3.0 ENVIRONMENTAL ANALYSIS

3.1 GENERAL DESCRIPTION OF THE SANTEE AND COOPER RIVER BASINS

The Santee River is formed by the confluence of the Congaree and Wateree Rivers and flows into Lake Marion, created by Santee dam. The Santee River Basin encompasses 1,279 square miles and is comprised of 11 watersheds including Lake Marion and its tributaries; Halfway Swamp; Jack's, Tawcaw, and Potato Creeks; the 37-mile-long bypassed reach of the Santee River below Santee dam; the Rediversion Canal; and the Santee River and its tributaries to the ocean. Santee River flows from Lake Marion are either diverted to Lake Moultrie via the 7.5-mile-long Diversion Canal or pass through Santee dam via the spillway or the Santee Hydroelectric Station. The river below the dam is a 37-mile-long bypassed reach until joined by the Corps Rediversion Canal from Lake Moultrie, and the river continues to its divergence into the North and South Santee rivers, which flow into the Atlantic Ocean. The majority of land in the basin is forested (42.5 percent), followed by wetlands (20.7 percent), scrub-shrub land (12.4 percent), agricultural land (11.7 percent), and developed and barren lands (approximately 1 percent). Water covers 11.7 percent of the basin area and is comprised of 934 stream miles, 94,664 acres of lake waters, and 5,276 acres of estuarine areas (SCDHEC, 2006a).

Flows released from Lake Moultrie via Pinopolis dam join Wadboo Creek to form the Cooper River. The Cooper River accepts flow from multiple tributaries before flowing into Charleston Harbor and the Atlantic Ocean. The Cooper River Basin covers 843 square miles; 52.7 percent of which is forested lands, followed by wetlands (16.1 percent), urban lands (primarily the City of Charleston - 8.3 percent), scrub/shrub lands (4.1 percent), and agricultural land (2.6 percent). Water covers about 15.8 percent of the Cooper River Basin area. The basin encompasses 8 watersheds, including Lake Moultrie and the Cooper River and its tributaries downstream of the project to the ocean, having 471 stream miles, 60,189 acres of lake waters, and 13,059 acres of estuarine areas (SCDHEC, 2006a and 2006b).

3.2 CUMULATIVE EFFECTS

According to the Council on Environmental Quality regulations for implementing NEPA, 40 CFR 1508.7, an action may cause cumulative effects on the environment if its effects overlap in space and/or time with effects of other past, present, and reasonable foreseeable future actions, regardless of what agency or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions over a period of time, including hydropower and other land and water development activities.

Where appropriate, we address potential cumulative effects in each specific resource section in this draft EIS. Based on information in the license application,

agency comments, other filings related to the project, and preliminary staff analysis, we have identified water quality and diadromous fish resources as having the potential to be cumulatively affected by the continued operation of the Santee Cooper Project, in combination with other activities in the Santee and Cooper River basins (e.g., operation of the Corps' St. Stephen hydroelectric facility).

3.2.1 Geographic Scope

The geographic scope of the analysis defines the physical limits or boundaries of the proposed action's effects on the resources. Because the proposed action would likely affect the resources differently, the geographic scope for each resource may vary. For water quality and diadromous fish resources, the geographic scope extends from the point upstream where the Santee River enters Lake Marion downstream to the Atlantic Ocean, and from Lake Moultrie down the Cooper River to Charleston Harbor.

3.2.2 Temporal Scope

The temporal scope of the cumulative effects analysis includes present and future actions and their possible cumulative effects on each resource. Past actions that may have affected water quality and diadromous fish resources are also considered, to the extent that information is available. Based on the potential license term, the temporal scope concentrates on the effect on the resources from foreseeable future actions extending 30 to 50 years into the future. Information from federal, state, and other agencies and other sources pertaining to past, present, and future actions and their effects on the aforementioned resources is reviewed and incorporated into our analysis.

3.3 PROPOSED ACTION AND ACTION ALTERNATIVES

3.3.1 Water Resources

3.3.1.1 Affected Environment

Water Quantity

The project is located on the Santee and Cooper rivers in eastern South Carolina, about 50 miles inland from the coast (see figure 1, appendix A). The drainage area consists of 15,000 square miles and comprises three major rivers: the Saluda, Broad, and the Catawba-Wateree in the Piedmont Region of the state. This area of South Carolina receives 48 inches of rainfall annually, on average (Encarta, 2006).

The Saluda and Broad rivers join to form the Congaree River, which in turn converges with the Wateree to form the Santee River. The Santee River generally flows southeast, beginning at the convergence of the Congaree and Wateree rivers, located about 7 miles upstream of the headwaters of Lake Marion. Before entering the impoundment, the Santee River receives drainage from Broadwater Creek and passes through Santee Swamp, which receives drainage from Tavern and Mill creeks. The river continues across two of South Carolina's geographic provinces, the Piedmont Region and

the Atlantic Coastal Plain, flowing to the north and east of Lake Moultrie into the Atlantic Ocean north of Charleston (figure 3, appendix A). The Santee River watershed consists of 120,589 acres or about 188 square miles of lands and waters of the Santee River and its tributaries, such as the Little River, Dead River, and Highland Creek, from the tailwaters of Lake Marion down to the Rediversion canal. The combined Santee River/Lake Marion watershed, which includes the Santee River and other Lake Marion tributaries, occupies a total of 222,737 acres or about 350 square miles (SCDHEC, 1999).

The Cooper River is formed by the confluence of the Jefferies station tailrace at Lake Moultrie and Wadboo Creek. Formerly a tidal estuary prior to construction of the Santee Cooper Project, the Cooper River is now a major freshwater river that flows southeasterly for about 50 miles to Charleston Harbor. Although its average flow increased from about 72 cfs to 4,500 cfs following project development, it is still influenced primarily by the natural tidal cycle, which ranges from 4 to 6 feet (SCPSA, 2004a; Corps, 2006). The Cooper River then merges with Mepkin Creek and the East Branch Cooper River and accepts drainage from the Back River, Goose Creek, and the Wando River before flowing into the Charleston Harbor and the Atlantic Ocean (figure 3, appendix A). The Cooper River/West Branch Cooper River, East Branch Cooper River, and Cooper River watersheds occupy a total of 209,899 acres or about 328 square miles (SCDHEC, 1999) downstream of the project.

The project includes two major impoundments, lakes Marion and Moultrie, which are connected by the Diversion canal. Lake Marion is impounded by Santee dam and is the most upstream project waterbody. It has a surface area of 106,700 acres and a drainage area of about 14,700 square miles above the dam (SCPSA, 2004a). Lake Marion receives the majority of its inflow from the Santee River. Other minor tributaries to Lake Marion include Squirrel Creek, Warley Creek, Spring Grove Creek, Richardson Branch, Little Poplar Creek, Big Poplar Creek, Webbs Creek, Mill Creek, and Eutaw Creek (SCDHEC, 1999). The waters of Lake Marion are discharged to the Santee River, via Santee dam and powerhouse, or to the Diversion canal, which feeds Lake Moultrie (see figure 2, appendix A) (SCPSA, 2004a).

Lake Moultrie covers most of the original headwaters of the Cooper River. As a result, the drainage area for the development is only slightly larger than the surface area of the impoundment which is 59,874 acres (SCPSA, 2004a). Lake Moultrie receives water from Lake Marion through the Diversion canal and from Duck Pond Creek on the western shore of the lake. The watershed, which includes Lake Moultrie and its tributaries, encompasses about 87,731 acres or 137 square miles (SCDHEC, 1999). Lake Moultrie discharges to the Cooper River via Jefferies station or Pinopolis dam, and to the Santee River via the Rediversion canal and the Corps' St. Stephen Hydroelectric Project (SCPSA, 2004a).

The Rediversion canal is an 11.5-mile canal connecting outflow from Lake Moultrie to the Santee River. The Rediversion canal was constructed by the Corps in 1985 as a mechanism to reduce shoaling in Charleston Harbor, thought to be the result of

increased flow and siltation of the Cooper River. In addition to the canal, the Corps constructed an 84-MW hydroelectric generating station at St. Stephen. The SCPSA operates the St. Stephen station cooperatively with the Jefferies station as part of the Cooper River Rediversion Agreement, though this development is not part of the licensed Santee Cooper Project. About 70 percent of the outflow from Lake Moultrie currently passes through this canal to the lower Santee River (SCPSA, 2004a). The Rediversion canal watershed occupies about 23,419 acres, or 37 square miles, of lands and waters of the canal and its tributaries such as Crawl Creek, Ponteaux Branch, and Mattasee Branch (SCDHEC, 1999).

Lake Levels

Lake levels at the project depend upon inflows to Lake Marion, the majority of which come from the Santee River (SCPSA, 2004a). For 1940 to 1999, the mean inflow[21] to Lake Marion was 15,500 cfs, with a maximum inflow of 224,000 cfs recorded in 1945 and a minimum inflow of 1,096 cfs recorded in 1981.

The Santee Cooper Project operates under a rule curve that sets daily target lake elevations for Lake Marion and accounts for seasonal flood storage (figure 4). Generally, the project targets an average lake level elevation of between 75.0 and 76.0 feet NGVD from mid-March through mid-October. Fall drawdown begins in mid-October and continues to early January, reaching an elevation just above 72.0 feet. Spring fill begins in January, with water levels returning to elevation 75.0 feet by mid-March. Lake Marion and Moultrie water levels are balanced by the Diversion canal. The water level of Lake Moultrie is about equal to the water level of Lake Marion, minus head losses through the Diversion canal (SCPSA, 2004a).

The project is generally operated to match outflow to inflows. Specifically, if inflows result in lake levels above the rule curve, the excess capacity can be discharged for hydroelectric generation. If lake levels fall below the rule curve, project generation is reduced to conserve water and return lake levels to the rule curve. To accommodate flood storage needs, the project reduces lake levels below the rule curve during unique circumstances in anticipation of flooding or higher than normal inflows. From July through October, lake levels are drawn down to elevation 75.0 feet or lower upon notification of adverse weather from the National Weather Service and the U.S. Geological Survey (USGS) (SCPSA, 2004a).

[21]Inflows to the project were approximated with data from streamflow gages located on the Wateree and Congaree rivers (USGS gage nos. 02148000 and 02169500).

Figure 4. Lake Marion rule curve. (Source: SCPSA, 2004a)

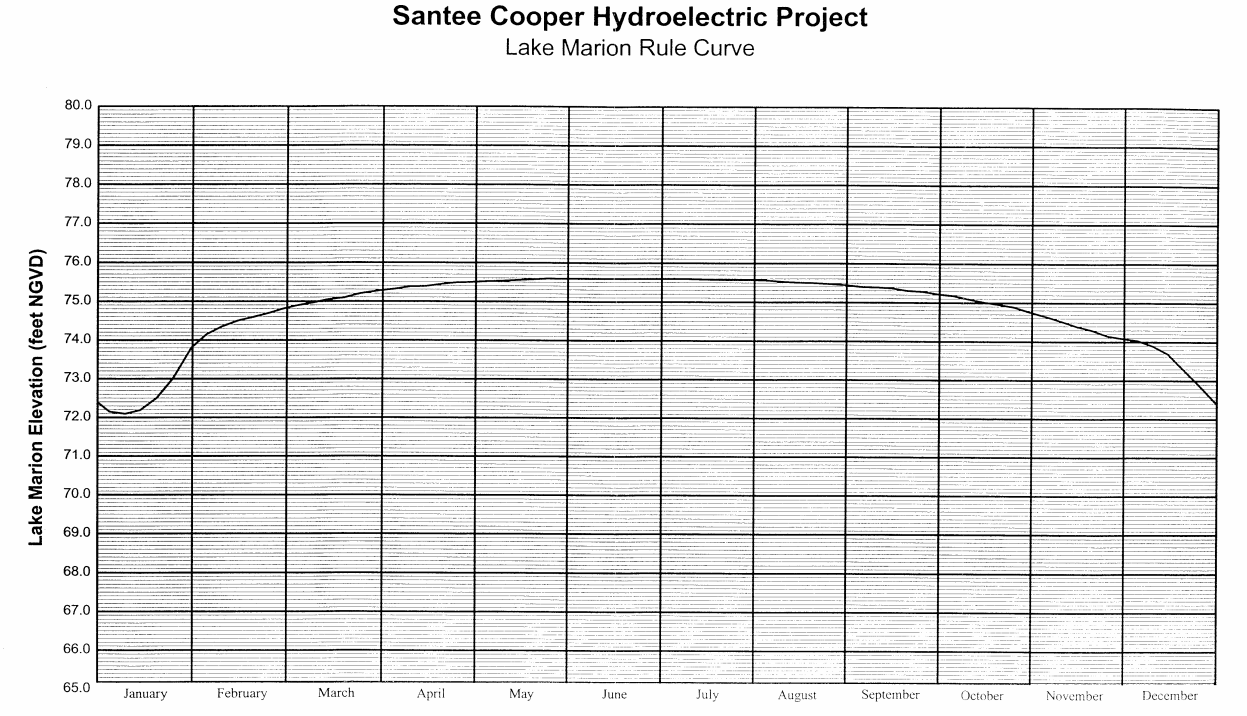

Figure 5 shows lake levels recorded between 1998 and 2005 at Lake Marion (USGS gage no. 2171000), which include the extended drought conditions experienced at the project from 1999 to 2002. Table 1 presents average monthly lake level stage data from USGS for 2000 to 2005. Due to the shallow nature and nearly level shoreline topography of the lakes, small changes in lake level can translate into sizeable areas of exposed shoreline. According to stage-area relations developed from bathymetric data for the lakes, each 1-foot reduction in lake water elevation results in a reduction in surface area of about 3,860 acres on Lake Marion and 2,080 acres on Lake Moultrie (Patterson and Logan, 1988).

Figure 5. Monthly average Lake Marion water surface elevations from 1998 to 2005 (USGS gage no. 2171000). (Source: USGS, 2006a)

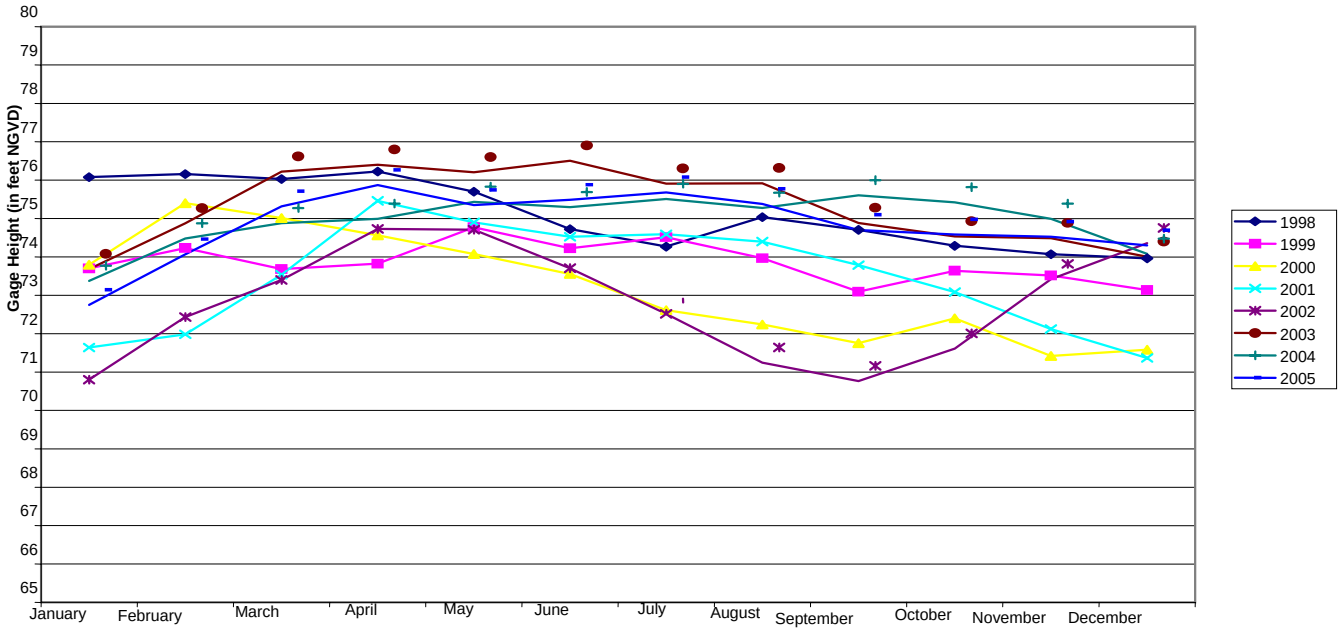

Table 1. Lake Marion water levels for years 2000 to 2005. (Source: USGS, 2006a)

	Monthly Average Stage Height (feet)						Monthly
Month	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**Average**
January	73.80	71.64	70.80	73.68	73.37	72.75	73.23
February	75.40	71.98	72.43	74.88	74.48	74.07	74.21
March	75.01	73.54	73.40	76.22	74.88	75.32	74.76
April	74.56	75.46	74.73	76.40	75.00	75.87	75.26
May	74.08	74.91	74.71	76.20	75.43	75.35	75.14
June	73.55	74.53	73.71	76.51	75.30	75.48	74.75
July	72.61	74.59	72.52	75.91	75.51	75.68	74.45
August	72.24	74.40	71.25	75.92	75.28	75.38	74.18
September	71.75	73.79	70.77	74.89	75.61	74.70	73.66
October	72.40	73.08	71.61	74.54	75.42	74.58	73.70
November	71.42	72.12	73.42	74.49	74.99	74.53	73.57
December	71.58	71.37	74.36	74.00	74.08	74.30	73.35

Note: Data obtained from available records for USGS gage no. 2171000. Only years with complete data were used.

Minimum and Operational Flows

The Santee Spillway Hydroelectric Station maintains a minimum flow of 500 cfs in the Santee River, from downstream of Santee dam to the Rediversion canal. Although a minimum flow of 500 cfs is mandated, SCPSA routinely discharges a continuous flow of 600 cfs to maximize the generation capacity of Santee Station. All normal inflow exceeding the minimum flow at Santee station is passed to Lake Moultrie via the Diversion canal. Lake Moultrie flows are discharged either through the Jefferies Hydroelectric Station or the Corps' St. Stephen development. When inflow to the project exceeds the generating capacity of all three generating stations during high flow conditions, the excess flow is passed through the Santee spillway Taintor gates (SCPSA, 2004a). Both the Jefferies and the Corps' St. Stephen developments are operated as semi-peaking facilities.

Discharge through the Jefferies Hydroelectric Station is limited to a weekly average flow of 4,500 cfs to the Cooper River, although instantaneous discharges may vary from 0 to 28,000 cfs, the hydraulic capacity of the development. SCPSA occasionally exceeds this weekly average flow by up to 2,500 cfs when generating units are operated at SCPSA's adjacent steam generating plant. As discussed previously, shoaling in Charleston Harbor has historically been a concern, thought to be the result of increased flow and siltation into the Cooper River resulting from the diversion of the Santee River flows into the Cooper River. The weekly average flow for the Jefferies Hydroelectric Station was determined by the Commission in 1995 to be "sufficiently small enough to substantially reduce shoaling in Charleston Harbor, but also sufficiently large enough to preclude salinity intrusion in the Bushy Park industrial complex located down river near Goose Creek, South Carolina" (SCPSA, 2004a). Furthermore, Supplemental Agreement No. 6, between SCPSA and the Corps, also includes a provision for discharging flow through the Jefferies Hydroelectric Station to mitigate high saline levels at the tidally affected Bushy Park industrial complex, located about 28 miles downstream of the project. Both the USGS and Corps operate salinity gages in the Cooper River that trigger alarms for two levels of salinity. A schedule of water releases from the Jefferies Hydroelectric Station has been determined for each salinity alarm level (SCPSA, 2004a).

As of 1990, SCPSA, with agreement from the Corps, has voluntarily increased the fixed minimum flow at St. Stephen to 5,600 cfs during the fish passage season (SCPSA 2004), generally March to mid-May. Flows from St. Stephen merge with the 500-cfs minimum flow released from the Santee station about 37 miles downstream of Santee dam and proceed another 50 miles to the Atlantic Ocean. The mean and maximum recorded flows at the SCPSA and Corps project facilities from 1985, when the St. Stephen Project was placed into operation, to 1999 are shown in table 2.

Table 2. Mean and maximum flows – Santee Cooper Project (1985-1999). (Source: SCPSA, 2004a)

Facility	Mean Flow (cfs)	Maximum Flow (cfs)
Santee Spillway	1,227	96,041
Santee Hydroelectric Station	542	660
Jefferies Hydroelectric Station	4,846	27,172
St. Stephen Hydroelectric Station	8,543	27,436

Tailwater elevation at the Santee spillway typically remains at about 27.0 feet NGVD, reflecting a constant discharge of 500 cfs through Santee station. The Jefferies station at Pinopolis dam discharges to the Cooper River, which is tidally influenced up to the tailrace. As a result, a typical tailwater rating curve does not apply. At the base of the Pinopolis dam, tailwater elevation is tidally affected by 2 to 4 feet, but can vary from about 1 to 8 feet NGVD within the range of project discharges (SCPSA, 2004a). Water levels downstream of Jefferies station experience only small, temporary effects resulting from project operations (Normandeau, 2002). Project operations result in generally less than a 1-foot rise in water level, which only occurs during low tide conditions and is smaller than the range of natural tidal variation.

Pinopolis Lock Operations

The primary operation associated with the Pinopolis lock is to provide navigational access between the tailrace canal and Lake Moultrie. The lock provides 67.5 feet of lift, which requires 729,000 cubic feet of water for each locking event. The lock is opened, as needed, to allow for the passage of boats from one-half hour after dawn until one-half hour before dusk year-round. The locking procedure for navigation takes from 20 to 45 minutes to complete, depending upon the number of boats.

The Pinopolis lock is also utilized for passage of anadromous fish species to spawning areas upstream of the Pinopolis dam, in cooperation with SCDNR. Scheduled locking events for fish passage are conducted at least six times per day at periodic intervals for 8 minutes duration during the spring spawning season, which typically runs from early February to late April/early May, depending on water temperatures. Operation of the lock for fish passage purposes is coordinated with fish lift operations at the Corps' St. Stephen generating station.

The lock opens about 1,350 times during an average year for both fish and boat passage. This frequency of operation releases up to 22,500 acre-feet of water annually, which is not available for power generation (table 3).[22]

Table 3. Estimated operations at Pinopolis lock. (Source: NHI, 2004, as modified by staff)

	Estimated Average Daily Locking for Navigation	Estimated Daily Locking for Fish Passage	Estimated Total Locking Events Per Month
January	-	-	3
February	-	6	168
March	-	6	186
April	-	6	180
May	4	-	118
June	6	-	165
July	5	-	167
August	5	-	140
September	4	-	111
October	2	-	50
November	1	-	33
December	1	-	25
Total Annual	813	534	1,347

Water Withdrawals

In addition to hydroelectric generation, terrestrial and aquatic habitat and recreational uses, the Santee Cooper Project provides water for irrigation, industrial uses, and municipal drinking water supply. In total, more than 25 million gallons per day (about 39 cfs continuous flow) are allocated to several farms and nurseries, Georgia Pacific, waterfowl and fisheries management areas, and to the Santee Cooper Regional Water System for drinking water supply. Approximately 173 million gallons per day

[22]The NHI 2004 Santee River Model used a report documenting the total openings between January 1982 and December 1986 as an estimate of average monthly operations for navigation. Estimates of average daily operations for fish passage in table 3 are based on SCPSA's explanation of locking events for fish passage provided in the Santee Cooper license application. Locking events for fish passage occur 6 times a day in the late winter and early spring (typically early February through late April or early May). Because locking events for fish passage occur more frequently during spawning season than passage for navigation, it is expected that boat passage during this season would be addressed by the 6 scheduled daily locking events.

(about 266-cfs continuous flow) are used by the Cross and Jefferies Steam Generating Stations for once-through flow station cooling loops (SCPSA, 2004a).

Through a pump system constructed by SCPSA as part of an agreement executed in 1975, FWS pumps water from Lake Marion into wetlands of the Santee NWR to create, protect, and manage migratory waterfowl and shorebird habitat. The Santee NWR is delineated into four management units containing waterfowl habitat as semi-permanently, flooded, open water ponds; agricultural fields; greentree reservoirs; and wetlands. Wetland and other habitats in all four units are seasonally flooded and drawn down through a series of pumps, intakes, and holding ponds hydrologically linked to Lake Marion (letter from Mark Purcell, Refuge Manager, FWS, to SCPSA, December 21, 2004).

Water level management of Lake Marion directly affects water level management of the Santee NWR, as the managed habitats are dependent upon seasonal water level variations created by waters from Lake Marion. According to FWS, optimum water levels for the Santee NWR from March through September are between 74.0 to 75.0 feet NGVD, with minimal flooding "to facilitate planting food crops and growth of natural vegetation conducive to waterfowl." Optimum water levels from October through mid-February are at or near full stage "to facilitate waterfowl use of fringe areas and to facilitate economical water transfer into the interior of the refuge" (letter from Mark A. Purcell, Refuge Manager, Santee NWR, to SCPSA, December 21, 2004).

Water Quality

Water Quality Standards

Lakes Marion and Moultrie, as well as the sections of the Santee and Cooper rivers flowing into or from the impoundments, are classified by the state of South Carolina as "Freshwaters." The designated beneficial uses are primary and secondary contact recreation, drinking water supply after conventional treatment in accordance with SCDHEC requirements, fishing, indigenous aquatic community habitat, and industrial and agricultural uses. The standard for dissolved oxygen concentrations (DO) is daily average not less than 5.0 mg/L, with instantaneous readings not less than 4.0 mg/L. Water temperatures shall not increase to more than $5^{o}F$ ($2.8^{o}C$) above natural temperature conditions or exceed a maximum of $90^{o}F$ ($32.2^{o}C$) as a result of the discharge of heated liquids. Primary uses supported by project waters, as well as their status, are reported in table 4.

