refer to section 3.3.2.2 for additional discussion of the scenarios and the modeling process used for the simulations. We use the results of these simulations to assess the effects of the operation-related recommendations.

In the following sections, we evaluate the effects of Idaho Power's proposed operations and of operation-related recommendations received from agencies, tribes, and other parties on aesthetic resources as they relate to reservoir drawdown and riverbanks downstream of Hells Canyon dam.

Reservoir Drawdown

Reservoir drawdown can create a distinct white- to buff-colored band along the perimeter of the reservoirs. This band of bare sediment can contrast in form, line, color and texture with the surrounding landscape and can affect riparian vegetation and noxious weed establishment and growth, which also affects the appearance of the drawdown zone. In this section, we evaluate the effects that proposed and alternative operations would have on the scenic integrity of the project area based on differences in the

timing and amount of bare sediment that would be exposed. The extent to which riparian habitat and the presence of noxious weeds would be affected is discussed in section 3.7.2.

Our Analysis

Under Proposed Operations, water levels in Oxbow and Hells Canyon reservoirs typically fluctuate by no more than 5 feet, although fluctuations of up to 10 feet can occur (see section 3.4.2.1, *Effects of Project Operations*). Although these reservoir fluctuations are minimal compared to those of Brownlee reservoir, the visual contrast of the bare shoreline is still present. Any time the reservoir levels are below full capacity, the drawdown effect is visible. Compared to proposed operations, neither Oxbow nor Hells Canyon reservoirs would be affected by the alternative operational scenarios.

At Brownlee reservoir under Proposed Operations, the drawdown effect would be most pronounced by the end of April (a drawdown of 44 feet, 77 feet, and 97 feet for medium, medium-high and extremely high water years, respectively) and least pronounced by the end of June when the reservoir would be full. The drawdown effect would be apparent again starting in early July and would gradually increase through mid-October when the reservoir refilled again. With a lower reservoir level, the drawdown effect is greater, and the impact on visual resource is greater. Under extremely low or medium-low water years, when there is no need to draw down the reservoir for flood control, there would be very little springtime drawdown and thus very little effect on visual quality.

Water level fluctuations in Brownlee reservoir and the resulting visual contrasts that would result from Scenario 1 (Reregulating) would be similar to those associated with Proposed Operations for all water conditions.

Reservoir elevations under Scenario 2 (Flow Augmentation) would be the same as under Proposed Operations for the first half of the year. Starting in late June, operations under this scenario would lead to an earlier and more rapid drafting of Brownlee reservoir in the summer under all water conditions. In the medium water year, for example, the 2,050-foot-msl reservoir elevation would be reached by the end of July (exposing a band of bare sediment around the reservoir equaling as much as 27 vertical feet), in contrast to reaching the same point in mid-October under Proposed Operations (table 87; also see figure 15). Compared to existing conditions and Proposed Operations, this earlier drawdown would adversely affect the aesthetic appearance of Brownlee reservoir by allowing for a larger band of bare shoreline to be visible for a longer period. This would occur during the summer months, which is the peak of visitor use (see section 3.10, *Recreational Resources*).

Table 87. Range of drawdown zone (feet) for Brownlee reservoir under Proposed Operations and the Flow Augmentation Scenario during July to October representing the following water conditions: extremely low flow (1992), medium flow (1995) and extremely high flow (1997). (Source: Brink and Chandler, 2005)

Water Conditions	July	Aug	Sept	Oct
Proposed Operations				
Extremely Low Flow	2	3–5	5–10	10–11
Medium Flow	1–4	4–8	8–19	19–26
Extremely High Flow	0–8	9–18	18–39	41–42
Scenario 2 (Flow Augmentation)				
Extremely Low Flow	7–28	28	25–28	17–25
Medium Flow	3–27	28	28–29	26–29
Extremely High Flow	0–27	28	28–44	43–45

Scenario 3 (Navigation) would differ from the Proposed Operation only under extremely low water conditions and only during June through July. Under this scenario, little reservoir refill would occur as inflow spikes would be passed through the project during these months Water level fluctuations resulting from this scenario would detract from the visual integrity of the reservoir by maintaining a band of bare shoreline into the summer months compared to existing conditions. This negative effect would result in only minor adverse changes from Proposed Operations and would occur only during low water years.

For all scenarios as well as Proposed Operations, the greatest aesthetic effect of Brownlee reservoir drawdown would occur from January through April and again around mid-October, with deep drawdowns of more than 40 feet. These deep drawdowns would occur when relatively few visitors are present. During the summer months, the visual effect would be most pronounced under Scenario 3 (Flow Augmentation), resulting in a drawdown zone of more than 25 feet that would last through the summer. Maintaining existing conditions or adopting Scenario 1 would result in the smallest drawdowns and would thus have the least adverse effects on aesthetics.

It appears that the presence of noxious weeds and riparian vegetation would not change substantially from existing conditions with any of the scenarios or Proposed Operations (see *Noxious Weeds and Invasive Exotic Plants* and *Riparian Habitat and Associated Wildlife* in section 3.7.2.1). Thus neither Proposed Operations nor any of the scenarios would substantially affect the visual quality relating to vegetation in areas surrounding the reservoirs.

Idaho Power's proposal to implement informational and educational measures interpreting the reservoir drawdown zone would help educate the public about the color contrast caused by the drawdown effect and how reservoir drawdown may be important to other resources.

Riverbanks Downstream of Hells Canyon Dam

River stage changes downstream of Hells Canyon dam can cause a prominent white-to-buff band along the edge of the river, which can contrast in form and color with the surrounding landscape. Also, stage changes in the river as a result of project operations can affect the establishment of sandy beaches and alter their composition downstream of the project, which can affect the visual diversity that arises from the presence of beaches and sandbars in the river environment. The extent to which riparian habitat would be affected is discussed in *Riparian Habitat and Associated Wildlife* in section 3.7.2.1.

Our Analysis

In its comment on the draft EIS, Idaho Power indicates that the white band downstream of the Hells Canyon dam is visible in pre-project photographs from the 1940s. No study has been done to determine what portion, if any, of the white band results from project operations.

Details of how Proposed Operations and each of the operational scenarios would affect river water-level fluctuation in terms of the maximum percentage of the streambed that is subject to dewatering is found in *Primary Production and Aquatic Macroinvertebrates* in section 3.6.2.1 and in table 40. The higher the percentage of streambed that would be dewatered, the greater the effect on visual resources since more of the shoreline would be exposed. Proposed Operations, Scenario 2 (Flow Augmentation), and Scenario 3 (Navigation) are similar to each other in having the highest percentages of river water fluctuations and thus the greatest effect on visual quality under all flow conditions, with one exception: during high water years, Scenarios 2 and 3 would both dewater only a small percentage of the streambed below the Salmon River compared to Proposed Operations. The percentage of the streambed that is subject to dewatering would be the lowest under Scenario 1b (Year-round 2-Inches-Per-Hour Ramping Rate) followed by Scenario 1c (Year-round 6-Inches-Per-Hour Ramping Rate). These scenarios would leave the smallest amount of the stream bank exposed and thus have the least effect on aesthetics.

As described in *Beach and Terrace Erosion* in section 3.4.2.1, Parkinson et al. (2003a) report that three of four monitored sandbars experienced both erosion and aggradation (buildup through sediment deposition) during a 1997 to 2000 monitoring study, while the fourth sandbar experienced only erosion. The report concludes that slope failure at Fish Trap Bar due to load-following operations is *not* expected and notes that the substrate along the two unstable transects is not sand and would thus have a higher strength (due to interlocking) than the rest of the transects.

Although project effects on undercutting and slope slumping are minor, the visual diversity of the river is decreased to the degree that an operational scenario increases the undercutting and mobilization of sandbars and thus the loss of beaches and sandbars. In general, the area of sand mobilization would decline under the alternative operational scenarios compared to Proposed Operations. The area of sand mobilization would be the smallest under Scenario 1 (Stabilized Hells Canyon Release) and Scenario 1b (Year-round 2-Inches-Per-Hour Ramping Rate), thus these scenarios would tend to preserve more beach and sandbar area and thereby maintain the visual quality.

Proposed Operations and all of the modeled flow scenarios would reduce the irrigation effect on riverbanks and thus plant assemblages within the area influenced by project operations would transition to drier cover types (see *Riparian Habitat and Associated Wildlife* in section 3.7.2.1). The loss of riparian habitat (table 68) would detract from the visual quality of riverbanks downstream of Hells Canyon dam and would occur under Proposed Operations and all operational scenarios but would be the least under Scenario 2 (Flow Augmentation).

3.11.2.2 Aesthetic Improvements and Resource Management

Project facilities and operations can directly affect the aesthetic character of the project area along the three reservoirs (Sullivan et al., 2001). Hardscape elements of recreational facilities and project developments often create contrasts with the natural landscape, as can transmission structures that are in the vicinity of travel corridors or silhouetted against the horizon. Power-generating and substation facilities often dominate views in localized areas, creating contrasts with the natural landscape. Deviations from native vegetation can also create visual contrasts.

As part of its settlement with the Forest Service and consistent with modified condition FS-22, Idaho Power proposes to develop an aesthetic improvement plan for the Hells Canyon Dam Site and Recreational Portal. The proposal and FS-22 call for Idaho Power to enhance the upper deck and the entrance and egress areas of Hells Canyon dam that would be incorporated into the Scenery Management Plan and to file the aesthetic improvement plan with the Commission for approval. FS-22 specifies that alterations may include changes in fencing material, color of materials, screening of stop blocks, parking, signage, pedestrian walkways, interpretation, viewing areas and landscaping provided that such alterations are consistent with the FERC approved security plan for the dam. A schedule for implementation, to be prepared by Idaho Power, would be included in the aesthetic improvement plan.

Idaho Power originally proposed to implement aesthetic measures as part of the HCRMP (see section 3.12.2.1, *Land Use Management Plan*), in which goals and objectives as well as policies and guidelines for aesthetic standards are discussed. Now, as part of its settlement with the Forest Service and consistent with modified condition FS-24, Idaho Power proposes to prepare a Scenery Management Plan for project facilities and operations on Forest Service lands within the project boundary and adjacent to the project boundary within 1 year of license issuance. This plan would include: existing transmission lines and associated service roads, design standards and guidelines for physical structures and landscaping, general aesthetic clean-up and implementation, replacement of guardrails and jersey barriers, mitigation of contrast from project facilities, and enhancement of other facilities.

Interior-25 recommends that Idaho Power develop a visual resource management plan (VRMP) for project facilities to address the design, maintenance, and construction of project facilities (both existing and future facilities) to preserve or enhance visual resource values in the project area. Interior

recommends that within 10 years of license issuance, this plan incorporate a landscape development plan that includes standards and guides. Interior also makes recommendations within this plan regarding improvements to transmission lines and rights-of-way (discussed below). The purpose of this recommendation is meant to ensure that physical structures are compatible and complimentary to the landscape character as they are related to architectural consistency and appropriateness. Interior includes specific measures to improve color and form contrasts as well as enhance facilities using paint color or color additives to concrete, vegetative or other screening and landscaping, and planting native vegetation, and states that the VRMP should apply to the following facilities: (1) dams, bypass canals, spillways (concrete structures); (2) switch yards, power houses, buildings, penstocks, power lines (metal structures); (3) project recreation facilities including campgrounds and day-use sites; and (4) power line access corridors and cutbanks. Interior recommends the improvements noted above should occur at both existing and newly constructed sites, but that replacing conductors with non-reflective materials could occur at a time when reflectors would otherwise be replaced.

Our Analysis

Idaho Power's proposed and the Forest Service-specified scenery management plan (FS-24), including the aesthetic improvement measures (FS-22), would serve as a framework to develop and implement aesthetic improvement measures for the project. The plan would reduce the visual contrast of project facilities with their environment to improve aesthetics and enhance the recreational experience near those facilities. Developing the scenery management plan for the entire project area would help ensure that enhancements to project facilities and the landscape surrounding the entire project maintains its scenic integrity.

The Hells Canyon dam detracts from the scenic integrity of the surrounding landscape and the design of the entry sequence does not reflect the importance of the HCNRA (Sullivan et al., 2001). Idaho Power's proposed and the Forest Service-specified aesthetic improvements to Hells Canyon dam would decrease the facility's contrast with the surrounding landscape.

Interior recommends developing a VRMP with standards and guidelines for landscaping and development that would include concrete and metal structures, recreational facilities and power line access corridors as facilities to adhere to Idaho Power's proposed standards and guidelines. Including this recommendation in the HCRMP would help ensure that all facilities within the project area are improved to a consistent aesthetic standard and would help reduce existing contrasts in color and form created by the project.