Table 4. Water classifications and uses for project waters. (Source: SCDHEC, 1999; SCDHEC, 2004*c*)

Water Body	Section	Classification	Uses	Status
Santee River	From junction of Congaree and Wateree rivers to	Freshwater	Aquatic life	Fully supported
			Recreation	Fully supported

Water Body	Section	Classification	Uses	Status
	Lake Marion			
Lake Marion	The entire lake	Freshwater	Aquatic life	Fully supported[a]
			Recreation	Fully supported
Santee River	That portion of the stream below Lake Marion to the North and South Santee rivers	Freshwater	Aquatic life	Fully supported
			Recreation	Fully supported
Diversion Canal	The entire canal between Lakes Marion and Moultrie	Freshwater	Aquatic life	Fully supported
			Recreation	Fully supported
Lake Moultrie	The entire lake	Freshwater	Aquatic life	Fully supported
			Recreation	Fully supported[b]
Tailrace Canal	From Jefferies station to Moncks Corner	Freshwater	Aquatic life	Partially supported[c]
			Recreation	Fully supported
Cooper River	That portion of the stream from U.S. 52 to about 30 miles above the junction of the Ashley and Cooper rivers	Freshwater	Aquatic life	Fully supported
			Recreation	Partially supported[d]

[a] Aquatic life uses are not supported at the confluence of Chapel Branch Creek (Station ST-025), sampled by SCDHEC, due to occurrences of copper in excess of the aquatic life acute standards.

[b] Recreational uses are fully supported but have been impaired due to aquatic macrophyte growth.

[c] Aquatic uses are partially supported due to pH levels.

[d] Recreational uses are partially supported due to fecal coliform bacteria.

Water Quality Monitoring

Both SCPSA and SCDHEC monitor water quality in the project impoundments and upstream and downstream reaches of the Santee and Cooper rivers. Overall, aquatic life and recreational uses are fully supported in Lake Moultrie and in the main channel of Lake Marion. A few impaired uses in Lake Marion coves result from low DO

concentrations and elevated bacterial and nutrient contamination not related to operation of the project. Recreational uses are fully supported in the Santee River between the dam and Rediversion canal; however, aquatic life uses are only partially supported due to low DO levels. Both recreational and aquatic life uses are fully supported in the Cooper River; however, decreasing DO concentrations and pH levels and increased metals contamination have been historically identified as concerns. For the most part, aquatic life and recreational uses were documented as fully supported within the project area (Mead & Hunt, 2002; 2004a; 2004b).

Dissolved Oxygen

The water quality issues experienced by Lake Marion are common in blackwater systems that drain watersheds receiving large anthropogenic nutrient inputs (SCDHEC, 1999), and are often characterized by naturally low pH and DO concentrations. Water quality monitoring conducted from 2001 to 2003 showed periods of chemical stratification whereby DO levels in the bottom layer were lower than the middle and surface layers for Lake Marion. During the first 2 weeks of August 2005, excursions below state standards were recorded on several occasions at Lake Marion monitoring sites. Most of these excursions (1.8 percent or 82 of 4,587 total readings) were hourly readings recorded from the lake bottom. The lake experienced continuous excursions below daily state standards that lasted over a week (8-10 days). In all, however, excursions were minimal, with instantaneous readings averaging 3.5 mg/L (0.5 mg/L below the standard) and daily readings averaging 4.2 mg/L (0.8 mg/L below the standard) for lake-bottom water, both well within the range of sample and/or equipment error. All excursions, instantaneous and daily, occurred mid-summer, during a period of peak algal productivity, and during late night and early morning hours, the low point of the diurnal oxygen cycle.

No violations of the state standard for DO were observed during monthly monitoring at the Jefferies station from September 2000 to October 2003, with DO levels ranging from a high of just over 13 mg/L to a low of about 5 mg/L in July 2003 (Mead & Hunt, 2002; 2004a; 2004b). Continuous water quality monitoring conducted at the Santee Station in August and September 2003, however, documented numerous measurements below state standards for hourly and daily average DO levels in the tailrace and at a site 11 miles downstream of the project discharge (Mead & Hunt, 2003). Because these low concentration values were not typical compared to historic data, Mead & Hunt (2003) hypothesized that increased algal growth, as a result of post-drought, high flow conditions, resulted in increased biological oxygen demand in Lake Marion, in turn affecting DO in project discharges.

A review of available USGS water quality data below Santee dam for January 2004 to December 2005 showed seasonally (late-summer) declining DO concentrations, marked by an increasing percentage of violations of up to about 6 percent of the total readings (728). The Cooper River, downstream of Moncks Corner, showed a similar

pattern during that same time period with 2 percent of the total readings (728) in violation of state standards (USGS, 2006b).

Excursions below state standards were recorded in the Santee River bypassed reach during 55 hourly readings and 25 daily average readings, and on two consecutive days in the Santee dam spillway. As with the lake monitoring sites, excursions were minimal and within sample and equipment error ranges. Instantaneous readings averaged 3.7 mg/L (0.3 mg/L below the standard) and daily excursions averaged 4.6 mg/L (0.4 mg/L below the standard), for the bypassed reach, about 2.6 miles downstream of the dam. The fewest excursions were recorded for the spillway with only one hourly reading below the minimum instantaneous criteria of 4.0 mg/L.

Temperature

Lakes Marion and Moultrie appear to be free of thermal stratification and associated problems, namely water quality impairments. Studies have shown that lakes Marion and Moultrie rarely experience thermal stratification for any extended period. Water quality monitoring conducted from 2000 to 2003 at several depths of both lakes show that, even during times of drought, conditions approaching thermal stratification were only briefly observed on warm, calm days. Project waters regularly meet state standards for water temperature. None of the monthly water temperature readings reported between 2000 and 2003 was in violation of the 90^{o}F maximum weekly average water quality standard.

Salinity

Salinity studies have been conducted for both the Santee and Cooper rivers. For the Santee River, several factors affect salinity, including streamflow, tidal fluctuations, wind, mixing and diffusion, inter-estuary exchange, and meteorological events. The two most prominent factors affecting salinity levels are tides and freshwater inflow, originating from the Santee Cooper Project and Santee River tributaries downstream of the project (Hockensmith, 2004).

Hockensmith (2004) reported that upstream advances of saline water decreased with increasing streamflow at both high and low tides. During high-streamflow and low tide conditions, freshwater extended downstream to the mouth of both the North and South Santee rivers. Conversely, during low-streamflow periods, saltwater incursion extended more than 5.2 and 3.6 miles upstream in the South and North Santee rivers, respectively (Hockensmith, 2004). Brackish water was reported to travel 13 miles upstream of the South Santee River. The South Santee River is generally more saline than the North Santee River because it has less streamflow of the two rivers.

Saltwater incursion in the Cooper River extends from Charleston Harbor upstream to several miles below the confluence of the West and East Branches of the Cooper River. As previously discussed, discharge flows from the Jefferies station are governed by an agreement between SCPSA and the Corps, to prevent high saline levels at the Bushy Park industrial complex. Kjerfve and Magill (1990) report that the salinity regime

of Charleston Harbor has changed as a result of the Santee Cooper Project; the monthly average harbor surface salinity decreased from 30.1 parts per thousand (ppt) to 16.8 ppt as a result of its original construction and operation. Salinity of the harbor rebounded somewhat after the construction of the Corps Rediversion Project in 1985, with typical readings of 22.0 ppt.

3.3.1.2 Environmental Effects

The following section discusses the effects of proposed and recommended measures and enhancements on water quantity and quality, including lake level management and minimum downstream flows and fish passage flows. Based on available historic data, the key water quality parameters of interest for Lakes Marion and Moultrie are excessive mercury and nutrient levels. Issues of concern for the Santee and Cooper rivers are DO levels.

Effects of Project Operations on Lake Levels and Downstream Flow Levels

Project waters have many uses, including wildlife, power production, waste assimilation, water supply, recreation, and aesthetic enjoyment. Management of lake levels and downstream flow regimes accommodate several functions including flood management, power generation, recreational use, and the maintenance of aquatic habitat.

Lake Level Management

Under the proposed action, SCPSA would continue to manage lake levels according to the current rule curve. Several agencies and interested parties recommend a modified rule curve that would target full pool elevation during December through February, and changes in water management such that the Upper Santee Swamp would have higher water levels during what is now a drawdown period (see section 3.3.3, *Terrestrial Resources*).

Our Analysis

Proposed Action

The existing rule curve allows for an annual fluctuation of water levels in Lake Marion between 75.5 feet during the summer to just above elevation 72.0 feet during winter drawdown in January. Recent lake level data indicate that under this operating regime, the Santee Cooper lakes experience considerable variation in seasonal water levels. Lake levels have historically deviated from the rule curve based on inflow conditions and water demands during different water years. The most significant recent deviations from the curve occurred during the extended drought conditions experienced by the Southeast from 1999 to 2002 (see table 1).

For our analysis, we calculated downstream flow requirements and rule curve priorities in comparison with typical instream flows experienced at the project to identify whether proposed lake level and minimum flow alternatives, discussed in detail below, could be met. The flow data were derived by combining the average daily flows from the

Congaree River (USGS gage # 01269500) and the Wateree River (USGS gage #02148000). We identified the following years as a basis for evaluating effects of water levels in the impoundments and downstream: average year, 1997; dry year, 2001; and wet year, 2003. Generally during an average year, inflow to the project is such that water levels can be maintained within the guide curve while still providing for existing water demands including minimum flow in the Santee River bypass, weekly flows from Jefferies, and allocations to St. Stephen for fish passage (during February 1 through April 15). The same is also true for a typical wet year. During dry years, it is expected that lake levels would be adjusted such that minimum flow requirements would be maintained downstream of Santee and Pinopolis dams for aquatic habitat and salinity abatement. In the 2001 dry year scenario, there were insufficient inflows to maintain lake levels and minimum flow priorities 45 percent of the time (24 of 53 weeks).

As discussed in further detail below, lake level maintenance may become an issue during average years, should water demands increase or as the prioritization of water use needs shift during dry years. While it is not anticipated that any drawdowns would result in adverse effects on water quality in the lakes, there may be adverse effects on resources within the riparian shoreline areas.

Agency and Interested Party Alternative

Agency and interested parties recommend modification of the rule curve, aimed at full pool elevations for project reservoirs during December through February. This measure would essentially result in annually sustained full or near-full stage conditions for both lakes Marion and Moultrie, since lake levels are already held at full pool from mid-March to mid-October, and winter full-pool requirements would not allow enough time for drawdown and recharge in November. Likewise, inundation of Upper Santee Swamp would require higher lake levels during December through February.

Under a year-round full-pool scenario, inflows to the project would be wholly allocated to outflows, not accounting for losses due to evaporation, leakage, etc. Average flows during the period when the lakes are currently drawn down, typically up to 11,000 cfs, would be required to supply the existing downstream flow requirements and water withdrawals. If lake levels are maintained at full pool during this period, any additional inflows, which during the average water year of 1997 reached a maximum daily average of 62,000 cfs in February, would be passed downstream in its entirety due to the inability of the project to store water and thus dampen flood flows.

A year-round full-pool rule curve would provide higher lake levels and greater shoreline inundation than under the existing rule curve. However, the current rule curve is designed to anticipate and provide adequate storage for normal seasonal inflows. In addition to the potential adverse effects on resources within the riparian zone, this recommended modification of the rule curve would reduce the reservoirs' capacity to provide flood storage and could potentially create significant short-term fluctuations of downstream flows during flood flow events in the late winter and early spring. While this is not expected to adversely affect downstream water quality, dramatic changes in

flow stage and velocity may adversely affect downstream aquatic habitat and increase erosion.

Under the agency recommendation of year round full pool, inflow to the project would be sufficient to maintain existing minimum flow allocations during typical average (1997) and wet (2003) years. During an average dry year (2001), if minimum flow requirements are prioritized above lake levels, lake levels would not be maintained approximately 58 percent of the time (31 of 53 weeks). If the modified rule curve and agency recommended alternative minimum flows are implemented simultaneously, and minimum flows are prioritized above lake level maintenance, there would be insufficient flows to accommodate all allocations approximately 9 percent of the time (5 out of 53 weeks) during a typical average year (1997) and 79 percent of the time (42 out of 53 weeks) during a typical dry year (2001). This would not be an issue during a typical wet year (2003).

Downstream Flow Regime

SCPSA proposes to operate the Santee Cooper Project as it has historically. As a result, a continuous minimum flow of 500 cfs would be maintained downstream of Santee dam,[23] and a weekly average flow of 4,500 cfs would be maintained downstream of Jefferies station. In addition, SCPSA proposes to provide 5,600 cfs to the St. Stephen development from February 1 to April 15 during anadromous fish migration season, contingent on water availability.

The agencies and interested parties recommend several alternative operating measures that would affect both lake water levels and downstream flow releases. They include increased minimum flows of 1,600 cfs from Santee dam and continuous seasonal flows at St. Stephen of 5,600 cfs (table 5).[24]

Table 5. Agency-recommended minimum flow regimes for the Santee Cooper Project. (Source: Agency recommended terms and conditions)

Period	Jefferies Powerhouse (Cooper River)	St. Stephen Powerhouse (Rediversion Canal)	Wilson (Santee) Dam (Santee River)

[23]SCPSA typically releases flows up to 660 cfs, the maximum hydraulic capacity of Santee Station.

[24]Operation of the St. Stephen Project is under the jurisdiction of the Corps and, therefore, outside of the scope of this analysis. However, this analysis will address the minimum flow recommendations for the St. Stephen Project, insofar as the prioritization of flows to the St. Stephen Project affects the flow requirements and environmental resources of the Santee Cooper Project.

Period	Jefferies Powerhouse (Cooper River)	St. Stephen Powerhouse (Rediversion Canal)	Wilson (Santee) Dam (Santee River)
February–April	4,500 cfs (weekly average)	5,600 cfs (continuous March – April)	30% of remaining inflow, with a minimum of 1,600 cfs
May–January	4,500 cfs (weekly average)	N/A	25% of remaining inflow, with a minimum of 1,600 cfs

The DSA, which both FWS and SCDNR are parties to, includes an alternative minimum flow proposal for downstream of Santee dam. The DSA proposal would require SCPSA to provide seasonal minimum flows below Santee dam of 1,200 cfs from May through January and 2,400 cfs from February through April (fish passage/spawning season). In addition to the flow regime, the DSA includes formation of a Technical Advisory Committee for Instream Flows that would evaluate the previous year's flows relative to generation, fish passage, spill, and habitat conditions in the Santee bypassed reach, and evaluate the ongoing effects of the flow regime based on generation records and monitoring studies.

The agency and interested party recommendations also include an Adaptive Management Plan. Under the Adaptive Management Plan, SCPSA would monitor flows over the next 10 years to determine if increased minimum flows have met ecological and navigational objectives, such as fish staging and spawning, sandbar and floodplain inundation, salinity abatement, and aquatic habitat maintenance. If all objectives are met, SCPSA would continue monitoring for the next 10 years. If objectives are not met, SCPSA would implement an alternative flow regime that apportions between 20 and 40 percent of project inflow to the Santee River, to be released from Santee dam for the next 10-year period.

The DSA includes a Drought Contingency Plan that would dictate operation of the project during low inflows and/or drought, in consultation with FWS and SCDNR. The plan would require a low inflow protocol to assure coordinated operations of the project and the Corps' facility during low flow periods, and that sufficient continuous flows are maintained in the Santee River.

Our Analysis

Proposed Action

Based on our own review of USGS flow data, as described above, we calculated average weekly inflows for representative dry (2001), average (1997), and wet (2003) years. We analyzed the effects of existing operations and agency and interested party

proposed minimum flows on lake levels and downstream flows. Under current project operations, there are sufficient flows to meet all water allocation priorities during a typical wet (2003) and average (1997) water year. Inflows to the project are sufficient to satisfy a 500-cfs minimum flow from Santee dam, a 4,500-cfs weekly average flow at Jefferies station, and a seasonal allocation of 5,600 cfs at St. Stephen during the fish passage season, while maintaining the existing reservoir rule curve. Based on the current water allocation schedule, the Santee River bypassed reach receives the existing required minimum flow of 500 cfs roughly 90 percent of the time on an annual basis (Normandeau, 2005a). When inflows are such that spills at Santee dam occur, they average 21,748 cfs with 16-day duration, and have a 1.7-year recurrence (Normandeau, 2005b).

In a typical dry year (2001), however, inflows are not sufficient to meet these priorities. During spring fill (January to mid-March), average storage flows of about 3,100 cfs daily are needed to maintain existing rule curve target lake levels. This need, coupled with minimum flows at Santee and Jefferies, would require average daily inflows of between 8,100 cfs and 13,700 cfs, including allocations to St. Stephen. From mid-March to mid-October, inflows needed for rule curve targets are negligible. As such, inflows of just over 5,000 cfs are required to satisfy water allocation priorities, not considering losses resulting from withdrawals, evaporation, seepage, etc. during this time.

Given that inflows in dry year 2001 ranged from a weekly average low of about 3,300 cfs in December to a high of about 21,000 cfs in March, sufficient flows to achieve rule curve and downstream flow targets for Santee and Jefferies were not available about 36 percent of the time (19 of 53 weeks). Including allocations for St. Stephen fish passage, sufficient flows were not available about 45 percent of the time (24 of 53 weeks).

Generation flows for St. Stephen (assumed to be greater than 8,100 cfs, which is the hydraulic capacity of each of the three St. Stephen's units, but would also include the minimum flow requirement) are available 55 percent of the time (29 of 53 weeks) during an average year (1997), 70 percent of the time (37 of 53 weeks) during a typical wet year (2003), but only 3 weeks of the year during a typical dry year (2001).

Agency and Interested Party Alternative

Agencies and interested parties (Coastal Conservation League [CCL] and American Rivers) recommend a minimum flow of 1,600 cfs downstream of Santee dam, 5,600 cfs at St. Stephen in March and April, and year-round full-pool elevation. For our analysis, we made the assumption that inflow water allocation would be prioritized as follows: (1) weekly average flow of 4,500 cfs to Jefferies station; (2) continuous flow of 5,600 cfs to St. Stephen during March through April; (3) maintaining lake levels per the existing rule curve; and (4) the agency-recommended minimum flow to the Santee River bypass.

We assumed the weekly average flow from Jefferies as the highest priority, to maintain necessary fresh water inflow to the Cooper River for the purposes of preventing saline waters from reaching the Bushy Park industrial complex, and to prevent shoaling in Charleston Harbor. This prioritization is consistent with existing operations and with the proposed action. In addition, a revision of the rule curve to maintain year round full-pool elevation would result in negligible inflow needs for lake level maintenance, because the level would not change over the course of the year and inflows would only be required for withdrawals, evaporation, seepage, etc. Thus, if agency recommended minimum flows can be accommodated under the existing rule curve during a normal water year, which is considered the baseline in our analysis, they could also be accommodated under the agency recommended year-round full-pool rule curve during a normal water year.

Using 1997 as a representative average water year, inflows to the project are such that after the first three priorities are accounted for, remaining inflow would occasionally fall short of supplying the minimum flow recommended by agencies and interested parties below Santee dam. Weekly average flows would not exceed 1,600 cfs downstream of Santee dam about 8 percent of the time (4 of 53 weeks). However, during two of those weeks, the remaining weekly average flows would be more than the existing 500 cfs but less than the recommended 1,600 cfs. The agency recommended 25 percent of remaining inflows (or 30 percent February-April) would provide flows equal to, or in excess of, the minimum 1,600 cfs 66 percent of the time (35 of 53 weeks). Flows exceeded 3,000 cfs to the Santee River bypass almost 20 percent of the time in 1997 (10 of 53 weeks) in the modeled scenario.

During a wet year (represented by 2003), minimum flows to the Santee River bypassed reach, and all other reaches, would be achieved in most months. However, during 2003, for two weeks, inflow to the project was such that, after the first three priorities are accounted for, the agency recommended minimum flows for the upper Santee River would not have been met. However, only one of those weeks, week 4 in January 2003, provided flows lower than the existing minimum flow requirement of 500 cfs downstream of Santee dam. Given that this year was following an extended drought period, it may not fully represent a typical wet year if the system was still in recovery during January. Agency recommended minimum flows of 1,600 cfs would have been met with the allocation of 25-30 percent of remaining inflow about 81 percent of the time (43 of 53 weeks), with remaining inflows typically providing several times the 1,600-cfs requirement.

For a dry year (2001), the average weekly inflows would be insufficient to meet the minimum flow regime at Santee dam recommended by agencies and interested parties for 34 weeks, after the first three priorities are accounted for. Additionally, overall inflow would be insufficient to provide the weekly average flow of 4,500 cfs from Jefferies station for 16 weeks, and would not be sufficient to provide 5,600 cfs at St. Stephen during 5 weeks in March and April. Under these circumstances, in order to provide for the downstream flow priorities, lake levels would need to be drawn down

below the guide curve to make up for inadequate inflow to the project. Depending on the length and severity of drought conditions at the project, lake levels could drop significantly over a period of time to supply the minimum flows, could be held at a lower elevation than the rule curve for a considerable length of time, and there could be no opportunities for lake level recovery to achieve rule curve targets.

After the first four priorities described above are met, we assumed that any remaining flows would be directed to the St. Stephen powerhouse for generation. Each unit has a hydraulic capacity of 8,100 cfs, so the minimum generation flow would be 8,100 cfs. During an average year (1997), after meeting all priorities, a minimum generation flow of 8,100 cfs would typically be available for St. Stephen on a weekly basis for 11 weeks from May to February. During a wet year (2003), the minimum generation flow would be available on an average weekly basis for 35 weeks from May to February. For a dry year (2001), this flow would generally not be available on an average weekly basis from May to February. Under the agency recommended alternative minimum flow regime, not accounting for agency modifications to the rule curve, inflow to the project would be sufficient to maintain the existing guide curve during typical average (1997) and wet (2003) years. During an average dry year (2001), if minimum flow requirements are prioritized above lake levels, existing lake levels would not be maintained approximately 64 percent of the time (34 of 53 weeks). As discussed above, the simultaneous implementation of the modified rule curve and alternative minimum flows could not be accommodated about 79 percent of the time (42 out of 53 weeks) during a typical dry year (2001).

Development of an Adaptive Management Plan for monitoring minimum flows would provide an assurance that improved downstream water quality, as well as enhancement of downstream aquatic habitat is accomplished. By setting a process that includes a schedule for regular review of effectiveness, and a mechanism to implement changes if warranted, achievement of management goals would be more likely.

DSA Alternative

The DSA, signed by FWS, SCDNR and SCPSA, includes an alternative minimum flow regime from Santee dam of 2,400 cfs during February through April and 1,200 cfs from May through January. During an average water year (1997), inflows would not be sufficient to accommodate all other uses and supply this alternative minimum flow regime approximately 8 percent of the time (4 out of 53 weeks). From February 1 through April 15, weekly average flows would not exceed 2,400 cfs about 20 percent of the time (2 of 10 weeks). From May to January, flows equal to or in excess of the minimum of 1,200 cfs would be provided over 95 percent of the time in 1997 (39 of 41 weeks). During a representative wet year (2003), this alternative minimum flow regime for the Santee River bypassed reach, and for all other locations, would be achieved in all but 2 weeks. During a typical dry year (2001), this flow regime would be maintained only 20 of 53 weeks, about 38 percent of the time.

After meeting all priorities, generation flows would typically be available for St. Stephen 23 weeks (43 percent of the time) during a typical average water year (1997). From mid-April to January, outside of the time period requiring minimum flows for St. Stephen, flows in excess of 8,100 cfs would be available for 16 of 43 weeks (37 percent of the time). During a wet year (2003), a minimum generation flow of 8,100 cfs would be available on an average weekly basis for 28 of 43 weeks (65 percent of the time) from mid-April to January. For a dry year (2001), this flow would not be available on an average weekly basis from May to January and would only be available for two weeks from February to April.

The DSA also includes a provision for providing attraction flows at the entrance to Pinopolis lock. Original fishway prescriptions filed by FWS under section 18 included a provision for an attraction flow of 600 cfs. It is not clear what volume of water is to be provided through the siphon for attraction flows under the measures included in the DSA, but it is expected to be negligible and offset by inflows. Furthermore, in extended drought conditions, it is expected that attraction flows would be minimized to accommodate other water obligations such as salinity abatement in the Cooper River, although attraction flows could be included as part of the minimum releases into the Cooper River.

Water allocation requirements within the Santee Cooper Project area are complex and must include consideration of many resources and operational needs, including maintaining project generation, supplying adequate water to the Cooper and Santee rivers, and maintaining appropriate lake levels in Lake Marion and Moultrie. Such water management accommodates numerous functions such as flood management, power supply, recreational use, and the maintenance of aquatic, wetland, and wildlife habitats. During drought conditions, such as that experienced in the region during 2001, difficult decisions must be made regarding prioritization of water resources.

The Drought Contingency Plan included in the DSA would provide guidance for project operations to ensure that sufficient continuous flows are maintained at all times in the Santee River to protect aquatic resources, rare species, and recreation. In connection with both the Drought Contingency and Adaptive Management Plans, as well as the operations and minimum flow monitoring and fish passage plans (discussed later in this section), development of a Technical Advisory Committee for Minimum Flows, as provided for in the DSA, would provide a mechanism for governance over these overlapping plans. Such a committee, through annual meetings, could oversee the implementation of minimum flows, fish passage, and water management measures. This would provide a mechanism to ensure implementation of measures as defined by the plans and required by the license, and provide a formalized program to evaluate the effects of these measures and identify potential modifications over the term of the license.

Locking Operations

SCPSA proposes an increase in locking operations for a minimum of six, 8-minute locks per day to facilitate fish passage at the project, and, through the terms of the DSA,

provide additional attraction flows for the lock entrance channel. In contrast, some agencies and other interested parties recommend a decrease in locking operations for the stated purpose of conserving lake levels. Additional discussion of other fish passage recommendations is included in section 3.3.2, *Aquatic Resources*.

Our Analysis

Proposed Action

Locking operations have a negligible effect on water levels at the project. On average, locking events occur about 1,350 times during an average year, counting both fish and boat passage. Locking events occur most often between February and September for the spring spawning season and during the recreation season from May through September. During spring spawning, lake levels are targeted for spring fill between elevation 74.0 and 75.5 feet NGVD. Over the course of 6 times per day the 8-minute locking events would use about 8,900 acre-feet of water from February through April, or about 100 acre-feet daily. During the peak recreation season, lake levels are targeted at between 75.0 and 76.0 feet NGVD. Locking events, during the recreation season (May through September) use, on average, 77 acre-feet of water daily.

The combined usable storage capacity of the two impoundments is about 529,000 acre-feet. A daily average loss of between 77 and 100 acre-feet associated with locking events would result in a cumulative loss/release to the Cooper River of about 21,000 acre-feet between February and September and a cumulative annual loss/release to the Cooper River of about 22,500 acre feet, or about 4 percent of total usable storage capacity. However, these losses are typically offset by project inflows even considering minimum flow obligations. Annual net inflows to the project (1985 – 2005) average 7,600 cfs per day annually, which equates to a total of 5,500,000 acre-feet (USGS, 2006c).

Although SCPSA proposes to increase locking for fish passage to a minimum of 6 events per day, it is not clear how many more locking events would occur over existing conditions. It is expected that the additional locking events would continue to have negligible effects on lake levels, considering project inflows.

Although these flows contribute to the 4,500-cfs weekly average flow requirement at Jefferies, the contribution is likewise negligible. For fish passage, locking results in a 1,500-cfs release for 8 minutes, six times per day for the months of February, March and April. During navigation locking, a flow of about 405 cfs is released for an average of 30 minutes about three times a day from May to February. These flows comprise less than 1 percent of the total weekly average flow requirements.

Agency and Interested Party Alternative

As discussed above, locking events have a negligible effect on water levels in Lakes Marion and Moultrie. Net inflows to the project on average are sufficient to accommodate existing minimum flow requirements and maintain lake levels as per the existing rule curve. Though locking event frequencies currently result in releases of up to

22,500 acre-feet of water annually, it is expected that an increase in locking events would not substantially affect lake levels considering project inflows accommodate these events under current conditions.

In their preliminary section 18 fishway prescriptions, NMFS prescribed an attraction flow of 600 cfs at the entrance to Pinopolis lock. The timing and duration of this flow was not specified. If it is assumed to be provided during the upstream fish passage season only (February through April) and given existing instream flow allocations, the attraction flow could be provided approximately 92 percent of the time (11 of 12 weeks) during a typical average water year (1997) and in all of these weeks during a typical wet year (2003). During a typical dry year (2001), the 600-cfs attraction flow could not be provided, along with all other prioritized flow allocations, approximately 75 percent of the time (9 of 12 weeks). The 600-cfs flow has the potential to interfere with navigational use of the lock, could not be provided during some stages of the locking operation, and would potentially reduce generation at the Jefferies powerhouse.

DSA Alternative

Fish passage measures included in the DSA call for the implementation of an unspecified attraction flow at the entrance to Pinopolis lock. In 2001, SCPSA installed a siphon from Lake Moultrie into the Pinopolis lock to provide an attraction flow of approximately 50 cfs for enhanced fish passage. As with locking operations, the effects of any additional attraction flow are expected to be negligible to both lake level maintenance and downstream resources and are offset by inflows. Furthermore, in extended drought conditions, it is expected that locking and attraction flows would be minimized to accommodate other water obligations such as salinity abatement in the Cooper River.

Project Operations and Flow Monitoring Plan

Although not specifically recommended by any entity, we evaluated the need for a project operations and flow monitoring plan, which would be prepared in consultation with pertinent state and federal agencies. An operations and flow monitoring plan would provide additional detail on how the project is be operated, including maintaining lake levels within the proposed guide curve, and developing schedules for implementing and maintaining minimum flows, attraction flows and generation flows. The plan would define the criteria by which compliance with the proposed guide curve and minimum flow/attraction flow schedules would be determined, and would outline the frequency of operations review to periodically confirm that the project is in compliance with a new license. The plan would also provide the data necessary for SCPSA and resource agencies to evaluate the effects of water levels and minimum flows/attraction flows on water quality and aquatic habitat. Finally, the plan would ensure that the intended mode of operations and minimum flow/attraction flows quantities are occurring during the new license term. Incorporation of the guide curve into an operations plan would help to ensure that historical water levels are maintained during the recreation season (see section

3.3.5, *Recreation Resources*) and that stable water levels are maintained, to the extent possible, for species that utilize near-shore aquatic and terrestrial habitat (see sections 3.3.2, *Aquatic Resources*, and 3.3.3, *Terrestrial Resources*).

Effects of Project Operations on Downstream Water Quality

Downstream Flow Regime

SCPSA proposes to continue operating the Santee Cooper Project under the existing operating regime. In addition, SCPSA proposes to implement continuous flows of 5,600 cfs at the Corps' St. Stephen's powerhouse during the spring fish migration season and to increase locking at Pinopolis lock for fish passage.

As discussed above, alternatives to the proposed action were recommended by various agencies and interested parties that may have an effect on water quality at the project. These include a revised reservoir rule curve, allocations to Upper Santee Swamp, higher seasonally-varied minimum flows downstream of Santee dam, reduced locking events for boat passage, development and implementation of a Drought Contingency Plan and Adaptive Management Program, and water quality monitoring and remediation, as necessary, in Lake Marion and the Santee River.

Furthermore, the DSA proposes an alternative minimum flow regime for Santee dam and additional attraction flows for Pinopolis lock.

Our Analysis

Proposed Action

SCPSA's proposal to provide minimum flows at St. Stephen of 5,600 cfs during February 1 through April 15, as well as the agency alternative for minimum flows from March through April at St. Stephen, would not change water quality conditions in the Rediversion canal and Santee River. This is because these flows have essentially been voluntarily provided since 1990.

Based on available data, excursions from state standards occur downstream of Santee dam during a brief window from mid to late summer, associated with low DO discharges from Lake Marion and high air and water temperatures. Such excursions are relatively short-lived and specific to the early morning hours, when the diurnal oxygen cycle experiences a low point as a result of biological respiration. Data, from continuous monitoring in 2003, indicated excursions on three of 14 days monitored (20 percent of the time). Low flow conditions in the Santee River during the hot summer months is likely a contributing factor, because it increases the rate that the river will warm in response to increased ambient air temperature, which in turn decreases the oxygen solubility of the water. However, due to the depth of the Santee station intake structure, water entering the Santee River bypassed reach from Lake Marion during these low DO periods consists of oxygen-depleted bottom waters. This is likely the primary contributor of low DO levels in the river. Thus, the occasional reduced water quality of the Santee River is due in part to project operations.

SCPSA's proposal to increase locking events is unlikely to have any effect on water quality downstream of the project. Since Lake Moultrie has been classified as fully supporting aquatic life and recreation, and does not experience thermal or chemical stratification, supplemental water releases would not have an effect on water quality of the Cooper River.

Agency and Interested Party Alternative

The agency-recommended flow regime would require that a year-round minimum flow of 1,600 cfs be released into the Santee River from Santee dam, or 25 to 30 percent of inflow (depending on the season), whichever is greater. The proposed increases in minimum flow would benefit water quality in the Santee River bypassed reach. Temporary, short-duration DO levels below state standards (20 percent of the time during a two-week continuous sampling event in August 2003) are likely the result of environmental conditions that include high ambient air temperature, biological respiration, release of water with low DO levels from Lake Marion bottom waters, and low streamflow. Additional flow releases from Santee dam would consist of spilled surface waters that do not experience the same reduced DO levels as bottom lake waters, which currently supply the 500-cfs minimum flow. In addition, spillage of over 1,000 cfs, under the agency 1,600-cfs flow recommendation, would increase aeration of waters below Santee dam, resulting in DO levels that could approach or attain saturation levels. During a normal year, based on 1997 data, weekly average flows would be high enough to provide 1,600 cfs downstream of Santee dam about 92 percent of the time. Thus, the agency-recommended minimum flows would likely improve DO levels in the Santee River bypassed reach.

According to CCL and American Rivers, one of the stated purposes of increasing the year-round minimum flow is salinity abatement of the lower Santee River. However, during lower flow periods, any increased flow from Santee dam would be provided from flows that currently are sent through the St. Stephen project and returned to Santee River via the Rediversion canal. Salinity encroachment of the Santee River is directly linked to streamflow, which is largely determined by the combined project releases at Santee dam and St. Stephen. For example, under the agency and interested party alternative, combined flows of at least 7,200 cfs (1,600 cfs at Santee dam and 5,600 cfs at St. Stephen) would be released to the Santee River downstream of the Rediversion canal during March and April. Exceptions to this may occur during drought or low water years when inflow is such that minimum flows could not be provided unless lake levels are lowered. Increases in flow to the Santee River bypassed reach would be offset by decreases in the Rediversion canal discharge, resulting in no net increase in flows in the lower Santee River. In addition, the alternative minimum flows would minimally affect salinity encroachment further downstream, as it was determined that flows greater than 20,000 cfs are required to maintain freshwater conditions in the lower river at the Francis Marion National Forest (Hockensmith, 2004).

DSA Alternative

The DSA includes a minimum flow release of 1,200 cfs from May to January and 2,400 cfs from February through April, into the Santee River. As with the agency alternative, the proposed increases in minimum flow would provide benefits to water quality in the Santee River bypassed reach for two reasons. Additional flow releases would consist of higher DO, spilled surface waters and spillage of over 1,000 cfs would increase aeration below Santee dam. During an average water year (1997), flows of between 1,200 and 2,400 cfs would be provided seasonally about 92 percent of the time.

With respect to salinity abatement, combined flows of at least 8,000 (2,400 cfs at Santee dam and 5,600 cfs at St. Stephen) would be released to the Santee River downstream of the Rediversion canal during February though April, except under drought conditions. Because increased flow from Santee dam would be provided from flows that are currently directed to the St. Stephen project under low flow conditions, there would be no net increase in overall flow in the lower Santee River, with no change in salinity conditions in the lower river.

Project Operation Management Plans

The agencies and interested parties recommend the development of an Adaptive Management Plan, as discussed above. The Adaptive Management Plan would offer a mechanism to assess the effectiveness of flow alternatives in meeting navigation and ecological objectives for the Santee River. The DSA also proposes formation of a Technical Advisory Committee for Instream Flows in an effort to provide on-going evaluation of the effects of minimum flows on fish passage, habitat, and generation. We earlier identified the need for a project operations and flow monitoring plan.

Our Analysis

Agency Alternative

We do not expect the agency recommended Adaptive Management Plan to provide any additional benefits to water quality of the Santee River beyond what is achieved from the proposed increase in minimum flows. Commitment of 1,200 to 2,400 cfs, if primarily spilled from the dam, would likely be sufficient to resolve low DO levels in the Santee River bypassed reach during normal years. However, in order to provide the agency and interested party flows during dry years, lake levels or the 4,500-cfs weekly average flows in the Cooper River may have to be modified. Also, salinity abatement in the lower Santee River can not be achieved by reapportioning water flow between Santee dam and St. Stephen Project, because it is the combined project discharges that affect salinity levels downstream.

DSA Alternative

During drought conditions, such as that experienced in the region during 2001, prioritization of water resources for the protection of aquatic habitat and recreation must be addressed. Should flow releases resulting from a Low Inflow/Emergency

Contingency Plan approximate existing flows at Santee dam, which average 542 cfs, DO levels would continue to experience occasional excursions below state standards. However, to the degree that the Low Inflow/Emergency Contingency Plan could identify and outline criteria for some increase in the minimum flow by sacrificing lake levels or minimum flows in the Cooper River, the Santee River may experience improved water quality (DO levels) during times when episodes of low DO are most likely to occur. These potential lake level reductions, however, could contribute to higher water temperatures and lower DO levels in some locations by making the lakes shallower during the summer season, although the extent that could occur would depend on the extent of drawdown, which cannot be predicted at this time. In addition, near-shore riparian habitat could be dewatered during the summer rearing and growing season, as discussed in sections 3.3.2 and 3.3.3, *Aquatic Resources,* and *Terrestrial Resources,* respectively.

Formulation of a Technical Advisory Committee for Instream Flows would allow for regularly scheduled, on-going evaluation of various measures including fish passage and minimum flows. Incorporating the proposed roles of the committee into the fish passage, drought contingency, operations and minimum flow, and adaptive management (for minimum flows) plans would provide the benefit of a coordinated effort in implementing these plans.

Staff Recommended Measures

Development of a project operations and flow monitoring plan for monitoring minimum flows would help ensure that the required minimum required flows are provided, along with the probable benefits of improved downstream water quality (*i.e.*, higher DO) and enhanced downstream aquatic habitat. In addition, an operations and flow monitoring plan would provide an efficient mechanism for monitoring compliance with minimum flow and project operations requirements under a new project license and WQC.

Effects of Project Operations on Water Quality in Lakes Marion and Moultrie

Lake Level Management

SCPSA proposes to continue operating the Santee Cooper Project under the existing operating regime. Currently, SCPSA attempts to manage water levels in the lakes according to a rule curve that provides target water surface elevations on a seasonal basis (see figure 4). As stated previously, agencies and interested parties have proposed full pool elevations during the months of December through February. The DSA does not include lake level management as a provision of the settlement.

Our Analysis

The primary water quality issues for Lakes Marion and Moultrie, as well as other project waters, are identified by SCDHEC as mercury and nutrient levels. Lake Marion also exhibits occasional DO levels below the state standard. These water quality issues are common to systems that drain watersheds that receive large anthropogenic inputs

(SCDHEC, 1999), which result in excess sediment, nutrients, oxygen-demanding substances, pesticides, and heavy metals. A reduction in the nutrient and mercury levels of project waters would require a statewide and/or regional approach to reduce sediment loading from the 16,800-square-mile Santee and Cooper River basins, and the Chapel Branch watershed area, which is outside of the project boundary but was identified as having elevated concentrations of mercury (see section 3.3.6, *Land Management and Aesthetic Resources*). Thus, project operations, which consist primarily of small to moderate lake drawdowns and filling, are unlikely to contribute to the problem of mercury and excessive nutrient levels in project waters. However, measures undertaken as part of a shoreline management program, such as prohibiting the use of fertilizers within the project boundary and establishing buffer zones, would improve water quality at the project (see section 3.3.6, *Land Management and Aesthetic Resources*).

At Lake Marion, low DO concentrations were documented briefly during mid-summer in 2003 and 2005. The occurrences when DO levels dipped below state standards were likely a result of biological respiration. Low DO levels occurred during a time of peak algal productivity in the lakes, and during the late night/early morning hours when DO levels are lowest. Biological respiration that creates low DO levels is a typical phenomenon of shallow lakes that receive high nutrient inputs through runoff. As such, DO excursions below state standards are unlikely to be caused by project operations or lake management strategies, but rather the nutrient loading of the surrounding watershed. As a result, relatively small water level changes or fluctuations at the project resulting from changes to the rule curve, or any minor effects on lake levels from changes in the minimum flows, locking or attraction flows, would not affect water quality.

Project waters also contain levels of heavy metals, including mercury, that are high enough to warrant SCDHEC to issue a fish consumption advisory. Presumably, the sources of these contaminants are upstream of the project. Management of lake levels would not likely have any effect on influx of metals, but operations may have an effect on downstream levels through discharge of accumulated silt during periods of high flood flows. These flows, however, are beyond the control of the applicant.

There is some evidence that the grass carp stocking management strategy employed by SCPSA, in association with SCDHEC, may have contributed to a net improvement of water quality conditions in Lake Moultrie and Lake Marion. Nutrient concentrations were recorded as being generally lower and DO levels higher following implementation of the grass carp program**.**

Water Quality Monitoring

Agencies and interested parties recommend DO and water temperature monitoring in Lake Marion and the Santee River and implementation of management measures to enhance water quality, if necessary, to help improve water quality of Lakes Marion and Moultrie.

Our Analysis

Water quality conditions in the impoundments generally meet state water quality standards under existing operations. Though historic data show periodic excursions below state standards for DO during the mid summer, this occurs when lake levels under the rule curve are held at the highest level of the year. Periodic DO excursions below state standards are unlikely caused by project operations or lake management strategies, but rather the nutrient loading of the surrounding watershed in a region that experiences hot summers.

The lakes also have mercury levels considered high enough by the SCDNR to warrant fish consumption advisories for largemouth bass and bowfin. Though no data on mercury levels were presented for project waters, SCDNR water quality monitoring and fish consumption advisories from upstream sites in the Wateree River suggest that higher mercury levels in Lakes Marion and Moultrie are caused by pollutant inflow to the project, not reservoir operations. Though the SCDNR recommends that water quality monitoring continue at the project, project operations are not the likely cause of low DO levels in the impoundments. In addition, SCDNR has an ongoing water quality monitoring program, which includes sampling locations in the vicinity of the project.

3.3.1.3 Cumulative Effects

Prior to the completion of the Santee Cooper Project, significant flooding along the Santee and Cooper rivers was more frequent. The combined useable storage capacity of the Santee Cooper Project and the three other projects upstream of the Santee Cooper Project (Saluda, Parr Shoals, and Wateree) is 1.9 million acre-feet. Lakes Marion and Moultrie have a combined 529,000 acre-feet of usable storage, which equates to about 28 percent of the total usable storage in the basin. While the Santee Cooper Project has only about a quarter of the total usable storage in the basin and is the most downstream project, the project, in conjunction with the three upstream facilities, significantly reduces flooding in the Santee and Cooper rivers. Continued operation of the Santee Cooper Project would continue to affect flow distribution in both the lower Santee and the Cooper rivers, in that Santee River flows would still be diverted into the Cooper River and rediverted back into the lower Santee River via the Corps Rediversion project. Although increased minimum flows have been recommended by several entities for the Santee River bypassed reach, any minimum flow that may be required at Santee dam would not entirely restore flows to the lower Santee River. The Cooper River would continue to receive higher flows than historically occurred prior to the operation of the Santee Cooper Project.

Water quality at the project is directly affected by the quality of reservoir inflow from both the Upper Santee River and tributaries to Lakes Marion and Moultrie. The incremental effect of this input of low DO water from the Santee River, combined with the shallow, blackwater system of Lake Marion, results in occasional occurrences of low DO in the Santee River during late summer. Several sections of the project

impoundments and rivers as impaired due to mercury pollution. The source of the mercury is likely atmospheric deposition caused by actions other than operations of the Santee Cooper Project. Other land use activities in the basin have the potential to affect water quality in the lakes and in the lower Santee and Cooper rivers through the input of nutrients and sediments, including lawn and road run-off, agricultural activities, recreation use, and the removal of riparian vegetation.

Prior to the construction of the Rediversion canal, shoaling of Charleston Harbor was more substantial than under existing conditions (SCPSA, 2004a). When the entire flow of the Santee River was passed through the Pinopolis dam, suspended sediment levels were much higher at the upper end of the Cooper River, and settled out of the water column by the time water traveled to the Charleston Harbor. The Corps' Rediversion Project was designed to alleviate shoaling by rediverting a portion of the flow back into the Santee River. In doing so, flows were restored to the Santee River, which has helped to reduce the sediment load to Charleston Harbor. However, because significant dredging is regularly conducted in Charleston Harbor to accommodate shipping traffic, the extent of shoaling and the actual effects of the construction of the Rediversion canal are unclear.

3.3.1.4 Unavoidable Adverse Effects

The proposed action would continue to result in some unavoidable adverse effects on water resources in the Santee and Cooper River basins. Continued flow regulation to address water use demands, particularly during dry years, for a project with warm, shallow reservoirs would result in temporary excursions below water quality standards. The inability of the inflows to the project to meet both project and downstream water needs would result in lake drawdowns to meet downstream water needs or result in periods when minimum flows could not be provided.

3.3.2 Aquatic Resources

3.3.2.1 Affected Environment

Lakes Marion and Moultrie

Habitat

Lakes Marion and Moultrie vary substantially in habitat from shallow swamps and wetlands to vast open water with diverse structure. Lake Marion has a maximum depth of around 70 feet, but an average depth of only 12 feet, which provides abundant littoral habitat. Lake Moultrie also has a maximum depth of around 70 feet, but has an average depth closer to 20 feet and thus has both pelagic and littoral habitats. Lake Moultrie also has diverse shoreline cover, comprised of coves, islands, and beaches.

Prior to entering Lake Marion, the Santee River passes through the Santee Swamp, which removes a significant portion of the river’s nutrient load. Lake Marion can be classified as eutrophic. The SCDHEC reports that aquatic life and recreational uses are

fully supported in the main body of Lake Marion. However, some of the arms of the lake may have impaired habitat due to low DO concentrations, excessive vegetation, bacterial contamination, and elevated nutrient levels contributed by agricultural sources. SCDHEC reported that, due to elevated metal (copper and zinc) concentrations and sporadic oxygen deficiencies, aquatic habitat may be only partially supported in the Diversion Canal, which connects Lake Marion to Lake Moultrie (downstream). Although the canal is considered to be eutrophic, many indicators of trophic status show improving water quality characteristics. Water quality data collected by SCPSA show that aquatic life and recreational uses are fully supported in Lake Moultrie.

The scientific literature indicates that mercury generally enters a waterway through atmospheric deposition (EPA, 2005). Once in the water, mercury is bioaccumulated through the food chain, ending up primarily in fish. Mercury levels exceeding the state standards for fish consumption have been found in largemouth bass and bowfin in Lakes Marion and Moultrie.

Fish Communities

SCDNR routinely monitors fish populations throughout project waters. Over 50 species of fish occur within the project boundary, of which 15 are considered gamefish. A reproducing population of the federally listed endangered shortnose sturgeon (*Acipenser brevirostrum*) exists in the impoundment. A reproducing landlocked striped bass population is also present and became established after construction of the impoundments. Hatchery stocking of striped bass is used to compensate for high angling exploitation rates. The Moncks Corner Hatchery formerly produced larval striped bass for distribution throughout South Carolina and many other states. A new hatchery, run by SCDNR, annually produces 20 to 25 million striped bass and hybrids.

Among the 16 forage species present, the most common are gizzard shad, threadfin shad, and juvenile American shad and blueback herring, both of which are anadromous species. The gamefish present include largemouth bass, black crappie, white crappie, bluegill, and redear sunfish. White bass were stocked into project waters in 1952 and have established a fishery. Blue, white, flathead, and channel catfish populations support sport and commercial fisheries. American eel, a catadromous species, also exist within the project area and once supported a large commercial fishery.

Aquatic vegetation management depends on triploid grass carp. SCPSA, in conjunction with SCDNR, began stocking grass carp into Lake Marion in 1989 when *Hydrilla* infested both lakes. Additional grass carp stocked annually have controlled the *Hydrilla* population throughout project waters.

Overall fishing pressure is documented and studied through fish-tag returns and creel surveys. Blue catfish and bluegill were the most numerically-abundant species harvested in Lake Moultrie, followed by white perch, channel catfish and largemouth bass. Blue catfish were also the most abundantly harvested species by weight, followed by channel catfish, largemouth bass, striped bass and flathead catfish. A fish-

consumption advisory has been issued by the SCDHEC for the project lakes, cautioning people to limit the consumption of some species (bowfin, largemouth bass, and chain pickerel) due to mercury contamination.

A recent survey (Alderman, 2005) determined that a number of freshwater mussel species inhabit the project impoundments. Based on surveys conducted at 23 sites in each of the two lakes, 17 species of freshwater mussel were documented through the collection of live mussels and mussel shells. A species of special concern to FWS, the Savannah lilliput (*Toxolasma pullus*), was found in the limestone area of Lake Marion.

Santee and Cooper Rivers

Habitat

The Santee River bypassed reach from Santee dam to the confluence with the Corps Rediversion Canal is 37 miles long. This reach receives a nearly continuous 600-cfs flow from the Santee powerhouse, but has a required minimum flow of 500 cfs. Although during spring run-off, the 37-mile-long bypassed reach experiences brief high flow events, the duration and frequency of such flows, and the magnitude of base flows have been reduced by diversion of most flow to the Cooper River (Jefferies station) and to the lower Santee River (via the St. Stephen station). Because project inflow and storage is directed to the Cooper River as a first priority, some of the annual inflow that historically was available to the Santee River is now directed out of the basin either to the Cooper River via Jefferies station or further downstream in the Santee River via the Corps' St. Stephen station and is absent from the bypassed reach.

The Santee River below Santee dam is a low gradient river that descends to tidewater through the alluvial coastal plain geomorphic province to enter the Atlantic Ocean past a delta that defines a lower estuarine reach. The river below the Rediversion Canal is a tidally drowned valley complex, tidally influenced about as far upstream as Jamestown, SC, about 46 miles downstream of Santee dam (Hockensmith, 2004). Shoreland is comprised of floodplain forests that are generally healthy but have experienced minor vegetative shifts in response to reduced frequency and duration of floods since 1941 (TNC, 2005). An extensive delta complex exists at the mouth of the river where there is a north and a south channel (Hockensmith, 2004). Discharge in the Santee River, via Santee dam and/or St. Stephen, affects the saline/freshwater brackish water interface spatially and volumetrically. The Santee River provides habitat to numerous warmwater fish species of management and ecological importance, as well as provides a migratory pathway for native anadromous and catadromous species, including spawning and nursery habitat for shortnose sturgeon, and alosine species such as American shad and blueback herring.

The SCPSA and SCDHEC monitor water quality in the project impoundments and in the upstream and downstream reaches of the Santee and Cooper Rivers. Based on data collected by SCPSA, aquatic habitat is fully supported at both locations. According to the SCDHEC, water quality at Santee's Landing near the Santee spillway, fully supports

aquatic life. However, SCDHEC reports that intermittent instantaneous low DO recorded at its sampling site further downstream near the Highway 52 bridge indicate that aquatic life uses are only partially supported. SCDHEC also reports that many indicators of trophic status are decreasing, indicating improving water quality conditions.

The Cooper River channel was constructed downstream of the Jefferies powerhouse to convey the flow of the diverted Santee River into the Cooper estuary, Charleston harbor, and into the ocean. Water stage levels below Jefferies powerhouse as well as operation of the Jefferies powerhouse are affected by tidal cycles. The Cooper River at the powerhouse tailrace is about 395 feet wide, and the average depth is nearly 13 feet. Depth fluctuates ±3 feet due to tidal variation. The substrate is primarily hard packed clay. Velocities in the tailwater area are unknown, but must vary considerably with unit operation. Although the average weekly flow is 4,500 cfs, daily instantaneous flows at Jefferies can vary from 0 up to the full station hydraulic capacity of 28,000 cfs.

Both the SCDHEC and SCPSA routinely monitor the quality of project outflow to the Cooper River. SCDHEC reported that aquatic life is fully supported in the project outflow, and the outflow generally meets state standards for temperature and DO (see section 3.3.1, *Water Resources*). Previous water and sediment studies showed elevated concentrations of metals. Recent monitoring for trophic indicators suggests that project outflows were less eutrophic, which may indicate a trend of improving water quality.