Transmission Structures

The linear form and other attributes of transmission line corridors and tower access roads can contrast with natural features and detract from the visual quality of the environment. Regional transmission lines and towers are common detractors from valued landscapes, contrasting in form, line, color and texture in the SMS study area and dominating the foreground and middle ground views in several places. Transmission lines can also be highly reflective in sunny conditions and are visible on overcast days. Vegetation maintenance on transmission line rights-of-way creates gaps in native vegetation and produces a pronounced edge effect.

Idaho Power proposes to incorporate aesthetic concerns when upgrading or repairing the existing transmission line 945. The Aesthetic Subgroup developed several measures to address the visual effects of transmission line 945 and included the following standards: (1) when conductors are replaced or upgraded, non-specular conductors should be used; and (2) if a structure or series of structures needs to be replaced during a planned rebuild, structure type and in-line location should be reviewed with the BLM and/or Forest Service to incorporate aesthetic concerns, when compatible with engineering needs and designs.

As part of its recommended visual resource management plan (see above), Interior recommends that Idaho Power provide guidelines that address any new design, maintenance, or modification of transmission lines or associated rights-of-way to retain or enhance the visual resources of the area. Interior recommends that the plan explain how existing facilities would visually harmonize with the natural environment, for example, by replacing conductors with non-reflective material or replacing spectral wire with non-spectral wire during wire replacement during normal maintenance operations. In addition, Interior recommends that vegetation be managed in rights-of-way corridors to reduce visual contrasts created by the maintenance corridors according to VRM Class objectives.

Our Analysis

Transmission line 945 is the only project transmission line and is visible from only two of the SMS viewpoints. Idaho Power's proposal for improvements to transmission line 945 would help reduce the visual contrasts associated with these structures. The proposal is consistent with Interior's recommendation for improving the visual quality of transmission lines and their rights-of-way. However, Idaho Power's proposal does not include measures to enhance rights-of-way.

Creating a Transmission Line Aesthetics Plan within any overall aesthetics plan within the HCRMP would help improve the aesthetic environment by providing consistent guidelines for aesthetic changes. A plan that includes improvements to transmission structures as outlined in Idaho Power's proposal and Interior's recommendation, as well as right-of-way enhancements recommended by Interior, would help ensure that the negative aesthetic effects of transmission line 945 are ameliorated. Portions of Idaho Power's proposed design standards and guidelines for landscaping would be appropriate for enhancing deviations from native vegetation present in transmission line rights-of-way and could help diminish edge effects present in these areas. This is consistent with Interior's recommendation. However, because project transmission lines do not exist in the VRM study area, applying the standard VRM Class objectives may not be appropriate. In addition, because transmission line 945 is the only project line, the portion of Interior's recommended VRMP that includes modifications to transmission lines and rights-of-way would apply only to that line.

Idaho Power has proposed to develop standards and guidelines for new and existing physical structures; however, these standards and guidelines do not list transmission lines as one of the types of facilities to which these standards and guidelines would be applied. One of the long-term management strategies recommended in Sullivan et al. (2001) is a Transmission Line Aesthetics Plan. This report also lists several ways to reduce the contrast of transmission lines, including replacing conductors with non-specular materials to reduce reflectivity, painting towers to match the color of the landscape, and modifying vegetation management in transmission line rights-of-way to screen the lines and soften the edge effect. Creating specific standards and guidelines for transmission lines may not be necessary because transmission line 945 is visible only from two of the viewpoints established in Sullivan et al. (2001). However adapting the suggested enhancement measures for these viewpoints would bring these areas up to visual standards. These measures would include screening views of the transmission line, replacing lines with non-specular wire during normal maintenance cycles, and painting or dulling tower structures to minimize visual contrasts. In the event that new transmission lines are proposed, developing standards and guidelines for these facilities as well as using the suggested Transmission Line Aesthetics Plan found in the technical report on aesthetics as a guide would help reduce the aesthetic contrast of any new facilities.

3.11.2.3 Effects of Other Measures on Aesthetics

Sediment Transport

Implementation of measures to restore 14 acres of sandbars through sand augmentation, as specified in Forest Service 4(e) condition no. 4, would help maintain some current beaches and would

provide a buffer against continued beach erosion. Because beaches add to the aesthetic value of the river and provide attractive locations for recreational use, the sand augmentation measure would improve the aesthetic appeal of the river canyon.

Water Quality Measures

Idaho Power proposes to develop a reservoir aeration system to supplement DO into Brownlee reservoir (see section 3.5.2.2, *Dissolved*). The reservoir aeration system would comprise an onshore oxygen supply facility, including various pipes, hose lines, storage tanks and truck access. Depending on how and where the facility is constructed, it could detract from the visual quality of the landscape. Adhering to proposed and recommended aesthetic guidelines and standards for physical structures (see section 3.11.2.2, *Aesthetic Improvements and Resource Management*) and using landscaping and other screening measures would help the facility blend in with the natural surroundings.

Aquatic Resource Measures

Idaho Power's proposal to implement a native salmonid plan, as discussed in section 3.6.2.8, *Resident Salmonid Passage*, includes the construction of facilities and has the potential to affect the aesthetic character of the project. However, incorporating landscaping and other screening measures as well as the standards and guidelines for design and landscaping found within the HCRMP would lessen any visual contrasts that might occur.

Terrestrial Resource Measures

Idaho Power's proposal to eradicate, contain, and control non-native invasive plants and noxious weeds along the Snake River corridor from Weiser to the Salmon River confluence (see section 3.7.2.3, *Noxious Weed and Exotic Invasive Plant Management*) would improve the aesthetic character of the project by decreasing the visual contrasts created by non-native vegetation.

Cultural Resource Measures

Idaho Power proposes to stabilize archeological sites and recover archeological data to prevent possible damage by project operations (see section 3.9, *Cultural Resources*). These measures would help preserve historical sites in their existing condition. Applying the HCRMP's standards and guidelines for design and landscaping to construction of any new structure necessary for stabilization would decrease deviations from the native landscape such structures might create.

Recreation Measures

Idaho Power proposes several recreation measures that include developing and enhancing both dispersed and developed recreation sites and boat launches. These measures are intended to improve access, benefit recreation and improve facilities (see sections 3.10.2.2, *Recreation Plan,* and 3.10.2.3, *Recreation Site Improvements*). Any new construction could detract from the aesthetic character of the project. However, adhering to the proposed design standards and guideline for physical structures and landscaping outlined in the HCRMP would decrease the visual contrasts created by any new construction. Applying these standards and guidelines to recreation sites where no new construction is proposed could improve their visual quality by helping them blend in with the surrounding landscape. The proposed Litter and Sanitation Plan would also enhance the visual quality of the project.

3.11.3 Unavoidable Adverse Effects

None.

3.12 LAND MANAGEMENT AND USE

3.12.1 Affected Environment

The project is located in a rural part of western Idaho and northeastern Oregon within four counties: Washington and Adams counties in Idaho, and Wallowa and Baker counties in Oregon. Land use in the region includes agricultural and ranch lands, with some timber and resource extraction on mountainous Forest Service-managed lands. Most of the lands in the region and surrounding the project are under federal ownership, with a broad range of land-use designations. Unless otherwise stated, information in the following section is from the Idaho Power license application's *Report on Land Management and Aesthetics* (Idaho Power, 2003a, exhibit E.6).

3.12.1.1 Project Boundary

When the project was established, two methods were used to define the boundary. On private lands, the boundary was established at a reservoir elevation (contour line) and on federal lands, the project boundary followed surveyed section lines or sectional subdivision lines per the United Sates Public Land Survey. The existing project boundary on federal lands thus includes about 3,800 acres above the contour line.

The proposed project boundary, which would be the same as the existing boundary except that it would eliminate the 3,800 acres above the contour line, includes the reservoirs, the riverine reaches between the reservoirs, project facilities, appurtenant structures, and one transmission line. It extends for 95 miles on the Snake River from RM 343 near Weiser, Idaho, downstream to Hells Canyon dam at RM 247.6 and includes about 16,460 acres. Thirty-eight percent (6,340 acres) of this is above the normal high-water mark and thus remains unflooded.

3.12.1.2 Land Ownership and Management Jurisdictions

Land ownership in and immediately adjacent to the project follows a gradient of private ownership intermingled with BLM lands along the upstream portion of the project, including the Weiser Reach and Brownlee reservoir, to predominantly Forest Service-managed lands along the downstream Hells Canyon reservoir portion of the project area.

Regional Land Ownership

Lands adjacent to the project along the most upstream Weiser Reach are predominantly in private ownership. The BLM manages lands along the steeper canyon walls of Brownlee reservoir, as well as on the Powder River Arm where federal and private lands intermingle. Private ownership increases toward the end of the Powder River Arm to Richland, Oregon. The state-owned Cecil D. Andrus Wildlife Management Area lies just upstream of Brownlee reservoir on the Idaho side.

A similar pattern of federal lands interspersed with private lands occurs around Oxbow reservoir. BLM is the primary federal land manager in this area.

Most of the land surrounding Hells Canyon reservoir is under federal management. The Payette National Forest begins just downstream of Oxbow Village and continues north to the Hells Canyon dam on the Idaho side of the Snake River. Land ownership on the Oregon side of Hells Canyon reservoir is predominantly private interspersed with a few BLM-managed tracts from Oxbow Village downstream to the 652,488-acre HCNRA. The HCNRA, established in 1975 under Forest Service jurisdiction (Wallowa-Whitman National Forest), extends north from Hells Canyon dam on the Idaho side and from Copper Creek on the Oregon side to a point just south of the border between Washington and Oregon. Portions of the HCNRA overlap with Hells Canyon Wilderness, which extends north along both sides of the river from Hells Canyon dam.

Land Ownership within the Project Boundary

Idaho Power owns the majority (54 percent) of the unflooded land within the proposed project boundary[106] (table 88). Twenty-nine percent of the land within this project boundary is under federal ownership, and 13 percent is owned by private entities other than Idaho Power. Idaho Power owns or controls 3,450 unflooded acres within the project boundary and 1,850 unflooded acres outside of, but immediately adjacent to the project boundary. Most of the non-Idaho Power privately-owned land and BLM land, along with the small amount of state land, is located toward the upstream end of the project on Brownlee reservoir. Toward the downstream end of Brownlee reservoir, private lands within the project boundary all but disappear and land ownership is mixed between Idaho Power and BLM. Similarly, BLM and Idaho Power share land ownership along Oxbow reservoir. The Forest Service is the primary manager of lands within the project boundary along Hells Canyon reservoir; however, land on the upstream end of the reservoir is mixed between the BLM, Idaho Power, and private ownership (Johnson and Holmstead, 2003). No part of the project is located on tribal land.

Table 88. Land ownership and management by development within the Hells Canyon Project proposed project boundary, in acres. (Source: Idaho Power, 2003a, exhibit E.6)

Land Ownership	Hells Canyon	Oxbow	Brownlee	Total	Percent of Total Non-flooded Lands
U.S. Forest Service	330	0	0	330	5.2
Bureau of Land Management	30	270	1,210	1,510	23.8
State of Idaho and State of Oregon	0	10	200	210	3.3
Private (excluding Idaho Power)	160	60	620	840	13.3
Idaho Power Company[a]	270	980	2,200	3,450	54.4
Total Non-flooded Lands[b]	790	1,320	4,230	6,340	100
Total Flooded Lands	1,280	460	8,380	10,120	
Total Flooded and Non-flooded Lands	2,070	1,780	12,610	16,460	

[a] When buying land for the project, Idaho Power allowed the former owners to maintain certain use rights on the land; thus, there are limits on Idaho Power's control over some of their project lands.

[b] Non-flooded lands, which comprise 38.5 percent of the project area.

Land Management Plans

Major landowners within the project vicinity have created plans to guide their land management. These plans are discussed below.

Until recently, Idaho Power did not have a management plan for its lands within the project boundary. As part of the relicensing process, however, Idaho Power developed a HCRMP. We discuss the plan in section 3.12.2, *Environmental Effects*.

The Wallowa-Whitman National Forest is in the process of creating a new Forest Plan. However, the goals of the current plan adapted in 1990, as amended, include: protecting and preserving cultural resources; maintaining and enhancing air quality, soil productivity, water quality, and water quantity; maintaining native and desirable introduced or historical plant and animal species and communities as

[106] All mention in this section of the project area or project boundary refers to Idaho Power's proposed project boundary, which is described in section 3.12.1.1, *Project Boundary*.

well as ecosystem function; maintaining or enhancing riparian areas; protecting and managing habitat for the perpetuation and recovery of threatened, endangered, or sensitive species; providing for big-game winter ranges and selected summer ranges; protecting and enhancing anadromous fish habitat; providing a wide variety of recreational opportunities to all segments of society; providing for well-planned adjustments to landownership that are responsive to National Forest land management objectives; preserving the natural conditions and outstanding opportunities for solitude represented in the four wildernesses on the Wallowa-Whitman National Forest; providing for exploration, development, and production of energy and mineral resources on the National Forest in coordination with other resource values and environmental considerations; providing a safe and economical transportation system; controlling forest pests and noxious weeds; and managing range vegetation and related resources for wildlife and livestock grazing (Forest Service, 1990).