Fish Communities

Historically, seven diadromous fishes were reported from the Santee and Cooper Rivers including striped bass, American eel, Atlantic sturgeon, shortnose sturgeon, American shad, hickory shad, and blueback herring. Collection records for 1991, 2002, and 2003 have recorded 53 species in the Santee River bypass (table 6).

The Santee River watershed supports a diverse coastal ecosystem, including numerous introduced species of interest to anglers. Normandeau (2005a) reported that a minimum of 89 fish species are believed to occur in the Santee River, including freshwater, estuarine and marine species. This fish assemblage represents both warmwater and estuarine species common to the southeastern United States, including insectivorous, omnivorous and piscivorous species, both game and forage species groups. Migratory runs of American shad, blueback herring, American eel, shortnose sturgeon, and Atlantic sturgeon are present in the river. Striped bass and largemouth bass, important recreational species, occur within the reservoirs and river.

Table 6. Fish collected in the Santee River bypass in 1991, 2002, and 2003. (Source: SCPSA, 2004a)

Common Name	Scientific Name
American eel	*Anguilla rostrata*
American shad	*Alosa sapidissima*
Atlantic needlefish	*Strongylura marina*

Common Name	Scientific Name
Black crappie	*Pomoxis nigromaculatus*
Blue catfish	*Ictalurus furcatus*
Blueback herring	*Alosa aestivalis*
Bluegill	*Lepomis macrochirus*
Blue Spotted sunfish	*Enneacanthus gloriosus*
Bowfin	*Amia calva*
Brook silverside	*Labidesthes sicculus*
Brown bullhead	*Ictalurus nebulosus*
Chain pickerel	*Esox niger*
Channel catfish	*Ictalurus punctatus*
Coastal shiner	*Notropis petersoni*
Common carp	*Cyprinus carpio*
Creek chubsucker	*Erimyzon oblongus*
Dollar sunfish	*Lepomis marginatus*
Eastern mosquitofish	*Gambusia holbrooki*
Eastern silvery minnow	*Hybognathus regalis*
Flathead catfish	*Pylodictis olivaris*
Flier	*Centrarchus macropterus*
Gizzard shad	*Dorosoma cepedianum*
Golden shiner	*Notemigonus crysoleucas*
Grass carp	*Ctenopharyngodon idella*
Hogchoker	*Trinectes maculatus*
Inland silverside	*Menidia beryllina*
Ironcolor shiner	*Notropis chalybaeus*
Largemouth bass	*Micropterus salmonides*
Longnose gar	*Lepisosteus osseus*
Northern hogsucker	*Hypentelium nigricans*
Pirate perch	*Aphredoderus sayanus*
Pumpkinseed	*Lepomis gibbosus*
Redbreast sunfish	*Lepomis auritus*
Redear sunfish	*Lepomis microlophus*
Redfin pickerel	*Esox americanus*
Shorthead redhorse	*Moxostoma macrolepidotum*
Shortnose sturgeon	*Acipenser brevirostrum*
Southern flounder	*Paralichthys lethostigma*
Spotted sucker	*Minytrema melanops*
Spotted sunfish	*Lepomis punctatus*
Striped bass	*Morone saxatillis*
Striped mullet	*Mugil cephalus*

The historic Cooper River fish assemblage was not well documented, but was likely altered by habitat modification resulting from the diversion of the Santee River. A spawning population of the federally listed shortnose sturgeon estimated at about 200 adults inhabits the Cooper River below the Jefferies tailrace (Cooke, 1998; Duncan et. al, 2002). Anadromous adult blueback herring and American shad migration shifted to the Cooper River subsequent to diversion of the Santee River into the Cooper River, after the initial construction of the Santee Cooper Project. The tailrace is currently one of two migratory routes for diadromous fish species into the project lakes and the upper Santee River (the other being the Corps St. Stephen Project). Since the Corps Rediversion project, with diversion of Santee River flows back to the Santee River through the St. Stephen Project, anadromous fish runs have also shifted in large numbers back to the Santee River.

Fish Passage

Anadromous fish species, not including shortnose sturgeon, are passed upstream on the Cooper River at Pinopolis dam and on the Santee River at the St. Stephen station. The Pinopolis navigation lock has been operated since the 1950's to pass blueback herring and other anadromous species upstream during spring spawning runs. Fish passage estimates since 1975 are included in table 7. Currently, the lock is operated 6 times per day at 8 minutes per event for fish passage from February through April. To pass fish, the downstream gates of the lock are partially opened to form a "V-trap" allowing fish to enter while minimizing the opportunity to exit back into the tailrace. The downstream gates of the lock are closed and the lock is filled with water for 8 minutes requiring about 1,500 cfs. The upstream gates are then partially opened to facilitate upstream fish passage.

As part of rediversion, the Corps constructed a fish lift at the St. Stephen station on the Rediversion Canal, to mitigate for potential declines of anadromous fish passage at the navigation lock on the Cooper River. The St. Stephen fish lift, operated by SCDNR under an agreement with the Corps, was primarily constructed to pass blueback herring into Lake Moultrie as forage fish for the striped bass fishery and to mitigate for the shift in herring runs from the Cooper and Santee Rivers. In the 1990s, a flow agreement with the SCPSA was initiated and several modifications to the fish lift entrance channel were made to improve the collection efficiency and the overall effectiveness of the facility (Cooke and Leach, 2003a). In addition, a bypass siphon system, which can deliver supplemental attraction flow of about 500 cfs to the facility entrance, and a juvenile separating device to safely pass outmigrants downstream via this attraction flow, were installed in 2000.

The St. Stephen fish lift primarily attracts upper water column species and is not designed to attract or pass bottom oriented shortnose sturgeon, Atlantic sturgeon or American eel. According to Cooke and Leach (2003a) modifications will be needed to pass all targeted diadromous fishes. Presently, the lift passes American shad, blueback herring, striped bass and other non-diadromous fishes (table 8). Although large numbers

of herring and shad have been passed through the facility annually, the number of shad passed since 2000 has been less than that passed from 1995 to 2000. The number of herring passed has also recently declined. Bottom oriented fish, such as sturgeon, experience difficulty leaving the fish lock chamber and are unable to migrate upstream.

Based on the combined estimates from both fish passage facilities, Pinopolis and St. Stephen (tables 7 and 8), upstream passage has numbered in the millions of fish annually.[25] Data indicate that, in general, the annual biomass monitoring estimates declined in magnitude at the Pinopolis lock subsequent to 1986, and concurrently increased in magnitude at St. Stephen. According to SCDNR, combined blueback herring passage through St. Stephen and the Pinopolis lock has never equaled the pre-rediversion levels that occurred at the navigation lock (SCDNR, 2000; 2001; 2002; 2003).

The Atlantic States Marine Fisheries Commission (ASMFC, 1999) reports that commercial landings for both American shad and river herring have declined dramatically since the 1960's along the entire east coast. Though blockages of spawning reaches by dams and other impediments are cited as potential contributors to these declines, other issues such as over harvest, excessive striped bass predation, environmental changes, and loss of essential spawning and nursery habitat due to water quality degradation are also cited. Stock declines, therefore, are not unique to the Santee-Cooper system, have occurred prior to the construction of the Rediversion canal, and are caused by a multitude of factors beyond barriers to passage.

Table 7. Hydroacoustic counts of fish (herring units), biomass, the number of lock operations conducted per season, and annual average herring units per lock, for the Pinopolis lock, 1975-2005. (Source: Cooke and Leach, 2003a; SCPSA June 7, 2006 Request for Trial-type Hearing)

Year	**Herring units**	**Biomass (kg)**	**Number of Locks**	**Herring Units/Lock**
1975	2,167,000	295,000	99	21,889
1976	2,465,000	336,000	105	23,476
1977	6,329,000	861,000	105	60,276
1978	8,734,000	1,188,000	105	83,181
1979	8,500,000	1,151,000	105	80,952
1980	8,621,000	1,172,000	105	82,105
1981	3,485,000	474,000	105	33,190
1982	3,145,000	428,000	105	29,952

[25]Although species composition passing the navigation lock has changed since rediversion (Cooke and Chappelear, 1992; 1993; 1995), counts are still reported in biomass or "herring units" in order to examine the long term effects of rediversion. At St. Stephen, abundance is recorded by species at a counting station with viewing windows.

Year	Herring units	Biomass (kg)	Number of Locks	Herring Units/Lock
1983	2,652,000	361,000	105	25,257
1984	10,760,000	1,463,000	46	233,913
1985	1,414,000	192,000	54	26,185
1986	3,010,000	409,000	84	35,833
1987	1,703,000	232,000	87	19,575
1988	828,000	113,000	64	12,938
1989	397,000	54,000	72	5,514
1990	233,000	32,000	103	2,262
1991	329,000	45,000	85	3,871
1992	919,000	125,000	155	5,929
1993	578,000	79,000	146	3,959
1994	515,000	70,000	146	3,527
1995	461,000	63,000	196	2,352
1996	390,000	53,000	183	2,131
1997	510,000	69,000	165	3,091
1998	no operation	---	---	---
1999	566,463	77,039	180	3,147
2000	1,314,614	178,788	161	8,165
2001	1,320,427	179,578	175	7,545
2002	1,770,261	240,755	172	10,292
2003	1,775,763	241,504	241	7,368
2004	3,271,345	444,903	249	13,138
2005	---	120,635	225	536

Note: 2002 includes only actual counts, though counts for some operations were estimated for that year.

Table 8. Annual and total number of selected fish species passed at the St. Stephen fishway, 1986-2003. (Source: Cooke and Leach, 2003a, SCPSA June 7, 2006 Request for Trial-type Hearing)

Year	Blueback Herring	American Shad	Striped Bass	White Perch
1986	187,000	-	-	-
1987	74,000	-	-	-
1988	232,000	10,000	367	-
1989	147,000	27,000	1,113	15,000
1990	71,000	81,000	1,457	2,338
1991	400,000	176,000	20,829	11,319
1992	589,000	147,000	7,165	1,804
1993	345,000	159,000	15,463	4,675
1994	298,000	212,000	4,498	1,831
1995	561,000	445,000	25,748	814
1996	1,452,285	477,047	4,241	2,009
1997	176,814	387,755	5,369	343
1998	112,466	543,681	25,362	2,199
1999	182,798	306,493	1,755	220
2000	695,586	592,321	4,817	220
2001	1,862,015	165,875	1,517	189
2002	421,459	140,398	1,591	54
2003	86,909	298,902	3,198	268
2004	35,545	145,201	4,199	24
2005	175,229	215,428	2,084	47
To Date	8,105,106	4,530,101	130,773	43,354

Note: Counts made by: hydroacoustic gear, 1986 – 1987; real-time counts, 1988 – 1994; and counts from videotape, 1995 – 2005.

Prior to the rediversion, diadromous fish ascended the Santee River in small numbers when net discharge from the Santee River was substantially less than the Cooper River discharge. Subsequent to rediversion, an increased number of diadromous fish now ascend the Santee River and attempt to pass upstream at the Corps' St. Stephen fish passage facility. An unknown number of fish may also ascend further up the Santee River toward Santee dam, depending on prevailing flow releases from the dam and the amount of attraction flows. No baseline population data exist for American shad and blueback herring in the Santee bypass. These species, however, have been detected as present in two recent fish surveys including the MesoHABSIM study and the 2002 anadromous fish utilization study. Anadromous fish ascending the Santee River past the

Rediversion Canal can only utilize habitat in the bypassed reach, but cannot be recruited further up the Santee watershed without additional fish passage facilities at Santee dam.

The project facilities do not include dedicated downstream fish passage facilities for outmigrating diadromous fish species, although fish and boat locking events at Pinopolis lock may pass some fish downstream. Downstream passage from the lakes also occurs through the turbines at the Jefferies, Santee and the St. Stephen powerhouses, through a downstream passage facility at the St. Stephen development, and via Santee dam spill gates during spillage events.

Federal and state agencies are actively working to restore diadromous fishes to the Santee Basin as described in the 2001 draft "Santee Cooper Basin Diadromous Fish Passage Restoration Plan," a federal and state comprehensive plan. The draft restoration plan provides a framework for rebuilding populations of the Santee basin's diadromous fishes through restoration of access to former spawning and nursery habitat. The goal of the plan is to increase abundance and health of the Santee basin's diadromous fish populations using adaptive management. The plan seeks to:

- restore access to spawning habitat that is of sufficient quantity and quality to warrant fish passage;
- develop and implement safe and effective downstream passage to allow escapement of juveniles;
- maintain instream flows needed for fish migrations (including necessary attraction flows for fishways) and maintenance of habitat for fish migrations, spawning, and maturation;
- maintain, restore, and enhance water quality to support diadromous fish life stages; and
- identify and implement opportunities to conserve, protect, and restore existing riverine and associated wetland habitats.

According to the 2001 restoration plan, management goals for the restored American shad population are based on a density of 50 adult fish per acre of usable habitat. Because no historic data from the Santee River are available, plan authors developed estimates based on density and habitat estimates for the Connecticut and Susquehanna rivers. These methods provide an approximated planning target of up to 2.9 million adult American shad and 6.1 million blueback herring, if habitat in the Broad River is included (NMFS Preliminary Fishway Prescription, May 5, 2006). SCPSA questions the agencies projected population estimate of 2,900,000 shad because it is based on a density of 50 shad per acre and 58,000 acres of habitat. SCPSA argues that both the estimate of habitat available and the density value are excessive. Given its concerns, SCPSA provided an estimate of 23,000 acres of habitat in the basin, a density value of 20 shad per acre (based on the Delaware River shad population), and a projected population of about 460,000 shad.

3.3.2.2 Environmental Effects

Hydroelectric project operations have the potential to affect fisheries and aquatic resources, generally through changes in lake levels and river flows. Annual winter drawdowns have the potential to expose substrate that may be important habitat for fish and other aquatic species. During spring spawning, lake levels that are less than full pool provide less overall habitat in areas where spawning typically occurs. Lake level fluctuations occurring during spawning periods can also potentially dewater littoral rearing and nesting habitat, and reduce spawning success for a variety of fish species. Aquatic organisms trapped by receding water levels may be subject to desiccation or freezing.

Downstream, decreases in flow due to project operations can cause fish stranding; temporary loss of habitat or loss of habitat access; and dewatering of spawning areas and aquatic. Rapid changes in stream flow (both increases and decreases) also can affect fish behaviors that influence survival or growth. Furthermore, to the extent that project operations affect water quality (in particular temperature and/or dissolved oxygen), there can be implications to fish and other aquatic species.

Many Santee River fish species, especially diadromous species, require access to multiple habitat types to complete their life cycle. The inability of fish to naturally migrate upstream and downstream prevents access to habitats cyclically required by fish at different life stages. Dams on the Santee River presently prevent or impede some populations from accessing spawning and/or nursery areas, and limits access to riverine habitats that would otherwise be used by individuals currently residing above the dams.

Effects of Water Levels in Lake Marion and Moultrie on Aquatic Resources

Lake level management associated with project operations or with providing downstream minimum flow releases may affect fish and aquatic habitats within the lakes, if lake levels are fluctuated or reduced to meet operational objectives. Under the proposed action, SCPSA would continue to manage lake levels according to the existing rule curve. Several agencies recommend a modified rule curve that would target full pool elevations during December through February.

Our Analysis

Proposed Action

The existing rule curve allows for fluctuations of water levels in Lake Marion over the course of the year, targeting 75.5 feet during the summer and just above 72.0 feet during winter drawdown. Under the current operating regime, the Santee Cooper lakes experience considerable variation in seasonal water levels (see section 3.3.1, *Water Resources*).

During an average year (1997) and wet year (2003), inflows maintain lake levels within the rule curve, while still providing minimum flows in the Santee River bypass,

the weekly flows for Jefferies station, and allocations to St. Stephen for their operations, including fish passage.

During a dry year (2001), lake levels would be drawn down to provide minimum flow requirements downstream of Santee dam and Pinopolis dams for aquatic habitat and salinity abatement. As reported in section 3.3.1, *Water Resources*, in the dry year scenario, there would be insufficient inflows to maintain both existing lake level targets and minimum flow priorities 45 percent of the time (24 of 53 weeks). About 20 percent of these low-flow occurrences (10 out of the 53 weeks) would occur during the primary fish spawning season, February through mid-May. Any associated lake drawdowns could result in dewatered nests for shoreline substrate spawners, entrapment of young and fry in shallow pools, and/or desiccation and loss of rooted aquatic vegetation beds required for cover by some species. The degree of these effects would depend on the rate and duration of lake level recession.

Agency and Interested Party Alternative

Agency and interested parties recommend modification of the rule curve, aimed at full pool elevations for project reservoirs during December through February, which would essentially result in year-round full or near-full lake levels for both Lakes Marion and Moultrie. A year-round full-pool rule curve would provide higher lake levels and greater shoreline inundation than under the existing rule curve. If the lakes were maintained at a steady elevation year-round, shoreline-spawning species would not be at risk of spawning failure due to dewatering or stranding, and theoretically more shoal substrate would be available for colonization by aquatic insects and macrophytes. During dry periods, if maintenance of full pool is prioritized over instream flows, there may be periods when riverine aquatic habitat flow targets below Santee dam would not be maintained. The effects of reduced downstream flows into the Santee River are discussed below.

Effects of Project Flow Releases on Aquatic Resources

Project operations (flow releases) have direct effects on both fish species and aquatic and riparian habitats in the Santee and Cooper rivers. SCPSA originally proposed to continue current project operations and provide a minimum flow of 500 cfs in the Santee bypassed reach downstream of Santee dam. The agencies and interested parties recommend an increased Santee bypass minimum flow of 25 to 30 percent of remaining inflows (after Cooper River/St. Stephen minimum flows and lake level obligations are satisfied) or 1,600 cfs, whichever is greater. In the DSA, SCPSA, FWS, and SCDNR, propose an alternative minimum flow below Santee dam of 1,200 cfs from May through January, with an increase to 2,400 cfs during fish passage season, February through April.

Both SCPSA and the agencies propose a flow of 5,600 cfs downstream of St. Stephen during the fish passage season. For the SCPSA proposal this flow would be provided from February 1 to April 15, whereas the agencies recommend this flow during

March and April. Both SCPSA and the agencies also recommend a weekly average flow of 4,500 cfs in the Cooper River downstream of the Jefferies station. The instantaneous flow from Jefferies would continue to range from 0 cfs to 28,000 cfs, the estimated maximum hydraulic capacity of the station.

The agency and interested party alternative also includes an Adaptive Management Plan to assess the effectiveness of flow alternatives on aquatic habitats, among other resources. The DSA includes a provision for a Low Inflow/Emergency Contingency Plan to guide project operations during periods of low inflows or drought conditions. Fish passage measures at Santee dam originally prescribed by the agencies are included in the DSA and also include a baseline population survey to evaluate the effect of new instream flow regimes on anadromous fish populations downstream of Santee dam.

Our Analysis

Several studies have been conducted by SCPSA and the agencies to assess the effects of instream flows on fisheries and aquatic habitats. The MesoHABSIM study (Normandeau, 2005b) was conducted during 2004-2005. Although some agency consultation occurred, the record does not show that all agency concerns relative to the study design were resolved prior to study commencement. The study examined changes in wetted area and Weighted Usable Area (WUA – an index of habitat) for target fish species at flows of 600, 2,300, 5,000 and 8,000 cfs in the bypassed reach between Santee dam and the Rediversion Canal under conditions of no discharge from the St. Stephen project. Various anadromous and river-resident species and lifestages, and habitat types (such as riffle, run, side-arm, etc.) were assessed, although run habitat was found to be the most common habitat type.[26]

Anadromous Species

The MesoHABSIM study shows an overall increase in WUA for most species and lifestages at flows above 600 cfs, including a pronounced inflection point for all lifestages of striped bass and juvenile Atlantic sturgeon at 2,300 cfs (table 9). Shortnose and Atlantic sturgeon spawning habitat suitability, however, did not begin to appreciably increase until flows reached 2,300 and 5,000 cfs, respectively. Alosid spawning suitability decreased from 600 to 2,300 cfs, but increased moderately at flows above 2,300 cfs. This analysis indicates that habitat suitability for most species and life stages is clearly improved at all flows above 600 cfs, but the incremental benefits from 2,300 to 5,000 cfs, and up to 8,000 cfs, are more variable from species to species.

[26]SCSPA does not discuss how their initial or alternative flow recommendations would achieve habitat, water quality and ecological goals. Although execution of the MesoHABSIM study departed from the original study design, no party has raised issue with the habitat metrics (WUA) resulting from the study. Although the precision of some estimates may have limitations due to field and analytical issues described in the report, the data appear to be sufficient to at least illustrate trends at the four flows measured.

The MesoHABSIM study also examined habitat suitability for targeted anadromous species in two riffles. Results from this analysis are shown in tables 14 and 15. For both riffles, habitat suitability for all lifestages of striped bass and for alosid spawning increases rapidly between 600 and 2,300 cfs, and remains somewhat stable up to 5,000 cfs. Although WUA for both Atlantic and shortnose sturgeon are calculated for these riffle areas, these species rely more heavily on run and pools for foraging and cover habitat, and transiently occupy riffles during movement and migration. Therefore, a zone-of-passage criterion would be best applied to these species in the riffle areas, but that was not done as part of this study. Taken as a whole, the study results suggest that the greatest gains in habitat suitability for anadromous fish occur between 600 and 2,300 cfs, with additional gains at higher flows.

Table 9. WUA, in acres, and percent increase in WUA for each flow increment, for various species, life stages, and flows, Santee River downstream of Santee dam. (Source: Normandeau, 2005b)

Flow	Alosid - spawning		Atlantic sturgeon - adult		Atlantic sturgeon - juvenile		Atlantic sturgeon - spawning	
	WUA	% Incr.	WUA	% Incr.	WUA	% Incr.	WUA	% Incr.
600	955	--	41	--	188	--	0	--
2300	572	-40	181	341	582	210	8	Nil
5000	883	54	824	355	919	58	122	1425
8000	1753	99	1927	134	1929	110	1364	1018
	Striped bass – adult and juvenile		**Striped bass - spawning**		**Shortnose sturgeon – adult and juvenile**		**Shortnose sturgeon – spawning**	
	WUA	% Incr.	WUA	% Incr.	WUA	% Incr.	WUA	% Incr.
600	234	--	48	--	60	--	12	--
2300	621	165	529	1002	29	-52	58	383
5000	1002	61	787	49	827	2752	504	769
8000	2032	103	1702	116	1931	133	1783	254

Table 10. WUA, in acres, and percent increase in WUA for each flow increment, at Riffle 4 in the Santee River bypassed reach. (Source: Normandeau, 2005b)

Flow	Alosid - spawning		Atlantic sturgeon - adult		Atlantic sturgeon - juvenile		Atlantic sturgeon - spawning	
	WUA	% Incr.	WUA	% Incr.	WUA	% Incr.	WUA	% Incr.
600	2.0	--	0	--	0.1	--	0	--
2300	7.9	295	0.1	Nil	5.0	4000	0	--

5000	8.8	11	2.3	1300	6.5	30	0	--
8000	9.2	5	7.9	243	6.5	Nil	0	--

	Striped bass – adult and juvenile		**Striped bass - spawning**		**Shortnose sturgeon – adult and juvenile**		**Shortnose sturgeon – spawning**	
	WUA	**% Incr.**	**WUA**	**% Incr.**	**WUA**	**% Incr.**	**WUA**	**% Incr.**
600	0.03	--	0.02	--	0	--	0	--
2300	6.2	10667	4.6	13000	0	--	0	--
5000	8.6	39	5.0	9	2.3	Nil	0.01	Nil
8000	9.0	5	3.9	-22	7	204	0.44	3400

Table 11. WUA, in acres, and percent increase in WUA for each flow increment, at Riffle 5 in the Santee River bypassed reach. (Source: Normandeau, 2005b)

Flow	**Alosid - spawning**		**Atlantic sturgeon - adult**		**Atlantic sturgeon - juvenile**		**Atlantic sturgeon - spawning**	
	WUA	**% Incr.**	**WUA**	**% Incr.**	**WUA**	**% Incr.**	**WUA**	**% Incr.**
600	1.9	--	0	--	0.5	--	0	--
2300	3.9	105	0.7	Nil	1.7	240	0	--
5000	4.7	21	1.8	157	2.7	59	0	--
8000	6.6	40	5.4	200	3.4	26	0.8	Nil

	Striped bass – adult and juvenile		**Striped bass - spawning**		**Shortnose sturgeon – adult and juvenile**		**Shortnose sturgeon – spawning**	
	WUA	**% Incr.**	**WUA**	**% Incr.**	**WUA**	**% Incr.**	**WUA**	**% Incr.**
600	1.0	--	0.44	--	0	--	0	--
2300	2.9	190	1.2	173	0.7	Nil	0	--
5000	4.3	48	1.4	17	1.6	129	0.3	Nil
8000	7.2	67	3.5	150	4.2	163	2.2	633

Resident Aquatic Species

The study did not conclusively assess habitat suitability for individual resident species and life stages, but instead calculated WUA for "core habitat" at the four evaluation flows. "Core habitat" included backwater, deep pool, glide, pool, riffle, run, sidearm, and wetted area, with run and pool being the most common habitat types, and riffle, glide, and deep pool the least common. This analysis indicated an increase in wetted area with increasing flows, a decrease in glide and riffle habitat, and an increase in pool and run habitat. It is not entirely clear, however, what quantitative effect flow

changes would have on non-anadromous fish habitat suitability. Although riffles may be a relatively minor habitat component for this study reach, and actually decreases at higher flows, literature suggests that fluvial specialist species/life stages may rely on this habitat, because it is the most flow-sensitive and may serve as critical habitat (Bovee, 1982) for some lifestages of key species (Bain and Meixler, 2000). Thus, any habitat gains in the riffle areas should benefit resident species, while habitat losses would adversely affect these species. The analysis documents the hydraulic shift of riffles to runs, and glide to pool, as flow increases above 600 cfs. The presentation, however, is inconclusive as it does not clearly indicate the net habitat suitability of the study sites for resident species, across the range of flows.