The 1988 Payette National Forest Land and Resource Management Plan, as amended, has goals that include identifying and managing cultural resources and areas of Native American religious importance; providing habitat diversity to support all native vertebrate species and rare plant species; managing drainages containing habitat for anadromous fish and maintaining habitat for resident trout; managing soil and water resources; protecting air quality; managing and protecting riparian resources; managing existing and proposed Research Natural Areas; maintaining water quality, developing and managing wastewater collection systems, and preventing future pollution of surface or groundwaters; providing public access in appropriate and safe areas; and responding to notices of FERC Exemption, License, and Preliminary Permit Application for hydroelectric proposals.

The BLM's Baker Resource Management Plan Record of Decision (1989) contains management objectives for the following areas that fall within the Hells Canyon Project and adjoining areas: Lookout Mountain, Homestead, Oregon Trail, Sheep Mountain, and Baker County Miscellaneous. The management objectives include maintaining or improving the following: riparian habitat, habitat quality for featured wildlife species, bald eagle habitat, big game forage, suitable habitat for reintroduction of native wild species including bighorn sheep, and scenic quality. In addition, the plan includes enhancing recreational opportunities, protecting cultural resources, maintaining the Oregon Trail, providing historical interpretation, and maintaining the wilderness values of wilderness study areas. The plan's goals also include consolidating ownership patterns to improve resource management of private and public lands, maintaining availability of public lands for utility and transportation corridors, and maintaining lands for mineral extraction and exploration.

Federal lands within the Hells Canyon Project vicinity have a variety of land management designations. At the upstream end of the project, federal agencies have few restrictions on use and manage the lands to support public access, ranching, and recreational use. The BLM-managed Sheep Mountain Area of Critical Environmental Concern (ACEC) and Wilderness Study Area (WSA), located along much of the Oregon side of Oxbow reservoir and the upstream portion of Hells Canyon reservoir, is managed to "protect outstanding scenic qualities, and maintain or improve wildlife and crucial bald eagle winter habitat" (Johnson, 2003). Two other BLM-managed ACECs are located along Hells Canyon reservoir downstream of Oxbow dam: the Homestead ACEC is managed to "protect outstanding scenic qualities, and wildlife, bald eagle and sensitive plant habitat", and the McGraw Creek ACEC is managed through an agreement with the Wallowa-Whitman National Forest (Johnson, 2003). The Snake River through the entire HCNRA is designated as either wild or scenic under the Wild and Scenic Rivers Act. In addition, the Forest Service-managed Seven Devils Scenic Area is located along both sides of Hells Canyon reservoir and overlaps part of the HCNRA.

The following gives a brief description of land designations that occur in the project vicinity:

- **ACECs**—ACECs are BLM lands where special management is required to protect and prevent irreparable damage to important historical, cultural, or visual values, fish or wildlife

resources, or other natural systems or processes, or to protect life and safety from natural hazards (Johnson, 2003).

- **HCNRA**—The purpose of the HCNRA is "to assure that the natural beauty, and historical and archaeological values of the Hells Canyon area and the 71-mile-long segment of the Snake River between Hells Canyon dam and the Oregon-Washington border, together with portions of certain tributaries and adjacent lands, are preserved for this and future generations, and that the recreational and ecologic values and public enjoyment of the area are thereby enhanced" (Forest Service, 2005).
- **Wild and Scenic Rivers**—The Wild and Scenic Rivers Act states that "certain selected rivers of the Nation which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations" (Public Law 90-542, as amended; 16 U.S.C. 1,271–1,287).
- **Wilderness Areas**—Wilderness Areas are federally designated lands, created under the Wilderness Act of 1964, that: are protected and managed to allow natural ecological processes to operate freely; possess outstanding opportunities for solitude or a primitive and unconfined type of recreation; provide areas where natural processes can operate free of human influence and man is a "visitor who does not remain"; and contain ecological, geological, or other features of scientific, educational, scenic, or historical value (Forest Service, 1990)

3.12.1.3 Land and Water Uses

Idaho Power studied land uses in an 848,000-acre study area that includes the project and surrounding areas (Johnson, 2003).[107] Major land uses in the study area include cultivated agriculture, livestock grazing, hydroelectric power generation, recreation, wildlife habitat, and residential and rural residential use. Idaho Power found that approximately 76 percent of the study area (646,000 acres) is included in grazing allotments and approximately 65 percent is federally owned. Idaho Power reports that any mining that occurs in the area is likely recreational, and timber harvests have not occurred recently. Some commercial use exists on I-84, located on the upper end of the project area on the Oregon side. At the upstream end of the study area, near the Weiser reach, the rolling hills and level topography allow for agricultural and rural development, recreation areas, and other human uses. Intense agriculture and grazing occur on the Powder River arm. Only pockets of development occur downstream where the canyon walls are steeper.

Four types of uses occur on Idaho Power-owned land within the project boundary (Johnson and Holmstead, 2003). The first type, project-related use, includes O&M of the hydroelectric plant, transmission lines, Idaho Power residential areas, and parks developed by Idaho Power. The second type of use, secondary residential use, is use by residents of Hells Canyon, which includes the approximately 120 residents associated with Idaho Power (employees and their families), camp hosts, consultants, and county sheriffs' deputies. Livestock grazing is reported as the primary non-residential use by these

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[107] Idaho Power's approximately 848,000-acre study area for land use and aesthetics extends beyond the project boundary and includes 170 miles of river: upstream from the project boundary to the bridge near Weiser (RM 351.2; the Weiser reach), downstream of Hells Canyon dam to the northern boundary of the HCNRA (RM 176.1). The study area includes two mountain ranges: the Seven Devils Mountains in Idaho to the east and the Blue Mountains in Oregon to the west, forming the nearly 10,000-foot-deep Hells Canyon.

residents, whose recreational use is considered part of the third type of land use (see below). The third type of use is recreation by the general public, which is dominated by fishing, boating, lounging, sightseeing, and hiking. The fourth type of use is that authorized by specific leases and permits. Activities licensed under these permits and leases include livestock grazing and agriculture, parks owned by local and federal governments, recreational concessions, and private recreational structures, all of which must comply with the FERC project license. In addition to the above uses, unauthorized use, particularly unauthorized cattle grazing, also occurs on Idaho Power lands (Johnson and Holmstead, 2003).

Various public recreation parks are operated by Idaho Power, BLM, Forest Service, State of Oregon and Baker County, Oregon (see section 3.10, *Recreation*). The small residential communities scattered through the project area, which tend to be clustered together, are located on the Oregon side of the upper Brownlee reservoir, around Richland on the Powder River arm, at Idaho Power's Brownlee and Oxbow villages on the Oregon side, and at Homestead near Hells Canyon reservoir. The year round population of the study area is about 200 people (Johnson, 2003). Other human uses include recreation areas and sanitary facilities, Idaho Power's hydroelectric facilities, old mines, and a few scattered residences. Water uses within Hells Canyon Project include irrigation; water supply for livestock, agriculture, and industry; wildlife; hunting and angling; boating; aesthetics; commercial navigation and transportation; and hydropower.

In describing study area land uses, Idaho Power defined land uses by reach, including the Weiser reach upstream of the project area, Brownlee reservoir with four subreaches (upstream, central, Powder River arm, and downstream), Oxbow reservoir, Hells Canyon reservoir with two subreaches (upper and lower), and the river reach just downstream of the project area. A description of land uses along these reaches within and adjacent to the project boundary follows.

The Weiser Reach (bridge near Weiser to Cobb Rapids) is dominated by cultivated agriculture and rural development. The town of Weiser (2000 population of 5,343) is connected by a substantial road network to several major highways.

The Brownlee reservoir reach is dominated by livestock grazing and recreation. Camping that occurs along this reach is located on federal, private, and Idaho Power owned lands. Much of this reach is also used by wildlife and serves as critical winter habitat for elk and mule deer. For study purposes, Idaho Power divided this reach into four subreaches:

- **Upstream Subreach (Cobb Rapids to Burnt River/Spring Recreation Site)**—The rolling topography of this reach, dominated by cultivated agriculture, is where I-84 passes through the region on the Oregon side. Because of the proximity of the highway, the area includes several RV parks, the BLM-managed Oasis dispersed recreation site and Spring recreation site, Farewell Bend State Park, and commercial businesses. Steck Park, jointly operated by the BLM and IDFG, and BLM-managed Weiser Dunes area for ATV use are located on the Idaho side. Secondary roads, public access, campsites and other uses also occur within this reach.
- **Central Subreach (Burnt River/Spring Recreation Site to Swedes Landing)**—The Oregon side of this reach includes a private recreational residential community comprising residences that are used seasonally or occasionally in association with recreation. Easy road access for approximately 1 mile of this subreach makes it a popular destination for dispersed recreation, including fishing and camping. Wildlife habitat and grazing dominate the remainder of the Oregon side and the virtually roadless Idaho side. A former commercial recreation site, the Mountain Man Lodge, was in operation on the Idaho side until 1997.
- **Powder River Arm Subreach**—The downstream end of this side channel is virtually roadless and is used primarily for livestock grazing as well as wildlife habitat. The area

upstream from the small oxbow is generally developed. County-operated Hewitt and Holcomb parks and scattered residences lead to Richland, Oregon and Oregon Highway 86.

- **Downstream Subreach (Swedes Landing to Brownlee Dam)**—This virtually roadless subreach is dominated by livestock grazing and wildlife habitat. Idaho 71 drops toward the reservoir for a short distance, providing access to Idaho Power-operated Woodhead Park and the Brownlee dam. Dispersed recreation occurs in this area.

The Oxbow reservoir reach starts just below Brownlee dam and runs the length of the Oxbow reservoir. Dispersed recreation, along with the Idaho Power-owned Brownlee Village and Oxbow Yard, occur along Idaho 71. The Idaho Power-operated McCormick Park is located near the Idaho 71 bridge on the Idaho side.

The Hells Canyon reservoir reach starts downstream of Oxbow dam and runs the length of the reservoir to the Hells Canyon Visitors Center, downstream of Hells Canyon dam. Hells Canyon Road runs the length of the reservoir on the Idaho side, with limited reservoir access points. The unpaved Homestead Road runs 9 miles downstream, starting from Oxbow Village on the Oregon side. Along the upper reservoir, land uses include private residences, dispersed and residential recreation, and an airstrip. The BLM-managed Copper Creek dispersed recreation site is located at the end of Homestead Road. Due to the steepness of the Idaho side of this reach, this area is primarily limited to wildlife habitat and livestock grazing, with the exception of Idaho Power-owned Hells Canyon Park. Along the lower reservoir, land is managed by Forest Service for wildlife habitat and dispersed recreation, including the Forest Service-managed Hells Canyon Creek recreation site and Hells Canyon Visitors Center. The HCNRA comprises most of the Oregon side of this reach, which includes dispersed recreation and livestock grazing.

The River Reach, downstream and outside of the project boundary, comprises the HCNRA and the Hells Canyon Wilderness. The river is designated as either wild or scenic under the National Wild and Scenic Rivers System through the length of the HCNRA. Recreational uses include jet boating, power boating, float boating, fishing, hiking, hunting, and camping. A few cabins, ranches, and commercial lodges are permitted by the Forest Service, and Forest Service administrative sites also occur along this reach.

3.12.1.4 Road Management

The major roads accessing the project area on the Oregon side are Interstate Highway 84 near Farewell Bend State Park on Brownlee reservoir and Oregon Highway 86 at Oxbow dam. Baker County, Oregon owns and maintains a 40-mile gravel-surfaced road that parallels the west side of Brownlee reservoir between Huntington and Richland (Idaho Power, 2003a, exhibit E-1). County-owned and maintained roads run along the shorelines of much of Brownlee reservoir on both the Oregon and Idaho sides. The middle part of the Idaho side of Brownlee reservoir is virtually roadless. Idaho 71 provides access to Brownlee reservoir from Woodhead Park to Brownlee dam on the Idaho side. It crosses Oxbow reservoir just below Brownlee dam and becomes Idaho Power's Oxbow-Brownlee Road. This road ends at Oxbow dam where it intersects with Oregon Route 86.

Idaho Power owns and maintains two roads that provide primary access for both the public and Idaho Power to the portions of the project area where these roads are located: (1) the 12-mile paved Oxbow-Brownlee Road that parallels the Oregon side of Oxbow reservoir, and (2) the 23-mile paved Hells Canyon Road that runs the length of Hells Canyon reservoir along the Idaho side and just beyond Hells Canyon dam on the Oregon side and provides the only land access to the HCNRA and the Forest Service Hells Canyon Visitors Center. Although county owned, the unpaved Homestead Road, which runs 9 miles downstream from Oxbow Village to near Copper Creek, is maintained by Idaho Power from Oxbow Village to near Ballard Creek.