Proposed Action

Based on the water flow allocation analysis provided in section 3.3.1, *Water Resources*, and discussed above, the effects of an average year, wet year, and dry year were evaluated with respect to the availability of aquatic habitats. During a typical average year and representative wet year, inflows to the project are sufficient to satisfy the current minimum flow release of 500 cfs from Santee dam, a 4,500-cfs weekly average flow at Jefferies, and a seasonal allocation of 5,600 cfs at St. Stephen during the fish passage season, while maintaining the existing reservoir rule curve. According to results of the MesoHABSIM study, this results in maintenance of sub-optimal riffle and run habitat in the main channel of the Santee bypassed reach, maintenance of the existing saltwater/freshwater interface on the Cooper River, and maintenance of fish attraction to the fishway at St. Stephen. During a typical dry year (2001), however, minimum flow allocations to Santee dam and St. Stephen and weekly average flow targets at Jeffries can not be maintained 45 percent of the time (24 of 53 weeks).

Agency and Interested Party Alternative

With satisfaction of all other water allocation priorities, we estimate that an increased minimum flow of 1,600 cfs below Santee dam could be satisfied the majority of the time with other allocations remaining the same during a typical average year and wet year.

During the spring spawning season of February through April of a typical dry year, however, there were insufficient inflows to satisfy (1) the flow requirement at Jefferies for 3 weeks out of 12 (25 percent), (2) the recommended increased minimum flows at Santee dam for 9 weeks out of 12 (75 percent), and (3) the recommended fish passage flows for March and April at St. Stephen for 5 weeks out of 12 (42 percent). For the remainder of the year, Jefferies could not provide weekly average flows of 4,500 cfs 32 percent of the time (13 of 41 weeks), and Santee dam could not maintain 1,600 cfs about 61 percent of the time (25 of 41 weeks).

Given that sufficient flows were not available to satisfy existing year round flow requirements 45 percent of the time during a dry year, increased minimum flows of 1,600 cfs and higher would become increasingly difficult to satisfy. When existing downstream

flow release requirements are not met during February through April, upstream attraction for anadromous species may be reduced, fish migration through shallow riffle areas may be impeded, and spawning on gravel bars and side arms may not be successful. During periods of the summer when existing flows are low, solar warming and poor aeration may allow riverine waters to warm and/or reduce DO concentrations suitable for some aquatic organisms. This may stress or inhibit growth of individuals, and in extreme cases be lethal if there are no accessible refugia.

If adequate flows were available, the agency recommendation of a seasonally variable minimum flow of 1,600 cfs at Santee dam would significantly improve aquatic habitat and conditions for migratory fish movement in the Santee bypass, over that of the existing flow regime. This flow regime was identified by agencies, using the Santee River Model,[27] with the objective to restore targeted habitat and ecological functions to the Santee River by following a peak and valley pattern that conceptually mimics seasonal flow changes. The increased base flow and seasonally varying flows for the Santee River bypass are intended to approximate natural hydrologic cycles that support critical river ecological processes, enhance fish migration connectivity within the 37-mile-long bypassed reach, and provide habitat for diadromous species. Such a flow regime would introduce more flow to the Santee River below Santee dam, increasing the use of that river segment as a migratory corridor by diadromous species. However, it is not explicitly documented, other than by reference, exactly how data were quantitatively modeled and applied to derive specific flow targets other than the minimum flow, so we are unable to verify assertions that certain flows would achieve the stated goals. Although the restoration plan identifies some spawning habitat for these species in the Santee River bypassed reach (950 acres), the majority of basinwide spawning habitat (147,000 total acres) is located upstream from Santee dam.

Because the MesoHABSIM study did not analyze increments that are inclusive of the agency and interested party recommended flow, we cannot assess whether any inflection in WUA occurs between 600 cfs and 2,300 cfs, and thus cannot specifically address flows of 1,600 cfs. Flows higher than 600 cfs were shown to improve habitat, but higher minimum flows may not be entirely sustainable during normal water years and would likely have limited availability in dry years.

The baseline population survey for shad, herring and shortnose sturgeon included in the section 18 fishway prescriptions would evaluate the population response to a new instream flow regime below Santee dam. Furthermore, an Adaptive Management Plan would allow SCPSA to determine if project flows are sufficient to accommodate various ecological and navigational objectives over time, such as fish staging and spawning,

[27]Interior, NMFS, SCDNR SCDHEC, American Rivers and SCCCL, South Carolina Chapter of the Nature Conservancy, Catawba-Wateree relicensing Coalition, University of Massachusetts and University of Georgia collaboratively developed an ecosystem-based flow regime primarily by relying on an undocumented application of the Santee River Model (SRM), and Indicators of Hydraulic Alteration (IHA) software.

sandbar and floodplain inundation, and salinity abatement. The plan would provide for the implementation of alternative flows in the event that these objectives are not being met; thereby, providing protection of aquatic habitat in the Santee River downstream of the project.

DSA Alternative

This alternative would provide for a Santee River minimum flow of 2,400 cfs during the fish passage season and 1,200 cfs during the remainder of the year. Assuming existing allocations to Jefferies and the proposed fish passage minimum flows to St. Stephen, a flow of 2,400 cfs could be provided downstream of Santee dam about 83 percent of the time (10 of 12 weeks) during fish passage season, while a flow of 1,200 cfs could be provided 95 percent of the time the rest of the year (39 of 41 weeks) during a typical water year (1997). Inflows would be sufficient to satisfy flow allocations for this proposed flow regime during a typical wet year (2003). Allocations during a typical dry year (2001) would be more difficult to meet, with a flow of 2,400 cfs only available 25 percent of the time (3 of 12 weeks) during fish passage season, and a flow of 1,200 cfs available approximately 40 percent of the time (17 of 41 weeks) during the rest of the year.

According to the results of the MesoHABSIM study (see tables 13 through 15), a flow of 2,300 cfs at Santee dam would provide about 250 percent more suitable anadromous fish habitat, on average across all species and lifestages, than the existing minimum flow of 600 cfs. The results of the small boat navigation study (Normandeau, 2005b) indicate that flows less than 1,000 cfs appear to impact navigation and may, therefore, begin to impair fish movement through shallow riffle areas. Based on these results, we conclude that a flow of 1,200 cfs would improve habitat availability and suitability over existing conditions and also provide adequate fish passage through shallow riffle areas. A flow of 2,400 cfs during the fish passage season would provide even greater habitat and passage suitability compared to any of the lower proposed flows.

Normal inflow conditions are sufficient to accommodate the recommended additional spring habitat enhancement flow of 2,400 cfs below Santee dam, and the Low Inflow/Emergency Contingency Plan would provide for the appropriate flow allocations during periods of low inflow. Under the plan, SCPSA would attempt to provide as much of the additional flow as possible based on an evaluation of the operational condition of St. Stephen, during low inflow conditions. Specifically, the average daily flow of St. Stephen would be analyzed over a prescribed period so that flows from Santee dam do not exceed the flows from St. Stephen. This would ensure that adequate attraction flows are available from the Rediversion canal to move fish up to the St. Stephen station and fish lift, and not be overwhelmed by higher flows from the Santee River bypassed reach, during the fish passage season.

Water Quality Effects on Aquatic Resources

Water quality is an important component of ecological health, affecting primary productivity, and the growth and health of aquatic species, including fish. Compliance with state water quality standards ensures that water quality conditions are suitable for aquatic life. In addition to the rule curves and flow regimes proposed by SCPSA, agencies and interested parties discussed above, the agency and interested party alternative includes water quality monitoring and remediation for the Santee River (see section 3.3.1, *Water Resources*).

Our Analysis

Proposed Action

SCPSA proposes to continue operating the project in the same manner, thus the proposed action would maintain existing water quality conditions for aquatic resources (see section 3.3.1, *Water Resources*). In the Santee River, occasional excursions below state standards for DO would likely continue to occur. The effect of lowered DO on aquatic organisms may be sub-lethal or lethal, depending on the duration and extent of the episode. Sub-lethal effects can include inhibition of growth, reduction in motion, and altered behavior. These stressors can indirectly lead to mortality by making individual organisms susceptible to predation or pathogens. If DO falls below the metabolic threshold for a given organism, it can result in direct lethal effects. However, if low DO concentrations occur for brief episodes from mid to late summer, as indicated by data provided by SCPSA, the effects on aquatic resources is expected to be minimal, especially if mobile organisms can seek refugia.

As discussed in section 3.3.1, *Water Resources*, salinity in the Santee River is affected by project operations. The post-1941 diversion of Santee River flow to the Cooper River changed the ecological communities of the lower Santee River through increased salinity intrusion. The diversion of flow to the Cooper River concurrently altered a coastal estuary to a freshwater system. The Rediversion project subsequently altered both rivers by returning about 80 percent of the Santee's flow to its lower course, again causing landscape-level alteration of hydrology, sediment deposition, and salinity distribution, but also enabled a portion of the tidal Cooper River to remain a freshwater system between Jefferies station and just downstream of Bushy Park industrial complex.

Diadromous fish species may occur in freshwater, brackish water and saltwater by adjusting their metabolism. Migratory fish generally change their metabolism biorhythmically in accordance with seasonal migration patterns rather than instantaneously. Estuarine species live in an environment where salinity may change daily or periodically, thus are tolerant of a range of salinities and can remain in one area even if salinity shifts. Fish and mobile aquatic invertebrates that are salinity-intolerant must move if salinity rises or falls outside their tolerance range, but in some cases may endure brief episodes of salinity change.

Because the overall distribution of flows between the Santee and Cooper rivers would not change, the salinity conditions in the lower reaches of the two rivers would remain the same, and no new effects are anticipated.

Agency and Interested Party Alternative

Increased minimum flows of 1,600 cfs below Santee dam are expected to improve water quality and habitat conditions in the river through the aeration of waters downstream of the dam by spillage of higher DO surface waters. Although flows provided to the Santee River may be modified in terms of where they are discharged, Santee dam or through the St. Stephen station, the overall quantity provided to the river downstream of the Rediversion canal would remain the same as under existing conditions. Therefore, it is not expected that salinity conditions and associated effects on aquatic species habitat and distribution would change in the lower Santee River.

To the extent that water quality improvements would enhance the fishery and aquatic habitat of the Santee River, such improvements would have a positive effect on aquatic species.

DSA Alternative

As with the agency and interested party alternative, increased minimum flows below Santee dam are expected to improve water quality in the Santee River bypassed reach, although would not affect salinity in the lower Santee and Cooper rivers. Data collected near the US Highway 52 Bridge (Santee River) indicate that aquatic life uses are only partially supported due to intermittent instantaneous low DO levels, and higher minimum flows should act to minimize the occurrence of similar conditions.

Upstream and Downstream Fish Passage

Maintenance of efficient fish passage at the Santee Cooper Project is essential for maintaining and restoring diadromous fish populations in the basin, because the project is the corridor for diadromous fish to access four upstream sub-basins consisting of the Congaree, Saluda, Broad, and Catawba-Wateree. According to the 2001 Restoration Plan, passage at this project provides direct access to about 831 river miles and 77,000 acres of habitat in the Santee Basin (FWS et. al, 2001).

To enhance fish passage at Pinopolis lock, SCPSA proposes to increase locking events and provide attraction flows (amount not specified). SCPSA also proposes to improve the accuracy of the fish counting technology used to quantify upstream passage through the lock, before additional information or studies concerning passage effectiveness/lock effectiveness or optimization are undertaken at Pinopolis.

As described in section 2.3.1.3, FWS and NMFS preliminary fish passage prescriptions require a multi-phase approach. For Santee dam, it includes shad and herring population monitoring in the Santee River downstream of the dam, construction and operation of a trap and sort facility and eventually a permanent fish passage facility,

eel passage measures, and a monitoring and effectiveness evaluation. For the Pinopolis lock, it includes an improved fish monitoring system, attraction flows up to 600 cfs, a fish passage operations plan and effectiveness evaluation, eel passage measures, as well as additional upstream facilities if adequate passage is not met. The prescriptions also include post-licensing downstream fish passage studies to quantify downstream passage of diadromous fish at the Santee dam, Pinopolis lock and the Jefferies powerhouse, to determine the need for downstream passage facilities for diadromous species. The NMFS prescription requires consideration of shortnose and Atlantic sturgeon passage at the project facilities.

The DSA contains fish passage provisions that are essentially the same as the agency preliminary fish passage prescriptions, with some differences in timing of the measures, and no specificity for the attraction flow at the Pinopolis lock. As noted previously, NMFS is not a party to the DSA, but indicated they would consider the fish passage measures included in the DSA during development of their final fishway prescriptions.

Our Analysis

Proposed Action

Existing fish passage facilities at the project combined with the St. Stephen station are partially successful in allowing recruitment of anadromous fish to pass into both the Cooper and Santee rivers and the project lakes. For diadromous fish ascending the Cooper River, with the exception of sturgeon, there is agreement among the agencies and SCPSA that the Pinopolis lock is important in at least partially meeting the restoration plan fish passage goals. The absolute effectiveness of current Pinopolis lock operations as an upstream fish passage system, however, is not known because the existing hydroacoustic monitoring system is out-of-date and does not provide species-specific data. It is not now possible to assess whether existing upstream passage for target species is adequate to meet fisheries management objectives.

As previously discussed, the 2001 restoration plan includes goals for an American shad target population that assumes the production of 50 adult fish per acre of usable habitat, and 250 fish per acre of habitat for blueback herring. SCPSA suggests that a production of 20 shad per acre may be more appropriate. Although there is no way to determine which production potential is "correct," there is the potential for between about 460,000 and 2.9 million adult American shad and up to 6.1 million blueback herring to pass upstream, if all available habitat area in the Santee basin is fully exploited. Depending on flow allocations and resulting fish migratory behavior, this run would attempt to ascend the Santee Cooper system via the Jefferies and St. Stephen facilities, as well as the Santee dam.

Agency and Interested Party Alternative

Upstream fish passage measures prescribed by FWS and NMFS under section 18 for Santee dam include a trap/sort/transport facility, zone of passage flow, and

effectiveness evaluation. A fish lift would also be required if passage objectives are not being met. An eel fishway is prescribed for year 3 of the new license.

Pre-spawning adult diadromous fish are attracted to Santee dam during late February to May by discharges from the turbine and/or spills at the dam, which may result in flows ranging from approximately 500 to over 100,000 cfs. The number of shad and herring attracted to Santee dam is unknown, and thus the section 18 prescriptions include a baseline monitoring component to determine the populations of shad, herring and sturgeon in the bypassed reach below Santee dam. Following the monitoring study, SCPSA would be required to construct a trap and sort facility and implement a transport operation capable of passing initial target species passage numbers, no later than year 6 of a new license, unless otherwise determined by the agencies based on review of the baseline population monitoring study. The trap and sort facility would have an operating flow of up to 100 cfs, which would be available during the entire fish passage season (February through April) in an average year (1997) and a typical wet year. The operating flow would be available 25 percent of the time (3 of 12 weeks) during an average dry year (2001), if the agency alternative operational flow regime is implemented. This type of phased approach including the monitoring component, construction of a trap and transport facility, and implementation of a transport program has been or is being utilized on a number of major east coast river systems, including the Roanoke, Susquehanna, Connecticut, Merrimack, Saco, and Kennebec rivers.

The agencies also prescribed a multi-phase approach for fish passage at the Pinopolis lock, which would include a new hydroacoustic fish monitoring system, a fish passage operations plan, and effectiveness evaluation for the lock, with potential future improvements for fish passage at the lock or the Pinopolis station. A split beam hydroacoustic system, which would be a technology that could be employed, has the potential to provide information that the current counting system does not deliver, including an individual fish count when appropriate, or a biomass-based index when fish densities are high; directionality and size derived from target strength; and species identification based on target strength. Because the effectiveness of the existing lock in passing fish upstream is variable and considered low for some species, these measures would provide information necessary to determine potential future enhancements for upstream passage at the lock. If adequate passage objectives are not met, additional upstream passage facilities would be required at the Pinopolis lock or station.

Another fish passage prescription at the lock includes a fish attraction flow of up to 600 cfs. The added attraction flow would likely enhance movement of alosid species into the lock, but would not resolve issues associated with bottom-dwelling migrants, such as eel and sturgeon, which currently do not effectively move upstream past the upper lock sill. However, the prescription also includes an eel fishway that would be installed by year 3 of the new license.

In addition to the lock, other fish passage facilities designed for the anadromous clupeids may not address upstream passage needs for shortnose sturgeon and American

eel. Although the shortnose sturgeon is occasionally reported from fish lifts and ladders on other east coast rivers, the species does not appear to readily use ladders. The NMFS is prescribing a fish lift at Santee dam that should accommodate sturgeon. Such a facility may also be required at the Jefferies station, if lockage at Pinopolis lock proves to be ineffective. Fish lifts have been reported to pass small numbers of sturgeon, such as on the Connecticut River; however, some additional research may be required to develop a site-specific or an improved design for sturgeon.

For American eel, ladders such as those prescribed by the agencies, allow eels to "crawl" up an incline of wetted substrate, and have successfully passed eels upstream at other Atlantic seaboard dams. The effectiveness of ladders appears to hinge primarily on locating the entrance strategically at tailwater and/or spillway locations where upmigrating eel congregate, and providing an appropriate substrate. Placement of eel ladders at Pinopolis dam/Jefferies powerhouse and at Santee dam should improve upstream recruitment of young eels.

Since there are no dedicated downstream fish passage facilities at the project, except for lockage at Pinopolis, it is probable that some diadromous fish experience delay, injury or mortality while attempting to pass downstream through the project powerhouses. SCSPA developed an estimate of turbine entrainment potential based on rates observed at other sites (Normandeau, 2002). In addition, an estimate of turbine passage survival was developed based on survival rates measured at other sites with similar turbines to the Santee Cooper developments, and based on estimates derived from predictive models (table 12).

Table 12. Estimated average survival rate of juvenile and adult fish during downstream passage at the Santee Cooper Project. (Source: Normandeau, 2002)

	Average Survival Rate (%)					
	Juvenile Fish (by length)			**Adult Fish (by length)**		
Unit	**4 in.**	**8 in.**	**12 in.**	**15 in.**	**36 in.**	**60 in.**
Units 1 and 3 Fixed Propeller (Jefferies Station)	95	89	84	79	51	33
Units 2 and 4 Large Kaplan (Jefferies Station)	97	94	91	89	73	58
Unit 6 Small Kaplan (Jefferies Station)	95	90	85	81	58	48
Francis Turbine (Santee Station)	93	87	80	74	39	6

The evaluation indicated that the potential effects on three species, American eel, shortnose sturgeon and Atlantic sturgeon, would be high due to their large size. The effect on juvenile alosines and post-spawned shad and herring was expected to be minor (Normandeau, 2002). The turbine survival estimates appear reasonably consistent with those observed in the field at other sites, especially for juvenile fish. Smaller migratory fish (such as young-of-year alosids) have a lower probability of striking turbine blades, runners or other turbine components, and have less body area prone to hydraulically-induced damage from shear zones (Cada, 1990). Conversely, larger fish have a higher probability of encountering these conditions, and thus may be more prone to turbine mortality. However, among species there may also be significant variability in mortality rates, depending on variables such as body shape, skeletal structure, swimming behavior during entrainment and overall stress. The SCPSA assessment concludes that mortality for larger fish would be greater, and that at least for the larger lifestages, particularly sturgeon, some form of protection would help reduce mortality for downstream migrants.

The importance of minimizing downstream passage mortality varies among species and life stages. For alosid species, safe and efficient downstream passage of juvenile fish is perhaps more critical than for adults. Spawning recruitment for the population relies most heavily on the juvenile alosids safely emigrating to and maturing at sea and then returning to spawn as adults. Outmigrating adults have already spawned, and may or may not survive the out-migration and return to spawn in future years. For shad, more southern populations have historically had a lower percentage of repeat spawners, thus relying more on juvenile recruitment. Data suggest that there is a latitudinal gradient in the frequency of repeat spawning, with 100 percent of shad dying south of North Carolina after spawning, with stocks north of North Carolina having some repeat spawners, with the percentage increasing at higher latitudes (Walberg and Nichols, 1967; Klauda et al., 1991). However, recent evidence suggests that about 10 percent of South Carolina shad populations may return to spawn in following years (personal communication from B. McCord, Fisheries Biologist, SCDNR, dated August 24, 2006).

SCPSA's assessment concludes that turbine passage mortality for juvenile clupeid species is not likely a limiting factor, but poor outmigration escapement of emigrating juveniles (either due to delay or obstruction of out-migration) may reduce the total number of fish accessing marine nursery habitat, and thus limiting recruitment of future spawners. For species such as sturgeon, which are large, long-lived and have a population strategy relying on adults spawning multiple years, safe downstream passage of adults is more critical. Adult American eel are also relatively large fish that emigrate to marine waters prior to spawning, and thus successful spawning recruitment is enhanced by safe downstream passage for this species.

SCPSA conducted a feasibility study of measures to minimize the potential entrainment mortality of American eel, shortnose sturgeon and Atlantic sturgeon at the Santee and Jefferies hydroelectric stations (Normandeau et al, 2005). The review of

available protection measures for both stations included reduced spaced bar racks, Eicher Screen (Santee station only), development of operational protocols to enhance turbine passage survival, and installation of “fish friendly" turbines. The evaluation suggested that due to limited available research and testing data, additional research would be needed to determine if these protection measures would effectively protect these species during downstream emigration.

In general, it has been the practice of agencies to seek protective measures at water intakes to avoid or at least minimize impacts to migratory populations of fish due to unprotected passage. In the case of Pinopolis dam and the Jefferies station, downstream passage is afforded primarily through the turbines, incidental lock passage and spillage. In the case of Santee dam, passage is limited to turbine passage through the Santee powerhouse and over the spillway if the project is spilling. Most outmigration periods do not coincide with periods of extended spillage, however.

The agencies prescriptions to protect downstream migrants are consistent with those that have been utilized at other hydroelectric projects. However, alternative lower cost passage and protective measures have been adopted to pass these species at other projects, and could be reviewed for possible implementation at the Santee Cooper Project. Low cost measures often include the use of existing sluice gates or spill gates to provide interim or permanent downstream passage of anadromous species and other migratory fish. There are a number of projects that have existing gates (primarily downward opening) located at favorable locations adjacent to powerhouse turbine intakes that employ this type of powerhouse bypass system, including several projects in New England. Larger-scale spillage is also used on the Columbia River in Washington and Oregon for the downstream passage of salmon and steelhead smolts. The advantage of spillway passage is that there typically are few capital improvements or costs required, but the disadvantage is the “loss” of water for power generation.

DSA Alternative

The fish passage provisions of the DSA are very similar to those originally prescribed by FWS and NMFS. The primary difference between the DSA and the fishway prescriptions is the timing of implementation of some measures. For example, the Santee dam trap and sort facility is required to be fully operational by year 5 of the license under the section 18 prescriptions, but between years 6 and 8 under the DSA. There are also some differences in the measures required. At Santee dam, the DSA does not include a zone of passage flow as prescribed under section 18. For Pinopolis lock and dam, the DSA requires an unspecified attraction flow to be determined in consultation with the agencies, while the fishway prescriptions require an attraction flow of 600 cfs. These differences between the DSA and the prescriptions, however, are not considered to be substantial, and the DSA would provide adequate measures for upstream passage.

For downstream fish passage, while the original section 18 prescriptions are specific about the nature, design, and requirements for downstream passage facilities at

both Santee and Pinopolis dams, the DSA only provides for appropriate and effective designs as determined by the downstream passage evaluation studies. This provides added flexibility and allows for a range of options for meeting the objectives of safe downstream passage. Furthermore, a confirmatory survival study is required by the DSA to evaluate the turbine passage survival of target species. The DSA, however, does not specifically address passage and protection measures for shortnose or Atlantic sturgeon.

Staff Recommended Measures

Over time, assuming diadromous fish runs increase in the Santee River, there would be a need to allow some of these fish to pass upstream above Santee dam, to exploit upstream spawning habitat and thereby fulfill restoration plan goals. However, it is not clear that fish runs are sufficient to justify such facilities at this time. Development of a fish passage implementation plan, using a phased approach as outlined in the DSA and in the fishway prescriptions, would provide a mechanism for implementing appropriate fish passage measures, including for sturgeon. The plan would outline the activities necessary, including baseline and subsequent monitoring studies, fish facility design, construction and effectiveness testing, and a schedule for completing these major milestone steps in providing fish passage at the project. This would be similar to the approach taken on other river basins, such as the Kennebec and Saco Rivers in Maine, where fish passage plans include a defined timeframe for installation, based on achievement of specific target population sizes, followed by effectiveness testing, and facility modifications in order to achieve fish passage goals.

An alternative approach for downstream fish passage measures would be to design and implement fish outmigration measures commensurate with the degree of impacts revealed by ongoing and additional diadromous fish restoration management and monitoring studies, also taking into account emerging applicable fish diversion and passage technologies. Currently, there is a general lack of population data to determine the specific effects of the project and other outside factors (such as marine survival) on upstream recruitment and downstream escapement for diadromous fishes, including sturgeon. SCPSA's desktop turbine survival study only provides information relative to percentage of outmigrants surviving passage. The alternative approach could include an agency/SCPSA fish passage working group to design, review and integrate passage-related studies and management monitoring data, to determine cost-effective and biologically effective passage measures that would meet the objectives of the restoration plan.

An initial step in the downstream passage approach would be to develop more accurate estimates of the annual number of returning adults for each target species ascending the Santee River system through existing fish passage facilities, and approaching Santee dam, as prescribed by FWS and NMFS and as provided for in the DSA. Both SCPSA and agencies concur that existing acoustic data for the Pinopolis lock are not accurate and that additional monitoring with improved technology is needed. Outmigration studies would also be required, to estimate the extent and success of

outmigrating juvenile fishes, which could be correlated with adult returns in future years. Such a monitoring program would require multiple years of monitoring to determine trends and account for natural annual variability. These data could be used to determine the extent of additional spawning recruitment needed to meet restoration plan goals, and to identify project facilities where passage success is not adequate. This determination would help in identifying the location, design, capacity and operational parameters required to provide appropriate downstream fish passage measures. The monitoring and evaluation studies provided for in the DSA and in the fishway prescriptions would be consistent with this approach for addressing downstream passage.

3.3.2.3 Cumulative Effects

The project would cumulatively affect basinwide fish migrations. Restoration of Santee watershed diadromous fish resources relies on the ability of migratory fish populations to exploit available habitat throughout the entire watershed. Because this project is the downstream-most facility, it serves as a portal for migration for all fish requiring access to upstream habitat to fulfill their life cycles. Specifically, the project is the gateway corridor to four upstream sub-basins, totaling about 32,000 acres of waters, and consisting of the Congaree River, Saluda River to Saluda dam, Broad River to Parr dam, the Catawba River and the Wateree River to Wateree dam. The combination of the project dams and the upstream dams have inhibited or prevented fish passage to the majority of historically utilized Piedmont and fall line rocky-shoal habitat, the primary spawning areas for shad, striped bass, and sturgeon, with current fish access to only about 12 to 20 miles of these remaining habitats (NMFS Preliminary Fishway Prescription, May 4, 2006).