3.12.2 Environmental Effects

3.12.2.1 Land Use Management

Project facilities and operations can be incompatible with other land and water uses within the project boundary, such as when development of a recreation facility leads to shoreline erosion or adverse effects on wildlife habitat or cultural resources. Land management issues also include the adequacy of buffers that separate incompatible uses, and the adequacy of management measures designed to protect natural and cultural resources.

Idaho Power proposes to implement the HCRMP to guide land management decisions within the project boundary. The plan has already been developed and includes defining buffers between incompatible uses and establishing and maintaining compatibility between and among the various land and water uses in the project. Idaho Power defines a buffer as "an area or structure that lessens, absorbs, or protects against an impact from an adjoining land use or activity" (Johnson, 2003). In addition, the plan includes Common Policies that would provide for the management, protection, and/or conservation of natural and cultural resources. The management directive of this plan is to provide for continual human use and opportunities while protecting natural and cultural resources.

Various policies within the plan require the development of implementation tools and programs as well as management plans specific to a resource or issue, including but not limited to, the following:

1. Information and Education Program—including an interpretive plan to explain the significance of a place or thing to the viewer; an education plan to inform people about resources and to protect natural and cultural resources by making people aware of the consequences that their actions can have on these resources; and a sign plan to provide visitors with information;
2. Evaluation of Dispersed Recreation Sites—to evaluate resource conditions at existing dispersed recreation sites within certain land/water designations to determine actions that may be needed to protect natural and cultural resources from human disturbance;
3. Evaluation of Recreation/Riparian Interfaces—to determine over time whether recreational activities adversely affect the vegetation cover and to take actions to protect the vegetation where vegetation cover is adversely affected;
4. O&M Standard Practices—to establish standard practices for O&M activities to reduce conflicts with natural and cultural resources and recreation;
5. GIS Atlas—to document critical and sensitive resources, track and reference critical and sensitive resources when significant human actions are proposed, and implement a monitoring program for the HCRMP as well as for specific policies and management plans found within the HCRMP;
6. Land and Water Use Classifications—to designate land and water use classifications, including maps that show the geographic distribution of these classifications, and define policies for these land uses that are intended to balance the various uses. Details about how Idaho Power proposes to separate various land uses are found in Johnson (2003);
7. Idaho Power Interdisciplinary Team—to use an internal team composed of members with expertise from all resources to make decisions and provide input on all land/water use and management determinations related to this plan;
8. Administration—including a use authorization/consultation system, action by the interdisciplinary team, and annual report and review of work plans;

9. Forums for Other Coordination—including communication with stakeholders, identification of communication needs, and assembly of parties to discuss issues, their causes and possible resolutions;
10. Evaluation of Existing Agreements—bring existing agreements up to standards based on a new license;
11. Agreements with Agencies—to pursue development of memoranda of agreement with local, state, and federal agencies to establish regular procedures for consultation and permitting processes;
12. Agency Actions—to coordinate with agencies on enhancement actions that must be led by agencies;
13. Partnerships—to provide a forum for organizing cooperative management efforts; and
14. Best Management Practices—to formulate BMPs based on those of ODEQ and IDEQ and others to minimize environmental impacts of future development and significant human actions.

The Burns Paiute Tribe recommends that Idaho Power establish and fund a resource coordinating committee comprising involved stakeholders to review and maintain oversight over the implementation of project activities, including the implementation of mitigation, adaptive management, and license implementation decision-making.

AR/IRU recommend that the final license include an adaptive management approach and that a Technical Advisory Committee be convened to oversee adaptive management in the license. The Technical Advisory Committee, which would include the various stakeholders, would oversee study design and implementation, develop mitigation measures based on those studies, and oversee implementation and monitoring of the measures.

Our Analysis

Implementation of the HCRMP would help define policies that would minimize the potential for human interference with the goal of protecting natural and cultural resources. As proposed by Idaho Power, the HCRMP includes 99 common policies and 55 policies that would be specific to certain land use classifications or resource management classifications. Adopting the proposed HCRMP and its common policies and including the proposed implementation tools in consultation with stakeholders would help ensure that compatibility among land uses is achieved and maintained by determining appropriate land and water uses and applying standard approaches to managing human use and resource protection.

The plan also contains goals and objectives, land- and water-use designations and environmental resource management policies that would help maintain compatibility between and among the various land and water uses. Idaho Power has mapped the land- and water-use designations at a small scale to serve as a guide. Designating land use classifications for lands within the project and displaying them on a map would help project area users understand what uses would be permitted in various areas and help establish appropriate buffers between uses.

While Idaho Power proposes to implement the plan on the project lands owned or controlled by Idaho Power (5,300 acres), Idaho Power developed the plan in consultation with stakeholders and it is intended to be applicable to an 850,000 acre area surrounding the project, on lands owned by stakeholder parties and others. Idaho Power encourages other parties to implement key elements of the plan on their own lands. Consistent land use management policies within the surrounding area would help ensure that appropriate land uses are designated to protect environmental resources while allowing for human use in the broad area. However, we note that the Commission does not have the authority to require application

of the plan beyond the project boundary. Idaho Power may elect to apply the plan to its own lands beyond the project boundary, and other parties may similarly elect to apply the plan to their own lands.

The HCRMP includes development of several programs to minimize conflicts among various land uses, including the I&E program, dispersed site evaluation, evaluation of recreation/riparian interfaces, development of a GIS atlas, and monitoring environmental resources. Development of these programs would allow project users to participate in protecting important resources by informing them of land use designations and sensitive areas, help determine actions necessary to improve conditions that have been negatively affected by human use, help protect riparian vegetation where it is adversely affected by human use, help ensure that Idaho Power operations do not adversely affect important resources, and provide a mechanism for determining the effectiveness of such policies and allow for modifications as needed.

In addition, the HCRMP calls for development of several programs to facilitate coordination and consultation between local, state and federal agencies as well as other stakeholders. These programs, including the interdisciplinary team, administration, forums for other coordination, evaluation of existing agreements, agreements with agencies, agency actions, partnerships, and BMPs would include oversight of license implementation that would provide a forum for addressing the interests of all stakeholders and would help ensure a balanced approach to protecting important resources while allowing for human use and project operations. Formation of an oversight committee, as recommended by the Burns Paiute Tribe, could provide a standing forum for meeting the same goals outlined in Idaho Power's proposed plan. Similarly, formation of the Technical Advisory Committee recommended by AR/IRU would provide a standing forum for consultation over various adaptive management proposals. Because of the resource-specific nature of the adaptive management proposals, we discuss their merits and modes of consultation in the appropriate resource sections of this EIS, including sections 3.5.2.2, *Dissolved Oxygen*; 3.5.2.3, *Total Dissolved Gas*; 3.5.2.4, *Water Temperature*; and 3.6.2.3, *Anadromous Fish Rearing.* Formation of an oversight committee comprising representatives of the relevant agencies, tribes, and NGOs, with individual technical advisory subcommittees to address specific adaptive management measures and plan implementations, would provide an efficient forum for any consultations required by the terms of a new license.

As submitted with Idaho Power's license application, the proposed HCRMP includes only a few details about how the plan would be implemented. Idaho Power proposes that specific management plans be developed for resources or locations as part of the HCRMP, including: (1) from Exhibit E, E.3.1.3.2.1, the Native Salmonid Management Plan; (2) from E.3.2.3.2.1.1 and E.3.2.3 2.1.4, the general wildlife management plan developed as part of the Integrated Wildlife Habitat Program; (3) from E.3.2.3.2.2.1, the Transmission Line Operations and Maintenance Plan; (4) from E.3.3.3.2.1.2, the Cooperative Integrated Weed Management Plan; (5) from E.4.2.5, the Historic Properties Management Plan; and (6) from E.5.4.4, the Comprehensive Recreation Management Plan; and from the HCRMP, (7) from section 6.3.4.5, grazing/agriculture management plans; (8) from section 6.3.4.1.3, weed control; (9) from section 6.3.5.4, fencing to control open grazing; (10) from section 6.3.7.7, road maintenance; (11) from section 6.3.8.7, interpretive, information, and educational signage; and (12) from section 6.4.2.1.2, *Special Management Acres* (letter from C. Jones, Project Manager, Idaho Power, Boise, ID to the Commission, dated November 3, 2006). These plans would provide substantial opportunities for Idaho Power and stakeholders to cooperate in resource protection while allowing continued public use of the project.

3.12.2.2 Coordination with State and Federal Land Management Agencies

The Forest Service and BLM indicate that project-related activities that occur on or affect agency-administered lands within the project boundary may not be compatible with Forest Service or BLM management designations or may affect important resources on those lands.

The Forest Service (FS-1) specifies that Idaho Power obtain approval for site-specific project designs prior to any habitat or ground-disturbing activities on Forest Service lands and that if any Forest Service lands are added to the project boundary that Idaho Power obtain special-use authorization for occupancy and use of these lands. The Forest Service also specifies that Idaho Power obtain written approval prior to making changes in the location of any constructed project features or facilities, or in the uses of project land and waters on National Forest System lands.

The Forest Service (FS-2) specifies that Idaho Power prepare a resource coordination plan to establish a process for information exchange and to coordinate efforts for implementing license conditions, such as any required management plans, and ongoing project O&M activities potentially affecting Forest Service lands. This plan would include annual Forest Service consultation requirements; documentation of efforts to monitor project effects on other resources and effectiveness of required enhancement measures; means for revising or improving implementation strategies as needed; and standard operating procedures for activities on Forest Service lands.

Interior-1 specifies that Idaho Power consult and cooperate with the BLM prior to initiating activities on BLM-administered lands within the project boundary. Interior's condition would require Idaho Power to prepare site-specific plans for approval by the BLM, including a safety-during-construction plan and a spoils disposal plan prior to any ground disturbing activities on BLM-administered lands. It also recommends that Idaho Power prepare a hazardous substances plan prior to planning, construction, or maintenance that may affect BLM-administered lands. In addition, Interior calls for Idaho Power to restore BLM-administered lands to a condition satisfactory to BLM prior to any surrender of the project license or abandonment of project facilities.

Interior-2 specifies that Idaho Power prepare and provide a written report in consultation with the BLM documenting and/or evaluating measures necessary for the continued protection and utilization of BLM-administered lands and resources within the project boundary. Interior also recommends that BLM has the right to require changes to project operations through revision of 4(e) conditions.

The Oregon Department of State Lands (ODSL) recommends that Idaho Power obtain a lease from ODSL to occupy the state-owned submerged and submersible land underlying the three project dams as well as authorization from ODSL for project facilities or structures located on state of Oregon lands. ODSL indicates that the state owns the bed and banks of that portion of the Snake River within the boundary of the State of Oregon.

Our Analysis

The Forest Service's specification to obtain approval prior to initiating ground-disturbing activities that occur on Forest Service-administered lands would help ensure that resources located on these lands receive appropriate protection. The Forest Service specification to create a resource coordination plan to coordinate license implementation on Forest Service lands would allow the Forest Service and Idaho Power to collaborate in protecting Forest Service resources. However, rather than create a separate plan that would address consultation with the Forest Service, including details on consultation, coordination and reporting in the proposed HCRMP (see section 3.12.2.1) would provide an efficient means to implement consultation with the agency. The scope of activities would be limited to Forest Service lands within the project boundary.

Similarly, coordinating with and obtaining approval from the BLM for project related activities on BLM-administered lands would help protect natural resources on those lands. Developing Interior's recommended construction safety and waste disposal plans would help ensure that Idaho Power follows prudent construction practices. These policies and procedures would be appropriately established in the HCRMP (see section 3.12.2.1). Restoring BLM lands prior to any license surrender could be a reasonable measure, although Idaho Power's alternative approach offers a more flexible process because

it would allow for a plan to be developed specific to restoration needs if and when the license is surrendered.

Interior's recommendation that Idaho Power prepare a report documenting protection of BLM-administered lands within the project boundary is consistent with policies outlined in the proposed HCRMP. Incorporating details specific to BLM-administered lands into the HCRMP would help ensure that BLM concerns are considered. We note, however, that once a new license is issued to Idaho Power by the Commission, only the Commission has authority to require changes in project operations. BLM may file requests for changes to project operations over the term of any new license if unanticipated project effects on BLM-administered lands within the project boundary are identified

With respect to ODSL's recommendation that Idaho Power obtain a lease from ODSL or an OSDL authorization for facilities, it is unclear from ODSL's statement whether the agency is suggesting that the project has been operated to date without such authorization. Under the conditions of the existing license and any new license, Idaho Power is required to obtain all necessary permits to operate the project.

3.12.2.3 Law Enforcement

Disturbances requiring law enforcement at the project occur throughout the year and peak during the summer recreational season. Issues include conflicts between users and the timeliness of response to safety-related incidents in remote areas such as the HCNRA. Various stakeholders have commented that the level of resources for and support of emergency services provided by Idaho Power is not sufficient to provide for visitor safety.