During spawning season, American shad and blueback herring currently migrate via the St. Stephen fishway and Pinopolis lock through Lake Moultrie, the Diversion canal, and Lake Marion to the Columbia Shoals reach of the Congaree River, and to the Wateree dam on the Wateree River. Any inefficiency in fish passage at the project facilities and at St. Stephen, however, would have a cumulative effect on the entire river populations, as fewer fish would reach the upper-river spawning grounds. American shad spawning has been documented in the Santee River bypass below Santee dam, below the Wateree dam, and in the Columbia Shoals reach of the Congaree River, indicating that shad are utilizing the upstream most habitats currently available to them in the Santee River Basin. Blueback herring spawning habitats include the Santee and Cooper rivers, Lakes Moultrie and Marion, and the Congaree and Wateree rivers. Additional migratory fish access to the Broad River would be provided by a fishway that is currently under construction at the Columbia diversion dam (NMFS Preliminary Prescription, May 4, 2006).

Shortnose and Atlantic sturgeon typically spawn in boulder bedrock, cobble, and gravel shoal habitats of sufficient water quality and flow characteristics to ensure survival of egg and larval stages. It is likely that these spawning habitats historically included the fall zone and Piedmont sections of the Saluda, Broad, Congaree, and Wateree-Catawba

rivers. However, upstream migration is currently impeded by the Pinopolis and Santee dams, as well as the St. Stephen development, due to the lack of passage facilities that are adequate for these species. These effects would continue with the continued operation of the Santee Cooper Project until adequate fish passage facilities are provided for sturgeon.

The estuarine ecosystem of the lower reaches of the Santee River would also be cumulatively affected by the continued operation of the Santee Cooper Project and the Corps St. Stephen station. Studies indicate that the distribution and abundance of the flora and fauna in this reach is influenced by the net allocation of flow between the Cooper and Santee rivers, which would continue under the proposed action and identified alternatives, although an increase in minimum flows from Santee dam would somewhat restore aquatic and riparian habitat along the 37-mile-long bypassed reach.

3.3.2.4 Unavoidable Adverse Effects

Under the proposed action, maintaining the existing 500-cfs minimum flow at Santee dam would continue to constrain the habitat and ecological potential of the Santee River below Santee dam. Maintenance of either the agency-recommended or staff alternative minimum flows at Santee dam would partially restore the historical habitat and ecological potential of the Santee River below Santee dam, but significant flow would still be allocated to the Cooper River, and in dry years flows would be similar to existing conditions. Under all proposed alternatives, fluctuation in project discharge at Jefferies would continue to affect use of habitat by aquatic species in the Cooper River, particularly in areas closer to the dam.

Operation of the Santee and Jefferies stations would also continue to entrain fish and or block fish passage to some degree. These effects would continue, but would be minimized by developing and implementing a comprehensive fish passage plan that would result in improvements to existing fish passage facilities.

3.3.3 Terrestrial Resources

3.3.3.1 Affected Environment

Vegetation

The Santee Cooper Project is located in the Outer Coastal Plain Mixed-Forest Province, seaward of the Piedmont fall-line. Pine forest and floodplain vegetation predominate lands in the region that have been subject to disturbances such as fire, flooding, agriculture, and development. Upland communities are typically dominated by pines, with an open understory of grasses, sedges, and scrub oak. Loblolly and slash pine are commercially important in the region and are often cultured in plantations. Swampy lowlands and floodplains are characterized by bald cypress, gum, and water tupelo. Bog or marsh vegetation, including evergreen shrubs, dominates very poorly drained areas (Bailey, 1995).

Eight types of upland habitats and 10 kinds of forested wetlands can be found in the Santee Cooper Project area resulting in high species richness. The location and extent of these habitats are largely determined by local hydrology and soil conditions, as well as the intensity, distribution, and timing of development and disturbances. Table 13 summarizes the vegetation that occurs in the project area and that may provide habitat for special status plants and wildlife. Wetland habitats are discussed in more detail below.

Table 13. Examples of upland habitat types in the Santee Cooper Project area. (Source: SCPSA, 2004a)

Habitat Type	Representative Species
Natural Loblolly Pine Forests	loblolly pine, sweet gum (*Liquidamber styracilua*), red maple (*Acer rubrum*), silver maple (*A. saccharinum*), blackberry (*Rubus* spp.), wax myrtle (*Myrica cerifera*)
Pine Flatwoods	longleaf pine, slash pine, loblolly pine, sweet gum, blackjack oak, holly, bluestem (*Andropogon* spp.), asters (*Aster* spp.), sunflowers (*Helianthus* spp.)
Marl Forests	redbud, basswood (*Tilia americana*), slippery elm (*Ulmus rubra*), Shumard's oak (*Q. shumardii*), juniper, flowering dogwood, Carolina scaly-stem (*Elytraria carolinense*), arrow-arum (*Peltandra virginica*), and creeping bur-head (*Echinodorus cordifolius*).
Limestone Cliffs	sugar maple, yellow oak (*Q. muhlenbergii*), red mulberry (*Morus rubra*), Carolina buckthorn (*Rhamnus caroliniana*), shadow-witch orchid (*Ponthieva racemosa*), green violet (*Hybanthus concolor*), and tall bellflower (*Campanula americana*).

About 40 percent of the shorelines at Lakes Marion and Moultrie are developed with residences, marinas, hotels, other commercial operations, and lands developed for project facilities (SCPSA, 2003b). Development for residential homes is concentrated in the southern portion of Lake Marion and on three peninsulas of Lake Moultrie. There is little to no commercial or residential development along the Santee and Cooper rivers within the project boundary (see section 3.3.6, *Land Management and Aesthetic Resources*).

Wetlands

Wetland acreage totals more than 172,730 acres within and adjacent to the project boundary (SCPSA, 2004a). Among these are riverine (396 acres), lacustrine (131,112 acres), and palustrine (41,222 acres) wetlands (Cowardin et al., 1979; SCPSA, 2004a). Riverine and lacustrine systems are largely composed of open water habitats that generally lack vegetation, with the exception of aquatic beds and littoral emergent wetlands present within Lakes Marion and Moultrie. The dominant hydrologic input for the majority of lacustrine wetlands is lake levels, while riverine wetlands are affected by minimum and peaking flows from Santee and Pinopolis dams. Palustrine wetlands within and adjacent to the project boundary are composed of forested (31,937 acres), scrub-shrub (4,960 acres), unconsolidated shore (67 acres), unconsolidated bottom (434

acres), aquatic bed (266 acres), and emergent (3,558 acres) wetland subclasses. Distinct wetland communities in the project area include calcareous wetlands, non-alluvial, and floodplain wetlands. As with upland habitat types, the vegetation in these communities varies depending on the level, distribution and timing of ground disturbances, soils, and hydrologic conditions.

Lakes Marion and Moultrie

The majority of palustrine wetlands occur at the upstream end of Lake Marion and in the Santee River floodplain. In addition, lacustrine emergent and aquatic bed wetland habitats can be found along islands and within the littoral zone of both lakes. These wetland types provide habitat, forage, and cover opportunities for various species of plants and wildlife including waterfowl and fish. Survey results in 2004 by SCPSA documented about 10,225 acres of native aquatic species colonizing the littoral zones of Lake Marion (SCPSA, 2005a).

Lake Moultrie also contains palustrine emergent, scrub-shrub, and both broad-leaved and needle-leaved forested wetlands. These wetlands are generally concentrated along the north shore of the lake. Wetland areas below Pinopolis dam are tidally influenced according to the Cowardin et al. (1979) classification scheme.

Santee and Cooper Rivers

The river floodplain is also an important wetland resource because of its size, ecological integrity, and wetland functions. The floodplain provides habitat for a wide variety of plants and wildlife, as well as supports downstream river reaches with valuable organic debris for the food-chain, and removes sediments and pollutants from the watershed. The floodplain also provides downstream hydrologic support and provides flood-storage functions. The river floodplain category of wetlands includes the cypress swamps and bottomland hardwoods, a habitat best represented in the project area by the Fork Swamp Area or Upper Santee Swamp. This area is extensive, about 35,780 acres in size, and is located just north of the Santee NWR. The Upper Santee Swamp contains large tracts of both needle-leaved and broad-leaved deciduous forested, scrub-shrub, and emergent wetlands. Three plant communities of concern, namely bald cypress-tupelo gum swamp, bottomland hardwoods, and xeric sandhill scrub, occur in this section of the project area (table 14).

Table 14. Wetland habitat types have plant communities of concern in the Santee Cooper Project area. (Source: Mead & Hunt, 2002; Cowardin et al., 1979)

Wetland Habitat Type	FWS Classification	Representative Species
Bald Cypress/Tupelo Gum Swamp	Palustrine	bald cypress (*Taxodium distichum*), sweet gum (*Nyssa aquatica*), black gum (*N. biflora*), red maple, Carolina ash (*Fraxinus caroliniana*), and swamp cottonwood (*Populus heterophylla*).

Wetland Habitat Type	FWS Classification	Representative Species
Bottomland Hardwood Forest (first terrace bottomlands)	Palustrine	water hickory (*Carya aquatica*), overcup oak (*Q. lyrata*), sugarberry (*Celtis laevigata*), water oak (*Q. nigra*), willow oak (*Q. phellos*), green ash (*F. pennsylvanica*), hickories (*C. ovata, C. glabra*), viburnums (*Viburnum spp.*), privet (*Ligustrum sinense*), supple-jack (*Berchemia scandens*), summer grape (*Vitis aestivalis*), catchfly grass (*Leersia lenticularis*), day-flowers (*Commelina spp.*), ladies tresses (*Spiranthes spp.*), ferns (*Onoclea spp., Woodwardia areolata*), and calico aster (*Aster lateriflorus*).
Xeric Sandhill Scrub	Terrestrial	longleaf Pine (*Pinus palustris),* turkey oak *(Quercus laevis),* blue huckleberry *(Gaylussacia frondosa),* whortleberry *(Vaccinium spp.),* sand heath *(Ceratiola ericoides),* herbs (*Stipulicida setacea, Opuntia compressa, Arenaria caroliniana, Euphorbia ipecacuanhae, and Warea cuneifolia*) and grasses *(Aristida, Andropogon, Sporobolus and Triplasis).*

Other Palustrine Wetlands

Additional wetland areas are scattered in various locations along the shores on the project reservoirs and tributaries, and in association with the various islands, dissected shorelines, bays and sloughs in the lake. These wetlands are concentrated on the western portion of Lake Marion, along both the north and south shoreline.

Calcareous wetland habitats within the project area are of particular interest because of the rare and unusual plant species that are found within them. These habitats include the limestone sinks and sinkholes, as well as the transition areas between the calcareous and adjacent non-calcareous habitats. Rare plant species specially adapted to calcareous habitats include two species of spleenwort, *Asplenium hereroresiliens* (a species of national concern) and *A. resiliensis*, a state concern species. Species diversity can be high in these habitats, which also include many generalist species.

Wetland Habitats

As described above, wetland resources within the areas of Lake Marion and Moultrie are abundant, and based on the diversity of flora and fauna, they appear to be productive. Collectively, the assortment of wetland types and characteristics at the project provides abundant essential habitat to support wildlife requirements of forage, cover, and reproduction. Evidence of the productivity of the wetlands can be seen in the

diversity of wetland-dependant species that use them, including many species of mammals, amphibians, and reptiles. In addition, abundant avian species use the wetland habitats to breed and forage including numerous wading bird, waterfowl, songbird, and raptor species.

In 2002, SCDNR conducted an aquatic habitat improvement project aimed at establishing emergent vegetation along the shoreline of Lake Moultrie to enhance reproductive success of littoral zone fish species. Water willow (*Justicia americana*) was relocated from dense stands to about 1,000 feet of bare shoreline. Results of the project established six isolated stands of water willow in new areas (SCDNR, 2002). As of 2004, desirable aquatic vegetation is estimated at about 10,300 acres (SCPSA, 2005a).

Noxious and Nuisance Vegetation

Alligator weed, Brazilian elodea, water hyacinth, and perhaps most notably, *Hydrilla*, have been identified as noxious weeds in emergent and aquatic bed wetlands in the project area. These aggressive non-native species are a major management concern on a regional scale because of their affects on natural ecological functions, native species diversity, navigability, as well as economic and recreational impacts.

The Santee Cooper lakes are shallow, eutrophic, high nutrient load lakes which provide nearly ideal habitat for aquatic plant growth and consequently, have experienced severe infestations of aquatic macrophytes, such as alligator weed, Brazilian elodea, coontail, Southern naiad, and parrot feather. Prior to the introduction of *Hydrilla* in the early 1980s, these species actively competed with desirable plant species (Roach, 1989). Such infestations were controlled by herbicides.

Hydrilla is an abundant noxious aquatic weed and is included on the federal and several state noxious weed lists. Aggressive herbicidal control efforts proved ineffective with *Hydrilla* so a biological control plan using an exotic herbivorous fish, triploid (sterile) grass carp, was initiated in 1989. Reductions in *Hydrilla* using grass carp were evident within three years, and *Hydrilla* coverage was reduced to less than 500 acres by 1998. A stocking plan was approved in 1999, aimed at replenishing grass carp as they die-off in order to control *Hydrilla* re-growth in the lakes. Monitoring data suggest that the grass carp program is effective in reducing the extent of noxious weeds in the lakes, particularly *Hydrilla*.

Between 2000 and 2002, coverage of both *Hydrilla* and other aquatic plant species dropped from about 13,000 acres to 9,700 acres as a result of grass carp herbivory. Annual grass carp mortality, in the absence of restocking, is estimated to be about 32 percent, which corresponds to a decrease in individuals within the lake system from an estimated 26,100 at the end of 2002 to about 12,100 at the end of 2004. As their numbers continue to decline, the ability of grass carp to control *Hydrilla* will decrease. As of 2004, *Hydrilla* still appeared to be largely under control, even with the declining carp numbers. However, native plant species appeared to be rebounding from control efforts and recolonizing areas once infested with *Hydrilla* (SCPSA, 2005a).

Although *Hydrilla* appears to be largely under control, significant amounts of water hyacinth (*Eichhornia crassipes*) were reported in 2003 along the perimeter of the Cuddo unit of the Santee NWR, on the northern edge of the lake (Letter from Mark Purcell, Refuge Manager, FWS, to SCPSA, December 21, 2004). Like *Hydrilla*, water hyacinth is considered by the State of South Carolina as an illegal aquatic plant species and a plant pest; however, unlike *Hydrilla* it is not a federally-listed noxious weed (SCDNR, 2006). Nevertheless, dense mats of this species can have negative impacts on animal communities such as young fish and other species that inhabit the shoreline. Water hyacinth out-competes preferable forage plant species, shades benthic communities, and inhibits the diffusion of oxygen into the water (Cronk and Fennessy, 2001).

According to the Aquatic Plant and Habitat Management Goals for the Santee Cooper Lakes, localized control of infestations using chemical or mechanical methods may be used in areas where vegetation interferes with legitimate lake uses (SCPSA, 2005a). According to SCPSA's 2004 work plan, however, water hyacinth infestation levels and plans for its control have not been identified (SCPSA, 2005a). The plan reports that annual scheduled work will include continuing to monitor aquatic vegetation within the lakes during late summer by collecting high-altitude infrared aerial photography of vegetative cover, as well as conducting visual boat surveys and low altitude aerial surveys during the growing season. SCPSA and SCDNR also intend to develop a hydroacoustic monitoring plan to document vertical growth of aquatic vegetation (SCPSA, 2005a). An annual report on aquatic plant monitoring by SCPSA was scheduled for November 2005.

Wildlife

The diversity of cover types in the project area offer habitats for a variety of wildlife. Commonly observed mammals include white-tailed deer, gray and red fox, raccoon, opossum, muskrat, mink, river otter, striped skunk, gray fox squirrel, southern flying squirrel, marsh rabbit, eastern cottontail, and the occasional bobcat. Smaller mammalian residents include at least 13 species of rodents and 12 species of bats. Reptiles are well represented and include the American alligator, about 10 species of turtles, 9 species of lizards and skinks, and at least 34 species of snakes. Also, there are about 35 species of frogs, toads, salamanders and other amphibians present in the project area. Avian fauna is well represented, as well, and includes 12 species of herons and bitterns, 29 waterfowl species, 24 raptors (including the federally listed bald eagle), 26 shorebirds, 38 warblers, and 29 finches. Over the years, 293 avian species have been identified in the project area (SCPSA, 2004a).

The project area lies within a principal route of the Atlantic Flyway which is of great importance to many birds, especially migratory waterfowl such as flocks of canvasbacks, redheads, and lesser scaups that winter on the waters and marshes south of Delaware Bay. Between 2001 and 2004, waterfowl flocks ranging in size from 580 to 3,677 have been observed at various times in the SCPSA's wildlife management areas

(SCDNR, 2004). A well-known feature of the project is the complex of up to 23 separate waterbird rookeries along the shores of both lakes. The rookeries support great blue herons, little blue herons, white ibises, least terns, anhingas, double-crested cormorants, cattle egrets, great egrets, tricolored herons, black-crowned night herons, and yellow-crowned night herons. The colonies, depending on species and location, range in size from less than 10 to almost 2,000 active nests, based on SCDNR census data collected since 1995 (SCPSA, 2004a).

Management of Natural and Wildlife Areas

There are a number of managed natural and wildlife areas in the project area. 'Natural Areas' have been defined by SCPSA as outdoor sites that have historical, geographical, ecological, paleontological, biological, or recreational importance. They are categorized into three classifications: (1) islands, (2) shoreline areas, and (3) the bluffs adjacent to the Upper Santee Swamp. These lands are preserved from development for the protection of threatened or endangered species, cultural and historical resources, environmental quality, and wetland habitat, as well as ecological and aesthetic values (SCPSA, 2004a).

In addition to Natural Areas, about 18,600 acres of land in several shoreline locations are actively managed by state and federal agencies to encourage the productivity of non-game and game species such as white-tailed deer, turkey, dove, quail, Canada geese, and other waterfowl. These management areas include (1) the Santee Cooper Wildlife Management Area (WMA), on the shores of Lake Marion near Eutaw Springs; (2) the Santee National Wildlife Refuge (NWR), on the north and northeastern shores of Lake Marion; (3) the Sandy Beach Waterfowl Management Area (Sandy Beach), on the north shore of Lake Moultrie; and (4) additional small wildlife management areas scattered throughout the lake system.

The 2,828-acre Santee Cooper WMA is actively managed using prescribed fire, hardwood restoration and invasive species management to benefit deer, dove, quail, and small game habitat. A portion of the WMA, about 140 acres, is planted with a variety of crops during the spring and winter to provide wildlife benefit year round. Additional management strategies employed to benefit wildlife in the WMA include planting sawtooth oaks to replace mast trees lost during Hurricane Hugo in 1989, and placement of wood duck boxes to encourage nesting.

SCDNR and FWS actively manage the 15,096 acres of the Santee NWR. The NWR is divided into four discrete management units: Bluff, Dingle Pond, Pine Island, and Cuddo. Management objectives include the protection of migratory birds and their habitats, and the improvement and management of habitat for deer, furbearers, quail, and small game. All of the management units contain a diversity of wetland habitats, upland forests (and inclusions), savannahs, bays, early successional fields, and active farmland (Letter from Mark Purcell, Refuge Manager, FWS, to SCPSA, December 21, 2004).

The Bluff unit of the Santee NWR covers 514 acres and is occupied by pine plantations, agricultural fields, wetlands and visitor facilities. Two wetland areas in this unit, Five Pine Pond and Polly-Cantey Bay Pond, are managed to optimize wildlife habitat that is represented by moist soil, semi-permanently flooded habitat and floodable agricultural cropland. The Bluff unit is adjacent to both Persanti Island, which provides habitat for the federally endangered red-cockaded woodpecker (section 3.3.4, *Threatened and Endangered Resources*) and Jack's Creek, which provides migratory waterfowl habitat. The Dingle Pond unit protects a unique 80-acre Carolina Bay wetland. The Pine Island unit consists of 1,049 acres of wetland and upland habitats and supplemental crops. The Cuddo unit totals 4,203 acres of diverse managed wetlands and floodable upland units. Prescribed habitat disturbances such as burning, tree harvest or selective cutting, and flooding are used to enhance wildlife habitat values. Winter flooding to attract migrating waterfowl is accomplished through water recharge or pumping from Lake Marion. During the spring, the unit is drained to plant wildlife crops (Letter from Mark Purcell, Refuge Manager, FWS, to SCPSA, December 21, 2004).

Lake Marion provides the primary hydrologic input to these areas. Manipulation of water levels is achieved at various pumping stations and allows hydrologic exchange between Lake Marion and the wetland areas. Historically, lake drawdowns occurring during fall and winter have limited the transfer of water from the lake to the refuge. High lake levels experienced during the spring and summer have historically increased ground-leaching and prevented full drawdown of the NWR impoundments (Letter from Mark Purcell, Refuge Manager, FWS to SCPSA, December 21, 2004). Water transfer problems at the NWR in the past have been compounded by aged and malfunctioning equipment, as well as nuisance vegetation, which limited the ability to pass water the considerable distance necessary during low lake levels. Recently, modifications have been made to the NWR infrastructure including replacing pumping systems, and clearing and extending intake canals. These improvements have led to improved water management such that NWR has been able reach their management goals (Letter from Mark Purcell, Refuge Manager, FWS to SCPSA, December 21, 2004).

In 2002, SCPSA and SCDNR entered into a cooperative agreement to manage aquatic vegetation for the Santee Cooper Lakes. Its goal is to maintain 10 percent of the lake surface area as habitat for waterfowl, wildlife, fish and other aquatic organisms. This includes achieving a diverse assemblage of native aquatic vegetation, with at least 75 percent of vegetation composed of species that are beneficial to waterfowl, and effectively controlling non-native invasive species (SCPSA Comm., 2005c). The plan includes annual monitoring of aquatic plants by SCPSA, cooperative fish and wildlife monitoring by SCPSA and SCDNR, and *Hydrilla* control via grass carp stocking.

3.3.3.2 Environmental Effects

Hydropower operations cause water level fluctuations in Lake Marion and Moultrie and the Santee and Cooper rivers. Water level fluctuations may have positive or negative effects on wetlands and wildlife habitat that are within the fluctuation zone.

Additionally, the management of project lands has the potential to negatively or beneficially affect wetlands and terrestrial habitats through development restrictions or permitting, buffer zone requirements or allowances, and sensitive resource area protection, or lack thereof.

Effects of Project Operations on Lacustrine Wetlands and Wildlife

The primary effect of project operations on lacustrine wetlands and wildlife habitat originate from water level fluctuations. The effect of fluctuations depend upon the frequency and magnitude of dewatering and flooding, which in turn affects wetland structure (e.g., species composition and density) and function (e.g., provision of wetland-dependent wildlife habitat) (Cronk and Fennessy, 2001; Bain and Mills, 2004). Excessive dewatering can lead to desiccation of plants/soils and can facilitate the establishment of exotic or invasive plants. Excessive high water conditions can lead to die-off of native and/or woody species, and reduce plant species and community diversity. High water may also encourage colonization by invasive species. As such, excessive dewatering and flooding of wetlands can cause changes that affect the quality of forage and cover for wildlife species associated with riparian and wetland habitats (Cronk and Fennessy, 2001; Bain and Mills, 2004).

Water level fluctuations do not inherently constitute a negative effect on wildlife and their habitats, however. Under certain conditions of frequency and magnitude, water level fluctuations can serve important functions in maintaining healthy wetland systems. Primary productivity is enhanced by increased water inflow that carries nutrients and facilitates exchange of dissolved elements (such as phosphorus nitrogen, oxygen, and carbon). Also, many wetland plant seeds and seedlings require the drawdown phase for germination and establishment. Further, a changing hydrologic regime can benefit different species at different stages such that there is an overall increase in species diversity and diversity of vegetation types (Cronk and Fennessy, 2001).

SCPSA proposes to continue operating the Santee Cooper Project under the existing operating regime (see section 3.3.1, *Water Resources*), which targets a winter drawdown to elevation 72 feet in January, and results in fluctuations in water levels for both Lakes Moultrie and Marion. Lake levels at the project can experience the highest degree of fluctuation in the winter, depending on inflows to the project associated with wet, dry or average years. SCDNR water level data (gage no. 2171000) for Lake Marion from 1998 to 2006 indicate that lake levels may vary from year to year but tend to be stable during the summer months. During this period summer lake levels ranged between elevation 72 and 76 feet, and overall fluctuations from May through September were typically about two feet.

Several recommendations would affect water levels of Lake Marion and Moultrie. Specifically, the agencies and interested parties recommend changes in the rule curve that would create full-stage conditions during the winter months and enhanced water management of the Upper Santee (Sparkleberry) Swamp.

Our Analysis

Proposed Action

Both Lakes Marion and Moultrie have abundant littoral habitat due to their shallow nature and nearly level shoreline topography. Consequently, small changes in lake level can translate into sizeable water level fluctuations along the littoral and riparian zone, and within connected wetlands. Under current project operations, the Santee Cooper lakes experience the greatest water level fluctuations during the winter months, particularly between December and the end of January, associated with drawing down the lake level to accommodate high inflows in the late winter and early spring. During the summer, project operations aim to maintain the lakes at or near full stage, which results in decreased water fluctuations (see section 3.3.1, *Water Resources*).

Water level fluctuations associated with seasonal drawdowns may affect some wildlife species that prefer steady water levels along the land/water interface. For aquatic furbearer species and waterbirds, a well-vegetated shoreline provides both access to foraging opportunities along the lake, as well as to ready cover from predators. If water levels drop appreciably to expose the shoreline, access to den entrances and foraging areas in or near the water may be compromised. Several mammalian species such as river otters, marsh rabbits, and opossum rely on, or benefit from, access to water from bushy or vegetated shorelines. In addition, many herpetile species burrow in the soil or leaf litter of the herbaceous understory located along the waters edge when inactive, as during periods of extreme heat or cold. Water drawdown during the fall or winter may increase the area of unvegetated ground between the waters edge and areas of suitable cover. Individuals that disperse from one habitat type to another may experience increased vulnerability to predation due to exposure. Because there is an abundance of vegetated shoreline in coves and wetland habitat along the perimeter of the lakes and throughout the project area, however, it is unlikely that the brief winter drawdown and lake level fluctuations would adversely affect these wildlife species.