Idaho Power proposes to continue to support local law enforcement, indicating that such support improves public safety in the project area by decreasing emergency response times and increasing law enforcement presence. This measure would continue Idaho Power's memorandum of understanding with Adams County, through which Idaho Power funds an Adams County deputy, vehicle mileage reimbursement, and living quarters in project housing. To supplement this measure, Idaho Power proposes to develop a law enforcement program in which it would regularly coordinate and sponsor a forum and provide funds for prioritizing the resources used among applicable law enforcement agencies. Idaho Power proposes to sponsor biannual meetings regarding law enforcement issues, resources, and responsibilities; provide access to its property and facilities; and contribute to the O&M costs associated with this measure.

Interior-4 specifies that Idaho Power develop and implement a law enforcement and emergency services plan that includes provisions for coordination and funding of law enforcement and emergency services personnel with jurisdiction within the project. This plan would address medical response measures, include provisions to coordinate with the BLM and local counties to assess law enforcement needs, provide funding for additional personnel in the event that additional law enforcement is found to be necessary on BLM-administered lands, and require Idaho Power to implement its proposals (outlined above) and to implement law enforcement provisions of the Baker County Settlement Agreement dated October 3, 2003.

ODFW-11 recommends that Idaho Power fund one additional land-based law enforcement officer and two additional part-time marine or law enforcement personnel and associated equipment for law enforcement on project lands and waterways. In addition, ODFW recommends that Idaho Power sponsor biannual law enforcement meetings and form a safety committee to address public safety issues and law enforcement efforts and to coordinate resource use among appropriate law enforcement agencies in the project area.

With regard to law enforcement, OSMB recommends that Idaho Power: (1) provide salaries and expenses for two full-time seasonal Baker County marine deputies annually for Brownlee reservoir,

(2) provide an effective marine enforcement and safety presence on the Snake River below Hells Canyon dam by providing for two marine officers who would spend an estimated 576 hours annually patrolling the area, and (3) facilitate biannual law enforcement proceedings.

Our Analysis

Idaho Power's proposed law enforcement program and continuation of assistance to local law enforcement is similar to Interior's recommendation and would help improve cooperation between law enforcement agencies and help clarify responsibilities for enforcing public use and safety measures. Idaho Power's proposed assistance to Adams County, Idaho and Baker County, Oregon demonstrate its commitment to contribute to law enforcement programs and cooperate with other entities to provide law enforcement services within the project boundary. In *Comprehensive Development* under *Law Enforcement and Fire Protection*, we discuss the issue of agency jurisdiction over law enforcement.

Because several state and federal agencies and counties have land management and law enforcement responsibilities within the project area, we see the merit of Idaho Power coordinating these efforts through biannual meetings, as recommended by Interior, OSMB and ODFW. Including such meetings in a law enforcement plan would assist in evaluating and coordinating law enforcement within the project area. While Idaho Power does not have the responsibility to manage and enforce boating regulations on project reservoirs, Idaho Power may be able to improve law enforcement by assisting in the coordination of the various law enforcement and emergency services agencies.

3.12.2.4 Fire Protection

The project includes a mix of private and public lands adjacent to large tracts of undeveloped lands. Fires started on Idaho Power-owned lands within the project could rapidly spread to adjacent properties or onto the large public tracts. Fire suppression is the responsibility of the counties and the federal land managers, but, given the rural character of the project, it is unclear whether this is sufficient to protect the health, safety and welfare of project visitors.

In its license application, Idaho Power mentions its "legal obligation to prevent and suppress fires on the lands that it controls" and of its contributions to "rural fire departments in communities near its projects" (Idaho Power, 2003a, p. H-52). As part of the HCRMP, Idaho Power proposes to continue to coordinate with public agencies regarding the occurrence of controlled and uncontrolled fires.

As part of their settlement, Idaho Power proposes and the Forest Service (FS-3) specifies that Idaho Power develop a fire prevention plan for National Forest System lands within the project boundary in which Idaho Power would: (1) analyze fire prevention needs to ensure that prevention equipment and personnel are available; (2) identify fire hazard reduction measures (e.g., eliminating ladder fuels, reducing fuel loading); and (3) provide the Forest Service with a list of the locations of available fire prevention equipment and the location and availability of fire prevention personnel.

Interior-4 specifies that Idaho Power evaluate the need for fire protection on BLM-administered lands in coordination with BLM and that Idaho Power provide for 100 percent of the costs if evaluations demonstrate the need for increased fire protection.

Our Analysis

Idaho Power's proposal to continue to suppress fires on its property and cooperate with agencies to manage visitor access during uncontrolled fires recognizes some portion of the licensee's responsibility for fire suppression in the project area. The proposal would help improve public safety in the project area. Incorporating policies as part of the HCRMP, such as how Idaho Power is to suppress fires on its lands, how it manages and communicates with project visitors during evacuations, and what type of

support Idaho Power contributes to fire agencies, would help ensure that the proposal meets public safety goals.

Developing a fire prevention plan for lands within the project boundary as recommended by Interior and the Forest Service could help prevent potential fires from spreading beyond project lands and would aid county and agency personnel if a fire were to move beyond the project boundary. Because fires often cross property boundaries, having Idaho Power develop a fire prevention plan only for Forest Service-administered lands within the project boundary would be of limited value in protecting all project resources. Developing fire management measures as a component of the HCRMP for all lands within the project boundary would be more protective of project resources. Defining these measures within the HCRMP would help improve public safety by defining the roles of the various agency, county and Idaho Power personnel; identifying the location and availability of fire equipment; and determining fire management needs. Idaho Power would be the best entity to coordinate efforts and hold meetings, but Idaho Power would bear the responsibility for funding only efforts required within the project boundary.

3.12.2.5 Boundary Modifications

The FPA requires the project licensee to provide safe public access to project lands and waters and include those lands necessary for project operations in the project boundary. In accordance with this law, the Commission requires that the project boundary contain the primary recreational facilities used to access project waters, as well as the lands necessary to ensure access for the term of the license, and the lands necessary to ensure an appropriate buffer between the project and neighboring lands.

Idaho Power proposes to remove 3,800 acres of federal land from the existing boundary. The new boundary would follow the same contour line as that followed on private lands, rather than following the metes and bounds system that was used to determine the project boundary on federal lands.

As part of their settlement, Idaho Power proposes and the Forest Service (FS-26) specifies that within 1 year of new license issuance, Idaho Power would provide the Forest Service with a map and aerial photos depicting the approximate location of the project boundary together with geographic information system (GIS), compatible with Forest Service GIS, shapefiles with metadata for the project boundary on National Forest System lands. The project boundary GIS data would be positionally accurate to ±40 feet, in order to comply with National Map Accuracy Standards for maps at a 1:24,000 scale. At locations on National Forest System lands where the project boundary has been surveyed and monuments placed on the ground, monuments would be logged using a global positioning system (GPS) with accuracies meeting National Standard for Spatial Data Accuracy (NSSDA) standards. These data would be used to geo-reference the project boundary within the GIS.

Interior-11 recommends that the modified project boundary include all of the land within the Airstrip, Steck Park, Swedes Landing, and Westfall recreation sites.

Our Analysis

In its license application, Idaho Power filed maps showing the proposed project boundary generally following contour lines around project reservoirs, with an expanded boundary where needed to encompass project facilities, recreation areas and parks. The proposed boundary would retain all project facilities including the Oxbow-Hells Canyon Road and Brownlee-Oxbow Road, both of which are owned and maintained by Idaho Power. In the license application, Idaho Power states that the land it proposes to exclude from the boundary is not necessary for project purposes such as public recreation, shoreline control, or protection of environmental resources. In that case, standardizing the boundary at the same contour line on both private and federal lands appears to be a sound approach to setting the project boundary. However, in its response to AIR LU-1 Idaho Power states that the existing land use of the lands to be excluded, all of which are federally managed, is multiple use dominated by recreation. Idaho Power further states that people camp in dispersed recreation sites in some of these areas.

Using Idaho Power maps, the BLM identified at least 15 recreational use areas that are located within some of the lands proposed to be removed from the existing project boundary (letter from D. Henderson, Vale District Manager, Department of the Interior, Vale, OR, to G. Green and C. Jones, Idaho Power Company, Boise, ID, October 29, 2004). In its response to AIR LU-1, Idaho Power defines these recreation areas as dispersed recreation sites that contain no facilities, and states that there are no project facilities located in the area proposed for removal from the project boundary. As such, Idaho Power states that these lands are not needed for project purposes. Nonetheless, dispersed recreation sites are used primarily for recreation and some provide direct access to the reservoirs. As such, we find that these dispersed recreational sites do serve project purposes. Including all dispersed recreation sites within 200 yards of project waters in the proposed project boundary and defining them on a map that includes the project boundary would clarify which sites would be included within the project boundary and would help ensure that dispersed sites are maintained in place to provide project access.

The recreation sites that Interior recommends for inclusion in the project boundary—Airstrip, Steck Park, Swedes Landing, and Westfall recreation sites—are currently at least partially located within the project boundary and provide access to the reservoirs. Including these recreation sites within the proposed project boundary would ensure that these sites continue to provide access to project reservoirs and recreational opportunities.

As part of any new license, Idaho Power would provide a revised Exhibit G (project boundary map) for the project that would include a detailed description and maps of the project boundary. This, in combination with Idaho Power's proposal, consistent with FS-26, that it provide aerial photos marked with the project boundary, would be a reasonable approach to defining the project boundary more clearly for the Forest Service on Forest Service-administered lands. Surveys may be necessary before any ground disturbing activities are undertaken to verify the boundary on the ground. This is true for all project lands, not just Forest Service lands. Such surveys would ensure that natural and cultural resources are not compromised and that ground disturbing activities occur only within the project boundary.

With respect to the Forest Service condition that it must give approval for any proposed boundary change, we note that the Commission would approve or disapprove of any proposed project boundary changes, taking into account the position of the land management agencies.

3.12.2.6 Road Management Plan

Idaho Power-owned or maintained roads within the project area provide both public access to project lands and waters and Idaho Power access to project developments. Project roads may have adverse effects on cultural and natural resources by allowing public access to areas where these resources occur. Appropriate project road management provides for safety and protection of environmental resources while continuing to provide reasonable public access to the project.

Idaho Power proposes to continue maintenance of roads that it owns and maintains: Oxbow–Hells Canyon Road, 22 miles; Homestead Road from Oxbow, Oregon, to Ballard Creek, 6 miles; and Brownlee–Oxbow Road, 12 miles. In addition, within the HCRMP, Idaho Power proposes to develop a Road Management Plan in consultation with county, state, and federal agencies. The plan would include three elements: (1) BMPs for roads within Idaho Power's jurisdiction to address maintenance concerns regarding cultural resources, noxious weeds, sensitive plants, threatened and endangered species, soil erosion, and aquatic resources; (2) a road atlas containing spatially based information regarding roads and sensitive resources to enable analyses of existing and proposed road maintenance activities in relation to at-risk resources; and (3) a public information program to reduce vehicle collisions with big game animals. Idaho Power proposes to enhance road management on its roads or on roads for which it has assumed maintenance responsibility. In addition to its road management plan, Idaho Power proposes to implement Common Policies in the HCRMP with respect to roads within and with access to the project area (Johnson, 2003). These policies include the following:

1. Idaho Power would allow public access on its roads except in cases where public safety and project security could be compromised.
2. Major road improvements intended to improve traffic flow, which can increase visitor use, should be minimized to protect wildlife, their habitat and cultural resources, especially in areas where these resources are sensitive.
3. Motor vehicle use should be limited to roads, access drives, and areas that are federally, state or locally designated for motorized vehicle use except when necessary for maintenance of lands and utilities.
4. Commercial use of Idaho Power roads is prohibited without written permission.
5. Vehicle use below the full pool elevation of the reservoirs, except for the launch and retrieval of watercraft, should be discouraged because it can damage soils, cultural resources and water quality.
6. Idaho Power would develop a Road Maintenance Plan to identify and describe maintenance activities.
7. Idaho Power's involvement in developing access drives for private or public use should be considered on a case-by-case basis.

The Forest Service (FS-12) specifies that Idaho Power implement the proposed Comprehensive Road Management Plan as it pertains to National Forest System lands to meet existing standards, designs, and O&M requirements. The plan would include maintenance of the Hells Canyon Dam Road for safe and reasonable use by the public, including access to the Hells Canyon Creek Visitor Center, parking lot, and boat launch, as well as dispersed parking areas between the dam and the visitor center.

ODFW-2 recommends that Idaho Power develop a Road Management Plan that is consistent with Idaho Power's proposal with the addition that road maintenance standards should not allow sidecasting.

Interior-3 specifies that Idaho Power develop an integrated travel and access management plan for BLM-administered lands affected by the project, to be incorporated into the Interior-recommended comprehensive recreation management plan and coordinated with the Interior-recommended IWHP and WMMP. Provisions within this preliminary condition include: (1) management goals and objectives consistent with BLM resource protection; (2) identifying Idaho Power's road management and maintenance responsibilities for roads for which it has assumed responsibility and for roads on BLM-administered lands affected by the project (including 101 miles of road on the Snake River, including Homestead, Oxbow, Hells Canyon, Brownlee, and Olds Ferry roads, many of which are outside the project boundary); (3) replacing culverts to provide aquatic connectivity and re-connect riparian function and structure on all class 1 and 2 streams where shotgun culverts are located along the Hells Canyon and Brownlee roads; (4) implementing a plan for non-motorized use of trails connecting recreation sites along the Oregon side of Hells Canyon reservoir and conducting a feasibility study for developing a trail system along the Hells Canyon, Brownlee, and Oxbow reservoirs connecting Farewell Bend State Park to the HCNRA; (5) implementing BMPs for road maintenance and improvements while considering traffic levels, the management of OHV use, and the protection of natural and cultural resources; and 6) developing a road atlas. BLM also specifies that access may need to be restricted during certain times of the year to protect natural resources and reduce collisions with wildlife.

Our Analysis

As proposed by Idaho Power and recommended by the Forest Service, ODFW and Interior, a Road Management Plan would improve access management throughout the project by considering appropriate traffic levels to protect natural and cultural resources while providing reasonable public

access. Such a plan would increase public safety by providing for road maintenance and management consistent with recreational demand and the goals of the HCRMP.

Idaho Power proposes to maintain the roads it currently owns and maintains (Oxbow–Hells Canyon Road; Homestead Road from Oxbow, Oregon, to Ballard Creek; and Brownlee–Oxbow Road) and points out that Interior's 4(e) condition would require Idaho Power to maintain roads outside of the project boundary. Interior has not established in the record a clear nexus between project operations and the need for road maintenance on all of the county and state roads outside of the project boundary. As part of its justification for modified condition no. 3 (which is the same as the preliminary condition), Interior relies on its preparation of materials for the trial-type hearing. It is our understanding that this new information was never heard before a judge, so the merits of establishing project nexus were never concluded in court. Part of Interior's position that there is a nexus is derived from a 1996 MOU between BLM and Idaho Power regarding cooperative management of land uses at Brownlee, Oxbow, and Hells Canyon reservoirs. However, this MOU was developed outside of the FERC process and does not appear to directly relate to project environmental effects. Given the numerous roads that provide access to the project, Interior's position appears to overstate the licensee's responsibility to provide reasonable public access to the project. Further, it is the responsibility of state and county governments to maintain roads that are within their jurisdiction and that are used for non-project purposes. For example, Olds Ferry Road, which Interior specifies that Idaho Power should improve, appears to be a county owned and maintained road that accesses not only the project but also the BLM-managed Weiser Dunes, the BLM- and IDFG-operated Steck Park, and dispersed recreation and camp sites as well as private residences and lots. We also note that any roads for which Idaho Power takes maintenance responsibility would need to be included within the project boundary.

As proposed by Idaho Power, the road management plan, to be developed in consultation with stakeholders and incorporated into the HCRMP, would address road management and maintenance needs for project related roads. As part of the consultation process, differences could be resolved about which roads Idaho Power would assume responsibility for. This would help ensure that reasonable access is maintained for the term of any new license.

Idaho Power's proposed plan lacks details that would be necessary to ensure public access and protect project-related environmental resources. The plan as proposed and recommended by ODFW would serve as a good base to improve Idaho Power's proposal, and the plan elements outlined by Interior would provide further guidance for improving access management. The recommended improvements in public information to decrease wildlife collisions would improve pubic safety and benefit wildlife, and a road atlas would help protect natural and cultural resources prior to any road maintenance activities. Replacing culverts would help protect aquatic resources. Providing the public with information regarding the presence of natural and cultural resources surrounding access points would help visitors understand the potential effects of their use that could, in turn, help prevent conflicts between human use and important resources (for example wildlife-vehicle collisions).

3.12.2.7 Effects of Other Measures on Land Management

Water Quality Measures

Idaho Power proposes to develop a reservoir aeration system, which would include the construction of an on-shore oxygen supply facility, to supplement DO into Brownlee reservoir (see section 3.5.2.2, *Dissolved Oxygen*). Constructing the proposed reservoir aeration system would include substantial ground disturbing activity. Locating this facility in an area where there would be little conflict with natural and cultural resources or recreation would minimize the effects this facility could have on these resources.

Aquatic Resource Measures

Idaho Power proposes to upgrade and enhance anadromous fish hatchery facilities. This measure, as discussed in section 3.6.2.12, *Hatchery Production*, includes the construction of holding ponds and the expansion of hatchery facilities. Idaho Power also proposes to implement a native salmonid plan, as discussed in section 3.6.2.8, *Resident Salmonid Passage*. This measure also includes the construction of facilities. Locating any construction that might include ground disturbing events within the project boundary and away from important natural and cultural resources would help reduce the effects such activity could have on other resources. Adhering to the policies for new development within the project boundary, as outlined in the HCRMP, would help minimize any adverse effects on other land use caused by proposed facilities.

Terrestrial Resource Measures

Idaho Power's proposal to develop a transmission line O&M Plan to address the effects of right-of-way management on botanical and wildlife resources (see section 3.7.2.4, *Road, Transmission Line, and Right-of-Way Management*) would help to minimize conflicts between project operations and natural resources by managing noxious weeds, restoring disturbed sites and timing activities to occur outside of critical periods for plants and wildlife. In addition, Idaho Power proposes to acquire manage, and enhance wildlife habitat to protect and enhance wildlife habitat and botanical resources; reintroduce mountain quail; and implement a wildlife habitat program (see sections 3.7.2.5, *Upland and Riparian Habitat Acquisition,* and 3.7.2.6, *Cooperative Wildlife Management Projects*). Defining land use designations from the proposed HCRMP for these areas would help ensure that they are protected from other project uses such as project operations and recreation.

Cultural Resource Measures

Idaho Power proposes to stabilize archeological sites and recover archeological data to prevent possible damage by project operations (see section 3.9.2, *Cultural Resources*). These measures would be consistent with the proposed HCRMP and would help define appropriate use and protect significant cultural sites found within the project.

Recreation Measures

Idaho Power proposes several recreation measures that include developing and enhancing both dispersed and developed recreation sites and boat launches. These measures are intended to improve access, benefit recreation and improve facilities, and many include the intention to protect natural and cultural resources (see sections 3.10.2.2, *Recreation Plan,* and 3.10.2.3, *Recreation Site Improvements*). Adhering to the policies and implementation tools proposed in the HCRMP intended to establish and maintain compatibility between and among the various land and water uses in the project would help off-set any conflicts these proposed recreation measures might create with other project uses and resources.

3.12.3 Unavoidable Adverse Effects

None.

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3.13 SOCIOECONOMIC RESOURCES

In this section, we review market conditions in the counties where the project is located and profile market characteristics of Idaho Power's electricity generation and its primary consumers. We use this information to establish a baseline of existing conditions from which to consider the economic effects of changes in electricity rates and other socioeconomic effects associated with relicensing the project.

3.13.1 Affected Environment

The project is located in four rural counties in two states, including Adams and Washington counties, Idaho, and Baker and Wallowa counties, Oregon. The economic performance of these counties is generally below state averages (BEA, 2005). While manufacturing, services, and government jobs have grown over the past decade, annual average wages and per capita income in the counties are somewhat below state averages. Many county residents are retired and on fixed incomes, and unemployment and poverty levels are higher than the state averages.

3.13.1.1 Idaho Power Electricity Generation and Rates

Idaho Power owns and operates 17 hydroelectric projects, two natural gas-fired generating plants, and one diesel-fired generating plant and co-owns three coal-fired generating plants (refer to section 1.2, *Need for Power*). Hydroelectricity represents approximately 55 percent of Idaho Power's total installed capacity. The Hells Canyon Project is the largest generation asset in Idaho Power's portfolio, accounting for about 38 percent of installed hydroelectric capacity and about 21 percent of Idaho Power's total generation capacity. As part of Idaho Power's resource portfolio, the electricity generated at the Hells Canyon Project is mixed with electricity generated and purchased from other sources and then distributed to a variety of industrial, commercial, and residential customers.

The availability of hydroelectric energy can affect both the amount of electricity and the net cost of electricity to customers (IDACORP, 2004). The amount of electricity that Idaho Power generates from hydroelectric sources varies annually depending primarily on stream-flow conditions and storage in upstream reservoirs.

On average, hydroelectricity makes up approximately 55 percent of Idaho Power's generation and purchases. Based on the recent historical average, the Hells Canyon Project accounts for approximately 38 percent of Idaho Power's generation and purchases, similar to the project's percentage of installed capacity discussed above.

Idaho Power provides electricity to more than 430,000 customers in an area of about 24,000 square miles, including 24 Idaho counties and 3 Oregon counties. Idaho Power serves all of the Hells Canyon Project area in Adams and Washington counties, Idaho, and Baker County, Oregon, but does not serve Wallowa County, Oregon, with the small exception of the area around the Hells Canyon dam (IDACORP, 2004). Demand for new electric service has been steadily climbing in the counties and the region since 2000, with approximately 13,000 new Idaho Power customers added in 2004.

Idaho Power's electricity sales typically exceed 13 million MWh per year (table 89). Industrial customers are the largest purchasing sector, accounting for about 39 percent of total sales.

Table 89. Idaho Power's sales of electricity in 2004. (Source: EIA, 2004)

	Sales (MWh)			
	Residential	**Commercial**	**Industrial**	**Total**
Idaho	4,389,994	3,411,043	4,773,507	12,574,544
Oregon	190,343	149,868	324,834	665,045

	Sales (MWh)			
	Residential	**Commercial**	**Industrial**	**Total**
Total	4,580,337	3,560,911	5,098,341	13,239,589
Percent of Total	34.60	26.90	38.51	100.00

Idaho and Oregon Public Utilities Commissions set Idaho Power's rates. Base rates are established through the Public Utilities Commissions' conditional approval of rate case applications. Base rates are adjusted annually through a Power Cost Adjustment (PCA) mechanism that allows Idaho Power to recoup costs based on the actual cost of generation in a given year.

In general, hydroelectricity is the least cost electricity in Idaho Power's blended power pool and provides base load and some peaking energy for customers, so changes in annual hydroelectric generation can affect rates. For example, when inflows to the hydroelectric projects are above normal, the net cost of annual generation is reduced by offsetting the need to generate using fossil-fueled plants and power purchases. In this type of water-year, the incremental additional cost of the PCA would be less than a normal year and Idaho Power's blended rates for that year would be lower than Idaho Power's average electricity rates.

Idaho Power's electricity rates are among the lowest in the region for investor-owned utilities in all rate classifications (Idaho Power, 2005l). Idaho Power rates are below both Oregon and Idaho state averages, and well below the U.S. average (table 90).

Table 90. Idaho Power's average electricity rates compared to Idaho, Oregon, and U.S. averages in cents/kWh, 2004. (Source: EIA, 2005)

	Residential	**Commercial**	**Industrial**
Idaho Power, Idaho[a]	6.02	4.59	3.91
Idaho Power, Oregon[a]	5.19	4.93	3.40
Idaho State Average	6.24	5.56	4.16
Oregon State Average	7.06	6.38	4.63
U.S. Average	8.70	7.98	5.13

[a] Source: IDACORP (2004). We estimated average rates by dividing average revenue by average generation for each sector. Idaho Power's actual rates may vary by state and county.

3.13.1.2 Relationship of the Hells Canyon Project to Local Governments

Idaho Power's primary socioeconomic relationship with governments within the Hells Canyon Project area is through payment of property taxes. In both Idaho and Oregon, property taxes for public utilities are assessed by the state based on capital investments rather than land value (table 91). The states redistribute Idaho Power's payments to the counties for emergency services, road maintenance and other county functions. Portions of these taxes are used to fulfill the counties' law enforcement, emergency service, and road maintenance responsibilities within the Hells Canyon Project area.

Table 91. Annual property taxes paid by Idaho Power to counties bordering the Hells Canyon Project in 2000. (Source: Idaho Power, 2003a, page E.5-166)

County	State	Taxes Paid by Idaho Power	Total County Property Tax Revenue	Idaho Power as Percent of Total
Adams	Idaho	$353,201	$2,983,354	11.84
Washington	Idaho	$958,812	$6,266,991	15.30
Baker	Oregon	$630,868	$11,311,000	5.58
Wallowa	Oregon	$380,002	$5,319,000	7.14

In addition to paying property taxes, Idaho Power also donates funds to specific law enforcement and emergency service agencies within the counties to provide additional services at the project (table 92).