Drawdowns and lake level fluctuations that directly affect the inundation of connected wetlands such as Carolina Bays and depressional wetlands may affect certain amphibian species, including salamanders, toads, and frogs, if lake drawdown occurs during the breeding season. For wetlands that rely on lake water for inundation, decreasing lake levels may suddenly dewater habitat occupied by amphibian eggs or larvae, leaving them stranded. The breeding season for amphibians is generally from May to August, a time period where Santee Cooper lake levels remain fairly stable and are targeted at full pool elevation. Although the degree of fluctuation that would lead to negative effects on amphibian breeding habitat is site specific, depending on various topographical and habitat characteristics, it does not appear that project operations are having a significant effect on breeding amphibians.

Low lake water levels during the fall and winter may affect avian use of the lake fringe. After initial drawdown, there is a temporary increase in foraging habitat for waterfowl and shorebirds as mud flats are exposed with emergent/submerged vegetation,

soils, and macroinvertebrates. Following exploitation of the flats, migratory and resident water birds would move to the new littoral zone area, which may be smaller in area than what existed at full-stage conditions and may accommodate fewer individuals. Although, the carrying capacity of the lake habitat and whether bird use approaches this value during full-stage or drawdown is unknown, data on bird use of the lakes during winter appears to show a pattern of increased bird use with increasing lake levels (SCDNR, 2004). Any decrease in lake fringe is unlikely, however, to have a significant effect on waterbirds, as the drawdown phase is of limited duration and refilling occurs rapidly (see section 3.3.1, *Water Resources*). Also, successfully managed waterfowl habitat appears to be abundant in the project area. During the 2003-2004 season, Santee NWR reported substantial waterfowl numbers, upwards of 5,000, using the various units during fall and winter and reported areas of 'excellent' and 'phenomenal' roosting and loafing areas (e.g., Bluff and Dingle units, totaling about 600 acres).

A relatively high number of active colonial wading bird rookeries are found along the margins of the Santee Cooper lakes, which may be an indicator of persistent high quality habitat under current operations. Colonial waterbirds have fairly specific habitat requirements, and are particularly susceptible to human disturbance, habitat alteration, and disruption of foraging grounds (Moore, 1990; Natureserve, 2005; Vennesland, 2000). Because of the sensitivity of these colonies, it is reasonable to expect that if project operations were adversely affecting the habitat, annual breeding colonies would exhibit some form of distress or decreased breeding success during regular monitoring, which has not been recorded.

Based on information for the project area regarding the diversity of wetland types, plant communities, and hydrologic regimes, among others, we do not expect that continued operations under the proposed action would adversely affect the wetlands and wildlife in the project area. Wetland-dependent wildlife species appear well-supported, and the number and variety of species inhabiting the area is indicative of a healthy wetland system.

Agency and Interested Party Alternative

The agency-recommended changes to the rule curve would result in full-stage conditions during the winter months, between December and February, and in turn increased inundation of Upper Santee Swamp. Such conditions would increase the amount of waterfowl and waterbird foraging, roosting, and loafing habitat and allow increased numbers of individuals to use the area as migratory stopovers or wintering grounds.

The recommended modification to the rule curve would also affect wetlands and wildlife habitat in the area by inundating bays, shoreline, and connected wetlands that are usually dry during the winter months. Full stage conditions in winter months would increase perennial wetland habitat as wetlands that usually experience a wet/dry cycle are converted to permanently inundated systems. A correlated change in the biotic communities of such areas in favor of more hydrophytic plant and animal species would

also be expected. Studies have shown that moderate levels of disturbance contribute to biodiversity; however, large disturbances (and lack of disturbance) can contribute to decreased species richness and increased invasive species colonization and dominance (Cronk and Fennessy, 2001). Thus, a large change in the hydroperiod, such as would result from the agency recommended rule curve, would likely have some negative effects on existing wetland habitats and wildlife, which are accustomed to the current hydroperiod.

Water level fluctuations do affect the management of the wildlife habitats of the Santee NWR. Specifically, the drawdown and filling of Santee Cooper lakes affects water transfers to and from the NWR. Current project operations are not timed to coincide with optimal water level management at the NWR, but these operations (as proposed to continue) do not appear to be having an adverse effect on the habitat in the NWR, and should not in the future, particularly in light of the recent infrastructure improvements to the refuge. Specifically, modifications to the NWR infrastructure including replacement of pumping systems, and clearing and extending of intake canals have resulted in the achievement of most refuge management goals as of 2001 (FWS Comm., 2004).

Effects of Project Operations on Noxious and Nuisance Vegetation

Under the proposed action, SCPSA would continue operating the Santee Cooper Project as it does currently. SCPSA would also continue grass carp stocking to control *Hydrilla*, and annual cooperative monitoring of aquatic plants, fish, and wildlife of the lakes. The agencies recommend extending the full pool elevation targets to include the months of December and January as well as development and implementation of an Aquatic Plant Management Plan. The DSA also includes measures to implement aquatic nuisance weed control measures at Santee NWR, as well as maintenance of refuge pumping stations.

Our Analysis

Proposed Action

The occurrence of noxious and nuisance vegetation in the project lakes is the result of several factors including watershed nutrient and contaminant input, and the natural lake characteristics (i.e., shallow and warm water). Additionally, contaminated recreational equipment such as boats can introduce and spread invasive species. Of the stresses already experienced by the lakes, water fluctuations caused by project operations are not expected to be extreme enough to dramatically affect colonization of exotic wetland species, particularly *Hydrilla*.

SCPSA has implemented management strategies to control the growth of noxious aquatic species in the Santee Cooper lake system with mixed results. SCPSA's aquatic vegetation management plan includes *Hydrilla* control via grass carp stocking, annual monitoring of aquatic plants by SCPSA, and cooperative fish and wildlife monitoring by SCPSA and SCDNR.

The use of grass carp as a management tool has had some negative effects on native vegetation, but the control of *Hydrilla* appears to be successful, according to the 2004 monitoring survey. Specifically, *Hydrilla* has been confined to less than 100 acres; there has been an increase in native aquatic vegetation that has colonized the littoral zone areas of Lakes Marion and Moultrie; and water quality improvements have been observed including increased dissolved oxygen concentrations in Lake Marion. Continued implementation of monitoring and management would continue control of noxious plants at the Santee Cooper lakes.

Observations of the spread of water hyacinth in the Bluff Unit of the Santee NWR (SNWS, 2003) indicate that exotic plant management focused on this species would be prudent. Water hyacinth is a warm water species that grows and spreads rapidly in habitats such as the Santee Cooper Lakes. It forms dense floating mats and has a high leaf turnover rate such that its average doubling time is 13 days (Cronk and Fennessy, 2001). Infestations reduce dissolved oxygen and increased decomposition in the water column resulting in anoxia, which leads to fish kills. It also smothers submerged and littoral vegetation important to waterfowl. Manual removal of small infestations is considered effective, however, once water hyacinth populations have become established more intense removal methods are required. Mechanical, chemical, and biological controls may all be used depending on the level of infestation, financial resources available, and maintenance plan used (Cronk and Fennessy, 2001). Early detection is key, however, and removal of new occurrences of this species and other invasive aquatic plants in the project area would be beneficial in preventing the species from overtaking areas currently populated by native vegetation.

Agency and Interested Party Alternative

Sudden extreme changes in hydrology, such as elimination of a drawdown phase, can lead to invasion of noxious and nuisance vegetation. Many invasive aquatic plants have wide ecological tolerances and reproductive capabilities allowing them to dominate the water column under conditions that stress less hardy native species. Currently, native species that occupy the shoreline and littoral zone of the Santee Cooper lake systems are adapted to a hydroperiod that includes flooding and drawdown periods. Under year-round full-pool conditions, these species would likely be displaced by fast-colonizing, opportunistic exotic species such as cattail, water hyacinth, and others.

In contrast, a variable hydrologic regime, one that includes raising and lowering water levels is often used as a nuisance plant control for lakes and reservoirs and wetlands (Cronk and Fennessy, 2001). Drawdowns to expose sediments of the rooted plant zone can bring about short-term control of some rooted nuisance species such as water hyacinth. However, it may also encourage growth of other exotic species that require mudflats for germination. In the absence of other controls, *Hydrilla*, for example, may increase in range during winter drawdowns (Cronk and Fennessy, 2001), although SCPSA has an effective control for *Hydrilla*.

In summary, effective control of noxious and nuisance vegetation requires a thorough understanding of the specific species requirements of the native community as well as likely invasive species. Any drastic change in the hydrologic regime, such as elimination of the drawdown phase, would require a thorough review and reassessment of current invasive plant control measures used in the lake system.

SCDNR and SCPSA entered into an agreement in 2001 to address aquatic plant management at the project. Implementation of an Aquatic Plant Management Plan would further the goals of the agreement which include controlling non-native invasive aquatic plants and maintaining 10 percent of the lake surface in a diverse assemblage of native aquatic plants that are beneficial to waterfowl.

DSA Alternative

SCPSA's *Hydrilla* control plan has controlled invasive and nuisance plant colonization at the project, however, patches of invasive plant growth have been identified at the Santee NWR. Colonization of exterior pump intake canals with surface and subsurface noxious aquatic vegetation has hampered water transfer efforts to the refuge (Letter from Mark Purcell, Refuge Manager, FWS, to SCPSA, December 21, 2004). Cleaning the intake canals has improved water transfer; however, the control of nuisance vegetation along the border of the Santee NWR, as recommended by FWS, would also benefit the refuge and the shoreline habitat of Lake Marion. Removal of exotic, nuisance aquatic vegetation would allow for the colonization of native species that can not normally compete with aggressive, non-native species.

Effects of Project Operations on Downstream Wetlands and Forested Floodplains

The magnitude, frequency, and timing of spills from Santee dam affects the wetlands and forested floodplains associated within the 37-mile long reach of the Santee River below the dam. The current spill management practices at Lake Marion minimize the amount and duration of spills when compared to inflows (Normandeau, 2005a). Among the potential ecological consequences of such hydrologic alterations is an increase of species more tolerant to dry conditions.

The magnitude, duration, and frequency of inundation are known to be the most important physical factors controlling the distribution of wetland plant species and wetland productivity (Wharton et al., 1982; Mitsch and Gosselink, 2000; Burke and Eisenbies, 2000; Cronk and Fennessy, 2001). Periodic flooding of riparian wetlands provides water to vegetation, while also replenishing nutrients. Overbank flooding also creates beneficial alterations to soil chemistry such as nitrification, sulfate reduction, and nutrient mineralization. Finally, the flowing water of overbank flooding oxygenates the root zone while flushing away waste products of soil and root metabolism including carbon dioxide and methane (from Brinson et al., 1981, in Mitsch and Gosselink, 2000).

According to studies of systems similar to the Santee bypass floodplains, inundation during winter and early spring is critical for ecosystem health of bottomland

swamp and forested wetlands (Mitsch and Gosselink, 2000; Meyer et al., 2003). Most dominant tree species in these communities release seeds from September to as late as March. The seeds require short-term, high discharge floods for transport to germination sites. Bald cypress and swamp tupelo are particularly dependent upon floodwaters for seed dispersal, as well as on the availability of open microsites for germination. During extended flood-free periods such microsites are often colonized by exotic or other species tolerant of arid conditions (Mitsch and Gosselink, 2000). Summer floods, conversely, may cause mortality of newly germinated seeds and can reduce recruitment (Meyer et al., 2003).

SCPSA proposes to operate the Santee Cooper Project as it has historically, which would include a continuous minimum flow of 500 cfs downstream of Santee dam. The agencies and interested parties recommend additional measures that would increase flows into the Santee River and the associated wetlands and floodplains, modify flows at St. Stephen during the fish passage season, and provide for the implementation of an Adaptive Management Plan to assess effectiveness of flow alternatives. The DSA includes an alternative minimum flow regime for Santee dam and the development and implementation of a Low Inflow/Emergency Contingency Plan for the operation of the project during low inflows. The recommendations are described in more detail in section 3.3.1, *Water Resources*, and section 3.3.2, *Aquatic Resources*.

Flows in the Santee River between Santee dam and the St. Stephen rediversion canal

Our Analysis

Proposed Action

The forested floodplain of the Santee River bypass has been affected by Santee Cooper project operations. As described in the section 3.3.1, *Water Resources*, minimum flow conditions (i.e., 500 to 600 cfs) in the river are maintained year round, resulting in periods of up to two years without high flows below Santee dam. The hydrology of this reach is characterized by long durations of flows limited to the required 500-cfs minimum flow, punctuated with occasional, brief full flood stage events. According to a 2005 forested floodplain survey, the brief full flood stage flow events are of insufficient duration to maintain the floodplain plant community (SCCNC, 2005), thus contributing to a loss of forested wetland plant species within the floodplains in this area.

Extended flood-free periods also affect floodplain wetland habitat (i.e., cypress-tupelo swamp and first terrace bottomland forest) on two fronts: directly, as upland species naturally transplant wetland species; and indirectly, as floodplain wetlands are replaced by managed pine plantations in areas that were historically too wet to support this forest type. Specifically, the bald cypress-swamp tupelo swamp and first terraced bottomland communities require annual floodplain flooding (approximately 194 and 100 days respectively) to persist (Wharton et al., 1982). To cover these floodplain communities in the Santee River bypass, an estimated discharge of over 20,000 cfs would

be required. Minor and moderate floodplain coverage is expected to result from lower flows of 8,000 cfs to 20,000 cfs (table 15) (Normandeau, 2005b).

Table 15. Modeled floodplain inundation for four flows in a 37-mile section below Santee dam. (Source: Adapted by staff from Normandeau, 2005b)

Discharge (cfs)	Percent Floodplain Inundation[a]
8,000	11
10,000	21
15,000	63
20,000	100

[a] Estimates are for conditions of no St. Stephen operations.

The mean spill volume from Santee dam is 21,748 cfs, a sufficient sized flow to inundate the floodplain. However, Santee spill events average 16 days and have a 1.7-year recurrence interval (Normandeau, 2005b). As a result of the decreased frequency and magnitude of flooding flows, cypress-tupelo swamp and first terrace bottomland forest in the Santee bypass are being replaced by upland plant communities such as early seral shrub-vine and invasive species, as documented through floodplain forest typing and inventory (SCCNC, 2005).

Agency and Interested Party Alternative

The increase in minimum flows recommended by the agencies (i.e., 25-30% of inflow or 1,600 cfs minimum) would provide little benefit to the floodplain and associated wetland communities. During most water years, the proposed minimum flow would provide less than 5,000 cfs flows in the bypass and supply just enough water to produce a thalweg in most of the bypassed reach. It is estimated that at 8,000 cfs, 11 percent of the floodplain becomes inundated (Normandeau, 2005b). Under the agency proposed minimum flow regime, an average weekly flow level of 8,000 cfs or greater would have occurred during only one week in an average water year (1997) and five, nonconsecutive weeks during a wet water year (2003). These events are of insufficient frequency, quantity or duration to provide significant benefits to the bald cypress/swamp tupelo and first terraced bottomland communities of the floodplains.

DSA Alternative

The proposed minimum flow regime included in the DSA (1,200 cfs/2,400 cfs seasonally) would also provide little benefit to the floodplain and associated wetland communities. During the typical average year (1997), weekly average flows would exceed 8,000 cfs in the Santee River only 4 percent of the time (2 of 53 weeks), after allocations to Jefferies and St. Stephen, including during fish passage season. During a wet year (2003), weekly average flows would exceed 8,000 cfs in the Santee River only 19 percent of the time (10 of 53 weeks). Spillage events under the DSA alternative

would therefore be of insufficient frequency, quantity or duration to provide significant benefits to the bald cypress/swamp tupelo and first terraced bottomland communities of the floodplains.

Flows in the Lower Santee River and Santee River Estuary

Our Analysis

Proposed Action

According to the 2005 floodplain forest study, the frequency and duration of flooding flows are sufficient to maintain healthy forested floodplains below the Rediversion canal (SCCNC, 2005). True cypress-tupelo stands are common and although some former cypress-tupelo areas are progressing into first–terrace oaks, a community that requires a shorter inundation period, there is no evidence of transition to upland communities.

SCPSA proposes to continue flows of 5,600 cfs through the St. Stephen powerhouse during the anadromous fish migration season (February 1 to April 15). These flows have been supplied voluntarily since 1990, and thus would not result in a change in current operations. Because flows of this level do not result in overbank flooding, existing forest floodplain conditions in the lower reach of Santee River would not be affected by this measure.

There are concerns regarding the effect of project operations on salinity encroachment from the Atlantic Ocean. Low flows in the Santee River, as a result of project operations, increases brackish and saltwater intrusion in the North and South Santee rivers, which may be causing a shift from freshwater-adapted vegetation to more saline species in the estuary (SCCNC, 2005). Because different plant species have specific salinity tolerances, changes in their distribution can be used as an indicator of salinity change over an area or over time (RPI, 2004). Study results report that between 1942 and 2000, there has been a 13.6 percent shift in freshwater vegetation to brackish or saltwater vegetation, and a 30.2 percent conversion of oligohaline vegetation (adapted to brackish or low salinity conditions) to more salinity tolerant species (RPI, 2004). In addition to concerns regarding the estuary, studies have shown that during low streamflow the Santee River experiences increased salinity as far upstream as the Wambaw Creek Wilderness in the Francis Marion National Forest. Increased salinity levels may affect the wetlands, vegetation communities, and wildlife species that rely on freshwater from the Santee River in the wilderness area, though the effects of salinity encroachment on resources in Francis Marion National Forest are currently unknown.

Agency and Interested Party Alternative

The agency and interested party alternative does not constitute a significant difference from existing conditions of providing flows of 5,600 cfs during fish passage season. In addition, the agencies flow recommendation would not affect the Santee River downstream of the Rediversion canal or the issue of salinity intrusion from the bay,

because the volume of water received by the lower Santee River would remain the same; it would just be discharged from a different location (i.e., Santee dam versus St. Stephen).

DSA Alternative

Flows in the Santee River downstream of the Rediversion canal would not change from existing conditions because flows would not increase or decrease but rather be redistributed from St. Stephen to Santee dam. Therefore, salinity intrusion from the bay would essentially remain the same as under existing conditions.

Flows in the Cooper River

Our Analysis

SCPSA proposes and the agencies recommend that a weekly average flow of 4,500 cfs be provided to the Cooper River from the Jefferies powerhouse. As discussed in section 3.3.1, *Water Resources*, this flow is currently provided based on an agreement between Santee Copper and the Corps. This flow provides a balance between reduced shoaling in Charleston Harbor and prevention of saline tidal water intrusion as far upstream as the Bushy Park industrial complex.

Prior to construction of the Santee Cooper Project, the Cooper River was a small tidal river with little fresh water inflow and an average flow of 72 cfs (SCPSA, 2004a; Corps, 2006). Since establishment of the Santee Cooper and St. Stephen projects, flows to the Cooper River have stabilized at a maximum average weekly flow of 4,500 cfs, and the river now constitutes a major, freshwater system. Although the first several miles downstream of the Jefferies powerhouse is a constructed channel, a system of wetlands have been created in the lower reaches of the Cooper River since the projects were developed. Since 1985, when the St. Stephen Project became operational, a reliable passage of 4,500 cfs has helped maintain tidal wetlands, forested uplands, isolated freshwater wetlands, and rice fields within the Cooper River corridor. These habitats have been partially or wholly created by current project operations, and thus would continue to benefit from continuing the existing flow regime.

Downstream Flow Management

Our Analysis

Both the Adaptive Management and Low Infow/Emergency Contingency Plans would benefit the wetland habitats and forested floodplains of the upstream and downstream reaches of the Santee River by including biological and ecological concerns in the prioritization of water allocation, monitoring the effects and identifying ecological issues that result from any new minimum flow releases and flushing flows, and by providing an avenue to adaptively revise flow prescriptions to meet objectives. As such, the net results of these management plans would be an overall enhancement of conditions for wetlands and wildlife that rely on the hydrologic resources of the project.

Effects of Land Management on Wetlands and Wildlife

Land use along the shoreline affects botanical and wildlife resources. Development has replaced natural cover types with impervious surfaces (e.g., homes, secondary structures, and roads) and managed vegetation (e.g. lawns, landscaping, and gardens) along some of the lakes shorelines, contributing to a loss of natural habitat. The primary mechanism for future management of lakeshore development is a permitting program that is administered by SCPSA, and management plans contained in the existing Comprehensive Land Management Plan (CLMP) (see section 3.3.6, *Land Management and Aesthetic Resources*).

SCPSA and the agencies have proposed improvements to several of the recreational facilities within the project boundaries (see section 3.3.5, *Recreation Resources*). SCPSA also proposes to continue management of lands within the project area under the provisions of the CLMP.

The agencies, however, recommended several measures that would affect the management of wildlife and habitats around Lakes Marion and Moultrie. These measures include the development of a comprehensive shoreline management plan that is updated every 10 years, and designation of Polly-Cantey Bay as a 'natural area' under the CLMP.

The DSA contains several measures pertaining to management of and improvements to the Santee NWR including erosion control measures, irrigation options on the Bluff and Cuddo Units, stand density reduction for 40 acres of pine/hardwood habitat on the Pine Island Unit, and the creation of a marked navigation channel in Jack's Creek.

Our Analysis

Proposed Action

Large-scale construction of new facilities is not proposed, so disturbance of upland vegetation is expected to be minimal. However, the construction of, and increased recreational use of any new facilities located on the shoreline could disturb plant and wildlife communities that utilize shallow water zones near those facilities. Protection of sensitive areas would be a primary consideration during development of recreational facility plans, which would be subject to state and local permitting requirements that would require avoidance of direct impacts to nearby wetlands.

The existing CLMP would continue to identify and implement shoreline stabilization methods that promote wildlife habitat enhancements.

Agency and Interested Party Alternative

While some management plans contained within the CLMP, such as the Shoreline Erosion Control Plan, contain a provision for updates every five years, there are no provisions for periodic review and update of the CLMP. Revisions and additions to the existing CLMP and related programs could allow for an adaptive approach to future land

use activities at the project. A revised or amended CLMP could also provide for outreach efforts and programs that qualify as public education to actively inform the public of how and where project resources may be used, and to manage public access.

Polly-Cantey Bay is located at the mouth of Dingle Pond Unit of the Santee NWR. Designation of this bay as a "Natural Area" under the CLMP would provide for its preservation, protection, and enhancement, while still allowing public use to the extent that it does not jeopardize the resource base (SCPSA, 2003b). Land use practices on Natural Areas restrict development, dredging or excavation, and encourage measures to enhance wildlife habitat, prevent erosion, and limit human-caused degradation. Safeguard programs are implemented to ensure recreation impacts such as littering and wood cutting are minimized or prevented. As such, the shoreline habitat and flora and fauna of the Bay would benefit from the designation of Polly-Cantey Bay as a Natural Area.

DSA Alternative

The DSA includes 12 measures for enhancements at the Santee NWR for waterfowl management and restoration. These measures include mechanical improvements or servicing and providing fuel for pumping stations; improvement of the navigation channel from Jack's Creek; aquatic nuisance weed control, and removal of invasive plant species on the Bluff Unit; removal of vegetation from the exterior canal and interior dikes on the Cuddo Unit; placement of rip-rap and bio-engineering technologies such as live stakes to minimize erosion along the lake shoreline at Shuler's Point and the southern tip of 100-acre Island; investigation and support of irrigation options on the Bluff and Cuddo Units; and mechanical stand reduction in 40 acres of pine/hardwood habitat on the Pine Island Unit, to promote the reestablishment and enhancement of forest birds and specifically red-cockaded woodpecker habitat.

All of these measures would provide for enhancement of habitat for waterfowl, forest birds, and related wildlife at the Santee NWR, with only minor negative consequences. For example, the removal of snags and stumps from Jack's Creek to clear a public marked navigation channel may affect bird usage of the area. The snags designated for removal may serve as bird perches for species such as anhingas, herons and egrets. Also, predatory species such as osprey and bald eagles may use exposed snags near or in the water from which to forage for fish. Regardless, the removal of the few snags in this channel would not have a significant effect on wildlife in the area because of the abundance of alternative available sites. Potential drawbacks of the proposed erosion control measures would be that using live stakes may not solve existing erosion problems, requiring that the shoreline be protected from erosion using other methods until the vegetation becomes established, which can take a couple years. Using rip rap, however, may create a barrier between upland areas and the shoreline, inhibiting wildlife access, and may provide little replacement shallow-water habitat for fish. The overall benefits of the DSA measures for the Santee NWR, however, outweigh any minor negative consequences.

Staff Recommended Measures

We considered the potential designation of the Fork Swamp (or Upper Santee Swamp) as a Heritage Site to protect the extensive bottomland hardwoods and flooded wetlands in the project area. The floodplain wetlands in this area provide important habitat for a wide array of wildlife and plant species. Protecting this large tract of land would curb regional forest fragmentation by linking several currently-protected lands in the area including Lake Marion and Santee NWR, Congaree National Monument, Poinsett State Park, Manchester State Forest, and Shaw Air Force Base. This connection would provide a series of corridors for wildlife, while protecting the elements, communities, and wetland function of the property.

3.3.3.3 Unavoidable Adverse Effects

As a result of the decreased frequency and magnitude of flooding flows, cypress-tupelo swamp and first terrace bottomland forest in the Santee bypassed reach are apparently being replaced by upland plant communities such as early seral shrub-vine and invasive species. This condition would not be expected to change under the proposed action or agency and stakeholder alternatives.

3.3.4 Rare, Threatened and Endangered (RTE) Species

3.3.4.1 Affected Environment

SCPSA's studies identified three federally listed endangered species that occur in the project area: the red-cockaded woodpecker (*Piciodes borealis*), shortnose sturgeon (*Acipenser brevirostrum*), and West Indian manatee (*Trichetus manatus*). In addition, FWS recently noted that the federally listed endangered wood stork and delisted peregrine falcon were found in the Santee NWR. The federally listed threatened bald eagle (*Haliaeetus leucocephalus*) and the state-listed threatened spotted turtle (*Clemmys guttata*) also occur in the project area. Several species of national concern known to occur in the project area include the least trillium (*Trillium pusillum* var. *pusillum*), Wagner's spleenwort (*Asplenium heteroresiliens*), Carolina lilaeopsis (*Lilaeopsis carolinensis*), as well as one species of state concern, the incised groovebur (*Agrimonia incisa*). Additionally, 16 plant or animal species, designated as state species of concern, may occur in the project area.