Table 92. Donations by Idaho Power to counties bordering the Hells Canyon Project for enhanced services in 2002 and 2003. (Source: Idaho Power, 2003a, page E.5-189)

County	Agency	City/Town	Amount
Adams County, Idaho	Adams County Sheriff Department	Council	$70,219
Adams County, Idaho	Council Medical Clinic	Council	$10,000
Adams County, Idaho	Indian Valley Fire District	Indian Valley	$1,000
Baker County, Oregon	Pine-Eagle Ambulance District	Halfway	$10,000
Baker County, Oregon	Pine-Eagle Medical Clinic	Halfway	$1,000
Washington County, Idaho	Washington County Sheriff	Weiser, ID	$26,000
Washington County, Idaho	Weiser Ambulance	Weiser, ID	$5,000
Washington County, Idaho	Weiser Hospital	Weiser, ID	$25,000
		Total	$148,219

3.13.1.3 Commercial Enterprises in the Project Area

In general, the counties bordering the project are rural, with slow population growth and economies dependent on small to medium-sized private businesses and government employment. Adams County, Idaho and Wallowa County, Oregon are among the most rural in their respective states, with small populations, relatively high unemployment, and relatively high levels of poverty (U.S. Census Bureau, 2005).

Washington County, Idaho, and Baker County, Oregon are along the Interstate 84 corridor and benefit from rail and road transportation infrastructure. In these counties, population and economic activity are concentrated along the highway, primarily in Weiser and Baker City, which, relative to the region, have a larger economic base in manufacturing and retail trade. Outlying towns in Washington and Baker counties are generally smaller and more rural, especially north of the Interstate 84 corridor. Government employment, primarily local and state employment, accounts for about 15 percent of total employment in all four counties.

Government activities generate the most economic activity for all industrial sectors in the four counties, ranging from 24 percent in Washington County, Idaho to 44 percent in Adams County, Idaho. After government services, manufacturing is the most important economic activity in the counties. While agricultural earnings appear to be declining in all of the counties, four sectors appear to be increasing in economic importance to the counties: retail trade, accommodations and food services, recreation, and real estate.

Five towns act as portals to the project, including Huntington, Richland and Halfway, Oregon, and Cambridge and Council, Idaho. The largest employers in these counties are a mix of government, construction, and retail trade. While these businesses are sensitive to changes in electricity rates, electricity is generally a relatively small portion (less than 1 percent) of their total operating costs (U.S. Census Bureau, 2000). Certain manufacturing industries are particularly sensitive to changes in electricity rates, where electricity can exceed 20 percent of operating expenses. These industries include certain chemical, gas, aluminum, and newsprint manufacturers, none of which exist in the four counties. Two small wood-processing manufacturing firms are located in Council, including Intermountain Woodworking, a cabinet and fine woodworking shop, and Western Timber Products, a wood re-manufacturing mill. For these industries, electricity represents approximately 0.93 and 1.57 percent of operating expenses respectively.

The Hells Canyon Project receives about 200,000 recreational visitor days per year, with the majority of visitors participating in fishing, boating, and camping within the project and the HCNRA (see section 3.10, *Recreational Resources*). A recent study suggests that recreational angling throughout Oregon and Idaho creates numerous jobs and contributes as much as $1.3 billion to the Oregon economy and $681 million to the Idaho economy (ASA, 2002). Another recent study of the economic benefits of Idaho's tourist economy indicates that tourism in the counties surrounding the project represents a substantial portion of retail and accommodation earnings (table 93). Direct and indirect expenditures on tourist and recreational services account for between two and three percent of total sales in the counties.

Table 93. Total visitor spending by county. (Source: Global Insight, 2005)

County	Transport	Food	Room	Entertainment	Shopping	Total	Percent of Total County Sales
Adams	$0	$1,110,000	$610,000	$350,000	$880,000	$2,940,000	2
Washington	$5,430,000	$5,340,000	$790,000	$1,600,000	$4,990,000	$18,150,000	3

3.13.1.4 Minority and Low-income Communities

The majority (83 to 96 percent) of residents in the project area counties are non-Hispanic white (table 94), with small populations of Native Americans (less than 2 percent). With the exception of Washington County, Idaho, where 13.8 percent of the population is of Hispanic or Latino origin, the counties surrounding the project have smaller populations of Hispanics or Latinos than their respective state averages.

Table 94. Total population and population percentage by race categories. (Source: U.S. Census Bureau, 2005)

	Oregon			Idaho		
	Baker County	**Wallowa County**	**State**	**Adams County**	**Washington County**	**State**
Population, 2004 estimate	16,470	6,976	3,594,586	3,451	10,059	1,393,262
White persons (%)	95.7	96.5	86.6	96.3	87.6	91.0
Black or African American persons (%)	0.2	[a]	1.6	0.1	0.1	0.4
American Indian and Alaska Native persons (%)	1.1	0.7	1.3	1.4	0.7	1.4
Asian persons (%)	0.4	0.2	3.0	0.1	1.0	0.9
Native Hawaiian and Other Pacific Islander (%)	[a]	[a]	0.2	[a]	0.1	0.1
Persons reporting some other race (%)	0.9	1.0	4.2	0.9	8.2	4.2
Persons reporting two or more races (%)	1.7	1.5	3.1	1.2	2.4	2.0
White persons, not of Hispanic/ Latino origin (%)	94.6	95.7	83.5	95.5	83.1	88.0
Persons of Hispanic or Latino origin (%)[b]	2.3	1.7	8.0	1.6	13.8	7.9

[a] Value greater than zero but less than half unit of measure shown.

[b] Hispanics may be of any race, so also are included in applicable race categories.

The U.S. Department of Health and Human Services defined the poverty level in 2005 for a family of three as income less than $1,340 per month (HHS, 2005). Between 13 percent and 15 percent of the counties' population has income below the poverty level, which is 3 to 4 percentage points higher than state averages (table 95).

Table 95. Poverty statistics and housing affordability statistics. (Source: U.S. Census Bureau, 2005)

	Oregon			Idaho		
	Baker County	**Wallowa County**	**State**	**Adams County**	**Washington County**	**State**
Median value of owner-occupied housing units, 2000	$84,700	$111,300	$152,100	$88,800	$90,200	$106,300
Median household income, 1999	$30,367	$32,129	$40,916	$28,423	$30,625	$37,572
Persons below poverty, 1999 (%)	14.7	14.0	11.6	15.1	13.3	11.8

Housing, however, generally remains affordable within the four counties surrounding the project. The U.S. Department of Housing and Urban Development's (HUD) generally accepted definition of affordability is for a household to pay no more than 30 percent of its annual income on housing (HUD,

2005). HUD considers families that pay more than 30 percent of their income for housing to be cost burdened and may have difficulty affording necessities such as food, clothing, transportation and medical care. In the counties around the project area, median income as a percent of median house price is 30 percent or more, indicating that the cost of housing does not appear to place additional burdens on low-income residents.

3.13.1.5 Native American Tribes

No Native American reservations are near or physically connected to the project and very few Native Americans live in the four counties adjacent to the project (see table 94). Nonetheless, the Snake and Columbia rivers are important historical fishing grounds for the tribes in the region, and the remaining runs of anadromous fish continue to provide important food for Native Americans (see section 3.9.1.6, *Traditional Cultural Properties, Sacred Sites, and Rock Art*). A recent study finds that, historically, salmon were the primary food source for the tribes listed in table 96 (Meyer Resources, 1999). The study makes a strong case that the decline in salmon returns to the upper Snake River blocked by dams within the basin adversely affected the socioeconomic conditions of the tribes. Specifically, the study links tribal culture and wealth to historical trade in salmon and indicates that the decline in salmon returns to the Snake River contributes materially to poverty and unemployment on the reservations.

The reservations in the region are among the poorest in the nation, with high levels of unemployment. Compared to the four counties surrounding the project, the tribes have lower household income, higher unemployment, and a much higher percentage of families in poverty (table 96). Meyer Resources (1999) found that "the tribes cope with overwhelming levels of poverty, unemployment that is between three and thirteen times higher than for the regions' non-Indians, and rates of death that are from twenty percent higher to more than twice the death rate for residents of Washington, Oregon and Idaho as a whole." The study goes on to link the current socioeconomic and demographic conditions to the loss of salmon as a food source and a trading currency, pointing out that the decline in salmon is felt most by the tribes at the upstream end of the Snake River. The study estimates that the tribes harvest less than one percent of the levels of salmon harvested prior to contact with non-native Americans.

Table 96. Descriptive statistics of reservations in the project vicinity. (Source: U.S. Census Bureau, 2007, 2005)

Reservation	Warm Springs	Burns Paiute	Shoshone-Paiute	Umatilla	Shoshone-Bannock	Nez Perce
Distance to project (miles)	200	80	110	100	200	160
Reservation population (no.)	3,190	145	2,037	1,608	4,922	2,998
Families below poverty (%)	27	44	31	40	28	18
Children under 18 below poverty (%)	30	60	35	20	37	22
Median household income ($)	28,203	28,750	22,604	38,125	27,145	27,696
Unemployment (%)	15	14	14	9	12	8
Tribal language speakers (%)	14	33	24	9	24	7

3.13.2 Effects of Project Operations on Socioeconomic Resources

This section of the EIS considers the extent to which proposed and recommended changes in Project Operations may affect socioeconomic systems. We consider the socioeconomic effects of Idaho Power's Proposal, the Staff Alternative, and a No-action Alternative.

3.13.2.1 Effects on Power Costs

Economists recognize the effects of energy prices on local and regional economic growth. Low electricity rates can attract private investment, leading to jobs, increased demand for goods and services, more disposable income, and eventually a growing local and regional economy. From an industrial and commercial perspective, low electricity rates facilitate growth and improve a firm's cost competitiveness. From a residential perspective, low rates allow households to spend more of their money in other ways, possibly contributing to economic growth. Idaho Power's rates are amongst the lowest in the U.S. and it follows that economic conditions in Idaho Power's service area have benefited from these low rates.

As described in section 4.0, *Developmental Analysis*, the proposed and recommended operational and environmental measures would reduce the net power benefits of the project. Ultimately, any increased cost to operate the project could lead to increased electricity rates across Idaho Power's broad service area. Idaho Power's proposal and the Staff Alternative would increase the cost of generating electricity at the project by about 0.19 cents per kilowatt hour and 0.39 cents per kilowatt hour, respectively (table 97)

Table 97. Cost and net annual generation of the proposed and Staff Alternative measures.

	Net Annual Cost of the Alternative (dollars)[a]	Adjusted Net Annual Generation (MWh)	Increased Cost for Project Power (cents/kWh)	Percent Increased Cost from No Action	Percent Cost Increase of All Idaho Power Generation
No Action	0	6,562,244	0.000	0.00	0.00
Idaho Power Proposal	12,529,900	6,562,244	0.191	4.05	1.54
Staff Alternative	25,703,600	6,549,344	0.392	8.30	3.15

[a] We define the net annual cost as the sum of the cost of new environmental measures plus the value of reduced power benefits.

Electricity generated at Hells Canyon Project is part of a mix of electricity generated and purchased by Idaho Power and sold to customers in Idaho and Oregon. The Hells Canyon Project is the largest generation asset in Idaho Power's portfolio, accounting for about 79 percent of installed hydroelectric capacity and about 38 percent of total generation capacity. In order to evaluate a rough estimate of potential changes in rates, we allocated 38 percent of the cost increase to the rate classes (table 98). Although it is unlikely that any rate increase would mirror the changes in table 98, the results imply the effects of implementing the environmental measures on rates would be relatively minor potential increases 1 to 3 percent over the No-action Alternative. The actual extent of any rate increase would be determined by the Idaho Public Utility Commission.

Table 98. Estimated change in Idaho Power rates by rate class for the proposed and Staff Alternative measures.

	No Action	Idaho Power Proposal		Staff Alternative	
	Rates (cents/kWh-2004)	Incremental Increase (cents/kWh)	Increased Rates from No Action	Incremental Increase (cents/kWh)	Increased Rates from No Action
Residential	5.99	0.92	6.08	0.189	6.18
Commercial	4.61	0.071	4.68	0.145	4.75
Industrial	3.35	0.051	3.40	0.106	3.46
Irrigation	4.86	0.075	4.93	0.153	5.01
Weighted Average	4.80	0.074	4.88	0.151	4.95

Any proposed or recommended measures that are implemented would also contribute to a range of benefits, including improved aquatic and terrestrial resources, expanded recreational opportunities, and increased expenditures within the communities that serve the project. Implementing the environmental measures would require expenditures from Idaho Power into the local and regional economies to oversee the measures, as well as to purchase goods and services needed to construct, monitor and maintain new environmental measures. The improved environmental and site conditions would benefit all project visitors, with larger benefits accruing to those people that live near the project and can more easily take advantage of the improvements, as well as to those communities through which visitors travel to reach the project and that would provide goods and services to Idaho Power for implementing the environmental measures. To this end, any increase in electricity rates needed to provide for the proposed and recommended environmental measures would constitute a transfer of benefits from Idaho Power's broad ratepayer base to the counties surrounding the project.

3.13.2.2 Net Cost to Local Government

The project would have little adverse socioeconomic effects on surrounding county governments. As shown in table 91, property taxes assessed to Idaho Power constitute significant portions of total taxes paid to the counties. These monies are used to fulfill the counties' law enforcement, emergency service, road maintenance, and other responsibilities. The project already attracts large numbers of visitors to rural areas around the project reservoirs and visitor use is likely to continue to grow over the term of any new license. Given the remote location and rural character of the project, the counties' costs for providing services to the project are likely higher than the cost of serving other, more centrally located businesses in the counties. The proposed and recommended measures recognize the additional costs to the counties for providing these services and include some funding in addition to taxes, improved law enforcement coordination, and improved communication systems. These measures would help offset the counties' direct and indirect costs of providing public services over the term of any new license.

3.13.2.3 Effects on Commercial Enterprises

Implementing each environmental measure that includes a cost would also have direct and indirect benefits on commercial enterprises in the project area. For example, funding construction of new project facilities, as well as the ongoing costs associated with maintaining and monitoring environmental plans, would create expenditures in the local and regional economy for equipment and services and would provide jobs associated with implementing the measures. While we do not quantify the economic benefits of these expenditures, they would accrue to many local and regional commercial enterprises.

Project–related recreational use contributes more measurable economic benefits to the portal towns and neighboring counties. While, for example, the act of angling at the project may appear to

generate little economic activity, visitors purchase tackle, boat and vehicle gas, food, and lodging, and pay usage fees. These expenditures generate direct and indirect benefits to local and regional businesses and counties.

The U.S. Natural Resource Conservation Service (NRCS) collects information for contingent valuation of recreational activities for watershed planning and other economic purposes. NRCS recommends use of the travel cost method to calculate recreational benefits, where researchers estimate primary and secondary expenditures associated with various recreational activities. Idaho Power did not collect recreational expenditure information from visitors to the project, but NRCS maintains a database of recreational travel cost studies, most recently updated in October 2005, with values for recreational activities estimated in more than 1,200 studies (Loomis, 2005).

Loomis (2005) found that the median recreational expenditure in Oregon, Washington and Idaho was about $33 per person per day, which, when applied to the number of visitors to the project, results in an estimated $5.8 million addition to the local economy (table 99). When considered by activity, direct project-related expenditures for recreation may be as high as $15 million per year. In addition to the primary benefits of the recreational expenditures on local business, they have secondary benefits as the millions of dollars work through the economy, generate expanded business, new commercial purchases, new jobs, and potentially increased household spending.

Table 99. Contingent valuation study results for recreational expenditures in Oregon, Washington and Idaho (n = 143) and estimated project-related expenditures for recreational activities.

	Estimated Expenditure per Person per Day[a]	**Number of Project Visitors per Day by Activity in Year 2000[b]**	**Estimated Direct Expenditures**
Average	$41.89	173,008[c]	$7,247,221
Median	$33.70	173,008[c]	$5,830,611
Camping	$70.01	129,756[d]	$9,083,574
Picnicking	$34.74	5,784	$200,959
Swimming	$6.06	2,319	$14,049
Sightseeing	$33.06	57,427	$1,898,378
OHV	$40.37	189	$7,617
Motor boating	$12.48	15,600	$194,619
Float boating	$144.68	253	$36,589
Hiking	$23.98	10,023	$240,317
Mountain Biking	$49.68	339	$16,841
Hunting	$43.87	677	$29,681
Fishing	$40.63	80,394	$3,266,371
Wildlife Viewing	$41.34	4	$186
Total		302,764	$14,989,181

[a] Source: Loomis (2005)

[b] Source: Idaho Power (2003a)

[c] Idaho Power estimated annual recreation days of 173,008.

[d] Idaho Power estimated annual recreation days by activity. Study results did not include camping as a separate and specific activity, but Idaho Power estimates that 75 percent of visitors stay overnight. For the purpose of estimating project-related recreational expenditures for camping, we include 75 percent of 173,008 recreation days based on the assumption that visitors would participate in recreational activities during the day in addition to camping. This assumption may lead to an overestimate of actual annual expenditures for the project by both inflating the number of visitors and because the estimate of expenditure per person per day may include expenditures for other recreational activities.

The proposed and recommended environmental measures would expand existing recreational opportunities, improve the reservoir and river fishery, improve terrestrial wildlife habitats, and improve scenic quality of the project. As a result of these improvements, Idaho Power expects that recreational use would continue to grow over the term of the new license as visitors take advantage of new recreational, wildlife viewing, and hunting opportunities. Any growth in recreational use would increase the project-related benefits to local and regional businesses associated with recreational expenditures.

3.13.2.4 Effects on Minority and Low-income Communities

In areas of economic depression, with high poverty levels and many residents on fixed incomes, increased electricity prices can contribute to increased poverty from increased living expenses, reduced number of jobs, reduced discretionary spending, and inflation. The extent of these effects depends on the level of electricity rate increase and the underlying economic conditions. Based on our rough estimate of a 3.5 percent potential increase in residential electricity rates, it does not appear that electricity rate increases resulting from the proposed project would have substantial adverse affects on minority and low-income communities.

Neither Idaho Power's proposed measures nor any of the recommended measures would have any noticeable adverse effects on neighboring county residents. In general, the benefit transfer from ratepayers to environmental enhancements and expenditures in the local economy would generally accrue to county residents. In addition, the proposed and recommended environmental improvements could benefit hunting, fishing and gathering activities in the area, which may contribute subsistence resources for people of limited means.

The demographic profile in section 3.13.1.4 indicates that the counties have higher than average elderly (age 65+) and low-income (less than $16,200) populations on fixed or limited incomes. For these populations, increased household expenses typically require commensurate deceases in spending on other items. A 2001 study in Washington found that electricity and natural gas accounted for approximately 3.3 percent of total household expenditures in low-income households (U.S. Census Bureau, 2005). During the energy price escalation in 2001, the state predicted that increased rates would raise the average low income and elderly household expenditures on electricity and natural gas to 5.2 and 4.9 percent, respectively, of total household expenditures (U.S. Census Bureau, 2005).

3.13.2.5 Effects on Native Americans

The Corps (2002) found that tribes in the region consider their fishing rights to include: (1) reasonable harvest of salmon, pacific lamprey, and river mussel shell, in addition to other species; (2) access to traditional places where harvest and processing can occur; (3) distribution of resources over the aquatic landscape in proportions adequate to be available for all affected tribes; (4) availability of desired aquatic resources at culturally significant places (e.g., fishing stations and grounds); and (5) sustainable aquatic resources and habitats to support present and future generations' harvest needs.

Five Native American tribes filed comments or testified about the draft EIS, including the Shoshone-Bannock Tribes, Fort Hall, Idaho; the Nez Perce Tribe, Lapwai, Idaho; the Umatilla Tribes, Pendleton, Oregon; the Shoshone-Paiute Tribe of the Duck Valley Indian Reservation, Idaho; and the Burns Paiute Tribe, Burns, Oregon. Although not immediately adjacent to the project, or within the four

surrounding counties, these five tribes indicated that relicensing the project affects the tribes because of the project's effect on anadromous fish passage and other resources.

It is clear from the record that salmon play an important role in modern Native American communities for commercial, ceremonial, and subsistence harvests. From a socioeconomic perspective, the tribes fishing practices, religious values, and community activities provide insight into the cultural significance of the project and the Snake River. Meyers Resources (1999) found that salmon remain connected to tribal material and spiritual life and that tribal peoples "look first to the salmon with hope for a better future." The Meyers Resource report (1999) makes a strong case that the declines in salmon returns associated with dams on the Snake and Columbia rivers constitute a transfer of wealth from the tribes to non-Indians. As declining salmon returns materially and culturally affected the tribes in the region, construction and operation of the dams created wealth for non-Indians by providing electricity generation for industry, flood control to protect downstream communities, and irrigation services for agriculture in the Snake and Columbia basins.

The proposed and recommended aquatic resource measures, taken together, would represent an improvement in aquatic resources over existing conditions, with the goal of improving salmonid returns to and above the Hells Canyon Project. These incremental improvements, although incremental, would help restore and maintain long-term ecosystem health and support the economic and social needs of Native Americans in the project region. In particular, providing assistance to the Shoshone-Bannock's streamside egg incubation project on the Yankee Fork would help support ceremonial and subsistence fisheries I the Snake River basin (see section 3.6.2.12, *Hatchery Production, Yankee Fork and Panther Creek*).

3.13.2.6 Effects of Other Measures on Socioeconomics

Aquatic Resource Measures

Idaho Power proposes and agencies, tribes, and NGOs recommend numerous environmental improvements that would improve the anadromous fish returns in the Snake River downstream of the project, including improvements to water quality, aquatic habitat, hatchery production and performance and fish passage. Cumulatively, these aquatic resource and water quality measures would reduce the projects net benefits, but would improve environmental conditions at and downstream of the project. Implementing these measures would have non-market social, cultural and environmental benefits, particularly in regard to improving anadromous fish runs. Implementing these measures would also create direct short-term investment into the local economy for any construction and rehabilitation measures that would be needed, as well as small ongoing expenditures toward monitoring and maintenance. Over the long term, and to the degree that aquatic resource improvements attract more visitors to the project for fishing and wildlife viewing, recreational expenditures in the local and regional economy would grow.

3.13.3 Unavoidable Adverse Effects

None.

3.14 EFFECTS OF NO-ACTION ALTERNATIVE

Under the No-action Alternative as defined by the staff, the project would continue to operate as it is currently. There would be no significant change to the existing environmental setting or project operation. No new environmental measures would be implemented. Most of the current project effects, both positive and negative, would continue at the same level. For example, power output would continue at the same level, recreational opportunities would be essentially the same, and the four fish hatcheries would continue their current programs.

Adverse water quality conditions would continue until such time as off-project water quality improvements began to manifest. Poor water quality conditions would continue to adversely affect aquatic resources due to: (1) low DO levels during the summer and fall in project reservoirs and within 7 to 10 miles downstream of Hells Canyon dam; (2) gas supersaturation within and downstream of the project when spills occur; and (3) high water temperatures in the fall months, adversely affecting fall Chinook spawning. Other adverse effects on aquatic resources that would continue include: (1) blocked access to anadromous fish and blocked migration of resident fish species; (2) continued mortality of federally-listed fall Chinook salmon from stranding and adverse effects on fish growth caused by fluctuations in outflows from the project; (3) an unknown level of stranding mortality of federally listed bull trout; (4) potential adverse effects on critical spawning habitat of fall Chinook salmon due to reduced gravel recruitment; and (5) continued lack of recruitment of white sturgeon in the three interdam reaches between Swan Falls and Hells Canyon dams.

Ongoing effects of project operation on riparian habitat and wetlands would continue as a result of: (1) seasonal drawdowns at Brownlee reservoir that would continue to prevent riparian habitat from establishing in the fluctuation zone and along the shoreline; (2) project impoundments that would continue to trap large volumes of sediment, which would continue to limit the establishment of willows in the reach downstream of Hells Canyon dam; (3) Brownlee reservoir's continuing to accumulate organochlorine compounds and mercury from non-project sources, which may pose a risk to fish-eating wildlife such as river otters, great blue herons, and bald eagles; and (4) the presence of the reservoirs continuing to preclude restoration of more than 10,000 acres of low-elevation big game winter range that was lost when the project was built.

Because project impoundments would continue to trap sediment, beaches and sandbars downstream of Hells Canyon dam would continue to degrade, to the detriment of recreational, aesthetic, cultural, and wild and scenic river values.

3.15 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Relicensing this existing project would not irreversibly or irretrievably commit any significant developmental or nondevelopmental resources in the basin. At any point in the future, project facilities could be modified or removed and any operational effects could be altered. There is no major new capacity or construction proposed or recommended that would commit lands or resources in an irreversible manner.

3.16 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

The Applicant's Proposal for the project is expected to provide an average of 6,562,244 kWh of energy each year to the region. This long-term energy productivity would extend for at least as long as the duration of the new license. Our evaluations are designed to identify and then minimize or avoid long-term decreases in biological productivity of the system, as well as enhance aquatic habitat and local and regional recreational opportunities.

If the project were operated solely to maximize hydroelectric generation, there would be a loss of long-term productivity of the river fisheries due to decreases in water quality and fish habitat. Moreover, many efforts to enhance recreational opportunities at the project would be foregone.

With the proposed operating mode, as well as with proposed and recommended enhancement and protection measures, the project would continue to provide a low-cost, environmentally sound source of power. The project would further many of the goals and objectives identified by agencies, tribes, and other interested parties.