Several habitats of special concern occur in the project area, as identified during the South Carolina Natural Heritage database inquiry. These habitats are considered unique because of their regional rarity, ability to support rare species, or general biological productivity. State-listed special concern habitats within the project area include limestone sinks, marl forests, bald cypress/tupelo gum swamps, bottomland hardwoods, swamp tupelo gum pond, calcareous cliffs, and numerous colonial waterbird breeding areas.

3.3.4.2 Environmental Effects

Project Operations and Management of Project Lands

Project operations and the management of project lands can affect the terrestrial and aquatic habitats of RTE species in the project area. Water level fluctuations in Lakes Marion and Moultrie and in the Santee and Cooper rivers can affect riparian and littoral habitats and wetlands that may serve as habitats for RTE species. Development and other ground disturbance activities on project lands also may affect wetlands and aquatic and terrestrial habitats.

Project operations have the potential to affect shortnose sturgeon. Specifically, adequate instream flows during fish spawning and passage season are required to provide suitable spawning, nursery and feeding, and migration corridor micro- and macrohabitat. Because there are no fish passage facilities at the project known to successfully pass sturgeon, the shortnose sturgeon population is divided into three groups: the Santee River below Santee dam, the Cooper River below Pinopolis dam, and the Santee Cooper lakes. Providing sturgeon passage at the project has the potential to open direct access to about 831 river miles and 77,000 acres of habitat in the Santee Basin for sturgeon now occurring below the dams.

Manatees dwelling below the Jefferies lock may make excursions into the lock system and inadvertently enter the project impoundments. Three issues associated with their presence is the inability of manatees to exit the lock and the lake and return to warmer waters during the winter months, resulting in stress and mortality, the potential for trapping and drowning manatees in the lock because of the configuration of exit culverts used to drain the lock, and the potential for propeller strikes by boats.

The bald eagle, the red-cockaded woodpecker and the wood stork could be affected by shoreline land use, both directly and indirectly attributable to project operation. Shoreline development is currently controlled, in part, by SCPSA under the policies of the CLMP; however, land uses beyond the project boundary are outside SCPSA's control. SCPSA's existing land management practices and CLMP, which includes measures that protect shoreline and terrestrial habitat, would continue to protect habitat for the bald eagle, red-cockaded woodpecker, and wood stork. Therefore, the project would not likely adversely affect either species.

Both project operations and land management practices have the potential to affect mussels and the spotted turtle. Seventeen species of mussel have been recorded in the project area, including 8 species of federal concern. Although the status of spotted turtles in the project area is unknown, they have occurred historically along the shores of Lake Marion (Mead and Hunt, 2005). Because mussels are generally limited to reservoir shoreline areas that are continuously inundated and that do not experience frequent water level fluctuations, there is little potential to affect those mussels. There is the potential to affect mussels in lotic habitats below the dams due to fluctuating flow releases. Spotted turtles also have the potential to be affected by the project in that they are susceptible to

certain land management practices that disrupt the forest floor, as well as project operations that affect wetlands and littoral habitat.

SCPSA proposes to implement the following protection and enhancement measures: (1) prepare species management plans for federally listed threatened and endangered species within the project boundary, and (2) develop sections of the CLMP to address areas identified as potential habitat within developable project lands, for protection of RTE species, and recommend mitigation measures to protect them**.**

The agency recommendations include the development and implementation of species management plans for RTE species known to occur near the project or affected by project operations, a red-cockaded woodpecker management plan for Persanti Island, a comprehensive shoreline management plan, and designation of Polly-Cantey Bay as a "natural area" under the CLMP.

Our Analysis

The effectiveness of the habitat management plan proposed by SCPSA lies in the details of the resource plans, which are yet to be developed. Effective management requires sufficient baseline knowledge to guide decision making on the type of mitigation measures required.

SCPSA proposes to prepare a species management plan for RTE species in the project area. This plan, prepared in collaboration with the appropriate agencies, would clarify what levels of disturbance are to be avoided, and provide guidelines for ensuring that disturbance to these species is minimized. Much of the habitat for special-status species lies outside the project boundary. However, project lands and waters would be integral to a species' overall habitat requirements. As such, RTE management plans, as recommended by agencies would need to include lands near, but outside of the project boundary, as well as those affected by project operations.

RTE species management plans could be developed as part of a regional management effort, in cooperation with adjacent property owners and/or wildlife resource agencies, to allow coordination of land and watershed management activities and to ensure that potential adverse effects on target species and their habitats are avoided or minimized. Development of RTE management plans would provide a coordinated mechanism for collecting, compiling, and mapping information about RTE species populations and their 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.

Overall, the development of the SCPSA-proposed RTE species management plans and revisions to the CLMP which focuses on identifying, protecting, and enhancing habitat for RTE species would provide benefits to the species. Agency recommended plans would be particularly effective if they are developed/revised in coordination with surrounding landowners and resource agencies such that they contribute to a larger,

regional plan of recovery. Including "adaptive management" in this plan would enable SCPSA to gage the effectiveness of management measures.

The agencies also recommend a comprehensive shoreline management plan that is updated every 10 years and is reviewed by federal and state resource agencies. Although SCPSA currently implements several shoreline management programs through its current CLMP (SCPSA, 2003b), it is not regularly reviewed. Collaboration with agencies to revise the existing CLMP would ensure that issues potentially affecting RTE habitats are addressed and that appropriate remediation is implemented.

Designation of Polly-Cantey Bay as a "natural area" under the CLMP would provide for its preservation, protection, and enhancement. The benefits to RTE would include targeted enhancement activities, developed in cooperation with resource agencies, which would improve RTE species habitat. RTE habitat would also experience indirect benefits through the preservation of shoreline vegetation, the discouragement of developments (including rights-of-way), and minimization of recreational impacts (i.e., wood cutting, littering, etc.).

It would also be appropriate to designate calcareous habitats as 'natural areas' such that they would be provided protection from development and degradation within the project area. Consequently, it would be appropriate that the CLMP address the management needs of rare and unusual plant species associated with calcareous habitats, in order to provide added protection.

Effects on Federally Listed Threatened and Endangered Species

Red-cockaded Woodpecker

The red-cockaded woodpecker is a federally and state-listed endangered species. This small, insectivorous bird excavates nest cavities in old growth trees such as longleaf or loblolly pine (NatureServe, 2005). Nesting is often done cooperatively in groups of seven to nine (SCPSA, 2004a). The red-cockaded woodpecker employs a cooperative breeding system in which up to nine helpers participate in the incubation of nestlings and fledglings and help defend the territory (NatureServe, 2005). Each member of the nesting cooperative usually has an exclusive roost cavity which requires a large territorial range with appropriately aged and sized tree species (NatureServe, 2005). Active colonies of this species have been observed in the project area in the Santee NWR, in loblolly pine forests on Persanti Island, and four separate colonies in Santee State Park (last observed 1992) (Mead & Hunt, 2005).

Habitat loss, fragmentation, genetic isolation, catastrophic events, and competition with other species for nest cavities are considered the biggest threats to this species. Old growth habitat requirements for this species have historically been in conflict with timber management practices throughout its former range, which has reduced the availability of cavity trees. Populations of this species have steadily declined throughout its range over the past 100 years (NatureServe, 2005). The population in the Francis Marion National

Forest was increasing prior to the destruction of most of the cavity trees and 80 percent of the foraging habitat by Hurricane Hugo (SCPSA, 2004a; NatureServe, 2005).

Section 4(e) terms and conditions originally filed by FWS call for the management of Persanti Island for red-cockaded woodpecker habitat. The DSA includes measures to enhance red-cockaded woodpecker habitat.

Our Analysis

Red-cockaded woodpeckers have the potential to exist in the project area. Because this species requires old growth pine trees that are 60 to 100 years old, it could be affected by SCPSA's forest management practices, which are inconsistent with the life history requirements of this species. Current forest management centers on maintaining "middle-aged" trees, and selectively thinning stands for disease and insect control. Such management practices may eliminate potential habitat for this species as well as prevent habitat from developing over the long-term.

Management that would benefit red-cockaded woodpecker habitat would focus on preserving old-growth pine stands, establishing an appropriate prescribed burning program, and eliminating hardwood trees near existing nesting/roosting cavities. The agencies recommend management of habitat for red-cockaded woodpecker in the project area on Persanti Island. However, because the status of this species is largely unknown within the project area, it would be more appropriate to first conduct an assessment of suitable or potentially-suitable habitat for this species within the entire project area. If suitable habitat is found, it would be appropriate to include RTE management recommendations for this species in the CLMP.

The DSA includes a provision for enhancement of 40 acres of habitat in the Santee NWR for red-cockaded woodpecker. This provision along with other measures, such as preparation of a species management plan, if required by a new license, would likely protect and enhance habitat for this species. Therefore, we conclude that continued operation of the project is not likely to adversely affect the red-cockaded woodpecker.

Wood Stork

The wood stork is a federally listed endangered species. This large, mostly piscivorous wading bird has long legs, a broad wingspan, and a long, thick, touch-sensitive bill that curves downward at the tip (NatureServe, 2006). Wood storks nest colonially in cypress trees, mangroves, or dead hardwoods overhanging streams or freshwater marshes, swamps, lagoons, ponds, flooded pastures, and ditches (SCPSA, 2004a). Depending on environmental conditions, a breeding pair will lay two to five eggs and will share incubation and foraging responsibilities. Young will hatch in approximately 28 days and fledge in about nine weeks but will remain dependent upon their parents for food for another month (FWS, 1999). Groping with their bills open, wood storks forage primarily in shallow water (about 15-50 cm deep) detecting and quickly snapping up fish with their sensitive bills. This feeding technique necessitates higher prey concentrations than other wading birds require. For this reason, wood storks

prefer wetlands where water levels recede during their nesting season so that they can gather sufficient quantities of fish to raise their young (NatureServe, 2006)(SCPSA, 2004a). FWS recently noted that wood storks have been found in the Santee NWR (FWS 2006), however the size and status of this population was not provided.

Alterations to wetland hydrology that prevent natural prey concentrations can compromise wood stork nest productivity and have led to chronic nesting failure in many rookeries, despite their rigorous protection. Habitat loss, due to wetland filling and drainage, has also had significant impacts on wood stork populations. Receding water levels below nest trees and human disturbances can also cause adults to abandon their nests, exposing the eggs and hatchlings to predation (SCPSA, 2004a)(FWS, 1999)

Our Analysis

Wood storks have the potential to exist in the project vicinity. Because this species preferes that the season of receding waters coincide with their nesting period, it could be affected by SCPSA's rule curve which balances many competing water uses. Wood stork nesting season varies geographically, however, and it can be delayed if habitat conditions are unsuitable. The nesting season for wood storks in the Santee NWF has not been identified, however, nesting colonies in southern Florida occur from November to January and often been delayed until February or March. Delayed nesting is thought to have contributed to a decrease in nest success because young are more likely to be in the nest when spring rains begin to flood surrounding wetlands and disperse fish into deeper pools. Studies of wood stork colonies in Florida indicate that wetland drainage and predation has initiated a trend toward relocation of historical nesting sites to altered or artificial wetlands with impoundments (FWS 1999).

SCPSA currently implements management activities which would be beneficial to wood stork habitat including preserving old-growth cypress, bottomland hardwood stands, and snags along the water, assisting the FWS in establishing an appropriate flood cycle in the NWR, and minimizing human disturbances near waterfowl nesting sites. The FWS recommends a modified rule curve which would allow for full pool elevation from December to February to enhance waterfowl habitat. Maintaining full pool elevation in Lake Marion during the nesting period would preserve potential nest sites for wood stork.

The FWS currently manages wetlands within the NWR for the benefit of waterfowl. The DSA includes provisions for maintenance of the pumps that FWS uses to manage water levels in the Santee NWR wetlands and an investigation on moist soil impoundment irrigation options on the Bluff and Cuddo Units for the benefit of many species, including wading birds. These provisions along with other measures, such as modifications to the existing CLMP would likely protect and enhance habitat for the wood stork. Therefore, we conclude that continued operation of the project is not likely to adversely affect the wood stork.

Shortnose Sturgeon

The shortnose sturgeon is restricted to the east coast of North America. Its distribution is believed to extend from the Saint John River, New Brunswick, to the Saint Johns River in Florida. Throughout its range, shortnose sturgeon occurs in near-shore marine, estuarine, and riverine habitats associated with large tidal rivers. Shortnose sturgeon appear to be estuarine anadromous in the southern part of its range (Kieffer and Kynard, 1993). Adults in southern rivers forage at the interface of fresh tidal water and saline estuaries and enter the upper reaches of rivers to spawn in early spring.

Prior to endangered species listing in 1967, shortnose sturgeon were commonly taken in the commercial fishery for Atlantic sturgeon, and as incidental catch in the riverine American shad fishery. Factors that may have led to the significant, range-wide decline of the species include overfishing and heavy industrial development. There are no reliable estimates of historical population sizes, because there were few confirmed reports of shortnose sturgeon, and the species was not distinguished from the Atlantic sturgeon in scientific reports and commercial catch data.

In the project area, construction of the Santee Cooper Project and creation of Lakes Moultrie and Marion has altered the distribution of the shortnose sturgeon population. The impounding of Lake Marion changed about 34 miles of riverine habitat into a lake environment. Populations of shortnose sturgeon within the Santee River Basin consist of a dam-locked group within Lakes Marion and Moultrie, a group in the Santee River below Santee/Wilson dam and St. Stephen powerhouse, and a group in the Cooper River below Pinopolis dam. Evidence of shortnose sturgeon spawning has been found in the tailwater of Pinopolis dam (Collins et al., 2003; Cooke and Leach, 2003b). Pinopolis and Santee dams currently impede upstream movement of sturgeon within the Santee River Basin.

From 1979 to 1991, shortnose sturgeons were recorded from Lake Marion, and in the Congaree and Wateree rivers above the dam (Collins and Smith, 1997). These fish represent an essentially landlocked population. A functionally landlocked population of shortnose sturgeon also exists in Lake Moultrie, above the dam that separates the lake from the lower coastal plain Cooper River. The following evidence suggests these are isolated populations of sturgeon: (1) passage of sturgeon through the St. Stephen fish lift is extremely rare (six fish since 1985); (2) limited results of a telemetry study at the Pinopolis lock indicate that passage occurs rarely or not all; (3) the behavior of the fish in Lake Marion, which indicates that they remain in the upper end of the lake away from the dam and the diversion canal; (4) successful spawning in the Congaree River has been verified; and (5) genetic comparisons of sturgeon in the lakes to sturgeon below the dams, which indicates some demographic independence from the Cooper River population.

Seven shortnose sturgeon were recorded from the Santee River drainage in 1978, and one fish was gillnetted in 1992 (Collins and Smith; 1997). In addition, 20 specimens

were recovered from a fish kill in Santee dam tailrace that occurred during a low dissolved oxygen event.

Cooper River shortnose sturgeons were documented during the late 1800s in what is now the metro Charleston area (NMFS, 1998). Eleven sturgeon were also taken in February 1995 in gillnets at the Pinopolis dam tailrace (Collins et al., 1996).

Shortnose sturgeon spawning occurs in late winter and early spring when water temperatures reach 9^{o}C. Female shortnose sturgeon deposit eggs that hatch in 5 to 8 days. Shortnose larvae have been collected in deep areas usually within the river channel. Laboratory studies suggest that in northern rivers larval shortnose sturgeon downstream movement occurs for about 2 days. Recent and similar studies with shortnose larvae from the Savannah River suggest movement periods exceeding 60 days (NMFS Preliminary Fishway Prescription, May 5, 2006). The longer larval drift stage suggests adaptation to spawning sites in southern coastal plains that are further upriver from lethal saline waters than those habitats in most northern rivers. Young-of-the-year sturgeons stay upriver for the first year of life, moving downstream to the salt-freshwater interface during the second year. In the Santee and Cooper rivers, spawning begins in freshwater from late winter/early spring when water temperatures increase to 8 or 9^{o}C. Spawning usually ends when water temperatures reach 12 to 15^{o}C. Growth of juvenile shortnose sturgeon is fast and these fish can reach lengths of 14 to 30 cm total length after the first year (Dadswell et al., 1984). In the Santee and Cooper River sturgeon reach 50 cm after only 2 to 4 years.

In 1998 and 1999, SCDNR conducted a study to determine whether there was a reproducing population of shortnose sturgeon in the Santee Cooper lakes and to evaluate habitat use and degree of separation from the riverine groups (Collins et al., 2003). The results of these studies indicate that there were four areas of the project which were heavily utilized seasonally by shortnose sturgeon: the river channel, two relatively small areas nearby, and a spawning site well up the Congaree River. The population is currently estimated at around 200 spawning adults, and spawning has been confirmed in the Jefferies powerhouse tailrace.

Upstream passage of shortnose sturgeon is negligible in the Santee River Basin. Only two shortnose sturgeons have been recorded passing the St. Stephen fish lift during the past two decades (1987 to present) (NMFS Preliminary Fishway Prescription, May 5, 2006). During late February to May, spills of more than 100,000 cfs at Santee dam spillway may occur, resulting in flows that draw fish up to the dam. There are no fish passage facilities at this dam, and upstream migrating shortnose sturgeon reaching the Rediversion canal may also be exposed to complex flow fields resulting from discharges from Santee dam and St. Stephen flows. Sturgeon passage at Pinopolis dam is also likely negligible. Bottom-oriented fishes, such as shortnose sturgeon, may experience difficulty leaving the Pinopolis lock chamber because the lock sill acts as a barrier, and they are unable to migrate upstream.

Sturgeon moving downstream from the impoundment to riverine areas must pass either through the turbines at the Pinopolis, St. Stephen, Santee powerhouse, or over the Santee spillway during spill events. Cooke and Leach (2003) conducted radio telemetry studies and confirmed downstream turbine passage of shortnose sturgeon at Jefferies station, the St. Stephen station, and spillway passage at Santee dam. The study monitored downstream passage of six sturgeons at Santee dam, six at St. Stephen, and one at Jefferies.

Our Analysis

SCSPA proposes to (1) increase the current fish passage operations at the Pinopolis lock to a minimum of six, 8-minute locks per day; (2) add attraction flows at the Pinopolis lock entrance channel; (3) acquire, install and test a better fish passage counting system for the Pinopolis lock; and (4) develop a shortnose sturgeon enhancement plan.

The agencies prescribed/recommended that upstream and downstream fish passage at Pinopolis and Santee dams be designed to provide safe and efficient natural migratory movements of shortnose sturgeon, and that minimum instream flows of 1,600 cfs be maintained in the Santee River below Wilson dam, to provide suitable spawning, nursery and feeding, and migration corridor micro- and macrohabitat for shortnose sturgeon.

The DSA includes provisions to improve and install additional fish passage facilities at the project, but do not specifically target shortnose sturgeon. Any fishway improvements, however, may benefit shortnose sturgeon passage. The DSA also provides for minimum flows below Santee dam of 2,400 cfs during fish passage season and 1,200 cfs the remainder of the year.

The current shortnose sturgeon population is subjected to population fragmentation largely due to existing fish passage conditions (NMFS Preliminary Fishway Prescription, May 5, 2006), and this, along with flow releases from the project, would be the primary effects of the project on the sturgeon. Improved upstream and downstream passage at the project would support the recovery of the population by enhancing habitat and population connectivity. The tailwater of the Jefferies station is the only identified spawning location downstream of the project on either river. Eggs have successfully developed and hatched from this site, however, recruitment has not been verified (Duncan et al., 2002). The salinity a short distance below Jefferies station is lethal to larval shortnose sturgeon (NMFS Preliminary Fishway Prescription, May 5, 2006), indicating that spawning below Jefferies is unlikely to result in successful year class recruitment. Shortnose sturgeon may need to spawn above the dam to have recruitment success.

Shortnose sturgeon collected in the project lakes have been documented to be less robust than comparable fish in nearby riverine systems, most likely due to poor habitat quality, and inadequate forage (SCPSA, 2004a). These fish would benefit from downstream passage to the forage-rich estuarine reaches. Cooke and Leach (2003)

confirmed downstream turbine passage at the Jefferies station, and spillway passage at Santee dam. The effects and amount of turbine entrainment and mortality is unknown; however, a literature-based "desktop" modeling evaluation suggests potential adult shortnose sturgeon mortality may exceed 20-30 percent (Normandeau, 2002).

SCPSA proposes to continue current fish passage at the project by providing six 8-minute lock operations at Pinopolis, and an attraction flow at the lock entrance. SCPSA also proposes to install a better fish passage counting system at the lock. All parties agree that before any additional information or studies concerning passage effectiveness/lock effectiveness are undertaken at the Pinopolis lock, the fish counting technology presently utilized to quantify upstream passage through the lock should be upgraded. Doing so would provide more accurate count data, thus improving the foundation of passage data necessary to adequately address effectiveness issues.

The 37-mile-long Santee River bypassed reach below Wilson dam is reported to contain significant run habitat, along with lesser amounts of riffle, pool and side bar habitats, all with fines, and gravel/rubble substrates. This river reach has the potential to contribute valuable habitat to support the spawning and rearing of shortnose sturgeon. Data show, however, that under existing base flow conditions of 500 - 600 cfs, water quality excursions may periodically result in lethal conditions for sturgeon. One fish kill involving shortnose sturgeon has been documented.

Habitat and flow modeling conducted by SCPSA shows that Santee River habitat suitability for sturgeon increases at flows higher than the existing base flow. In addition, navigability through two key riffle areas is improved to the point that SCDNR navigability criteria for small boats are met at a flow of 1,300 cfs, indicating that this flow would also maintain adequate zone of passage and habitat connectivity for adult shortnose sturgeon utilizing the bypassed reach. There currently is no fish passage at Santee dam, and SCPSA does not propose any at the dam. Both NMFS and FWS, however, filed preliminary section 18 fishway prescriptions that would require phased development of fish passage at the dam for sturgeon and other diadromous species.

Fish passage improvements that facilitate sturgeon migration in both the Cooper River and Santee River could benefit both individual fish as well as the basinwide population, by alleviating spatial constraints on the species. However, there is limited site-specific information available as to the best location and type of passage facilities for passing shortnose sturgeon, and the overall technology for the passage of sturgeon at dams is not well-developed. Existing fish passage facilities on the Atlantic Coast rivers which have shortnose sturgeon populations have recorded only sporadic passage of sturgeon. Additional research is required to determine the most effective upstream and downstream passage designs for sturgeon, and the locations for such facilities at the Santee Cooper Project. Until effective fish passage for sturgeon is developed, the project would continue to affect the upstream and downstream movement of shortnose sturgeon in the Santee and Cooper rivers, and would continue to fragment sturgeon habitat in the rivers. Sturgeon habitat in both rivers would also continue to be exposed to project flow

releases, and although higher minimum flows may be provided in the Santee River, the Cooper River would continue to be exposed to variations in discharge from the Pinopolis station ranging from zero discharge to 28,000 cfs.

NMFS issued the final recovery plan for the shortnose sturgeon in December 1998 (NMFS, 1998). The plan establishes procedures and guidelines, and identifies reasonable measures that are believed necessary to recover and/or protect the shortnose sturgeon. The recovery plan lists a number of Priority 1 actions "that must be taken to prevent extinction or to identify those actions necessary to prevent extinction" (NMFS, 1998). For the Santee and Cooper rivers, Priority 1 items are to:

- determine abundance, age structure and recruitment;
- document distribution and map sturgeon concentration areas;
- assess mortality from incidental capture;
- collect continuous dissolved oxygen data; and
- identify movement patterns and eliminate barriers to movement.

SCPSA proposes to develop a Shortnose Sturgeon Enhancement Plan, which, if developed in cooperation with NMFS, FWS, and SCDNR, could address Priority 1 recommendations from the Final Recovery Plan for the Shortnose Sturgeon (NMFS, 1998). Addressing these recommendations as part of SCPSA's plan would assist in the recovery of this species in the Santee and Cooper rivers.

SCPSA, FWS, and SCDNR have filed a DSA that includes conditions to resolve issues related to the section 18 fish passage prescriptions. The fish passage provisions of the DSA are similar to those originally prescribed by FWS and NMFS, except that the DSA does not specifically address passage for the shortnose sturgeon, or provide for a zone of passage flow for sturgeon and other species in the Santee River. The DSA, however, includes a new Santee River minimum flow of 2,400 cfs for the fish passage season and 1,200 cfs for the remainder of the year.

Measures proposed by the applicant and others, including the provisions of the DSA, would likely result in some benefits to the shortnose sturgeon, but would not eliminate all project effects on the species. Therefore, the project is likely to adversely affect the endangered shortnose sturgeon.

West Indian Manatee

The West Indian manatee is federally listed endangered species. This large aquatic mammal can reach lengths of 10 feet and a weight of 1,000 pounds (FWS, 1993). They have no hindlimbs, forelimbs are modified as flippers, and tails are flattened horizontally and rounded. Although primarily herbivorous, they will occasionally feed on fish and may spend about 5 hours a day feeding (FWS, 1993). Manatees must eat 4 to 9 percent of their body weight everyday and are known to forage on water hyacinth and hydrilla and many other species of aquatic plants (FWS, 1995).

Manatees can be found in fresh water canals, rivers, estuarine habitats, and saltwater bays and concentrate in areas of warmer water between October and April. When water temperatures drop below about 21 to 22^{o}C, they migrate to south Florida or form large aggregations in natural springs and industrial outfalls. Severe cold fronts have been known to kill manatees when the animals did not have access to warm water refuges (FWS, 1993). This species has been observed at various locations within the project including the Pinopolis lock (SCPSA, 2004a). Habitat loss and collisions with motor craft are considered primary threats to manatees, which are compounded by a low reproductive potential (SCPSA, 2004a).

SCPSA proposes to install manatee exclusion devices at Jefferies lock, modify lock operations when manatees are present, and prepare a management plan for this species. As discussed above, SCPSA also proposes, and the agencies recommend developing RTE species management plans, including one for the manatee.

Our Analysis

Manatees dwelling below the Jefferies lock may make excursions into the lock system and inadvertently enter the project impoundment. Once in the impoundments, manatees could consume large quantities of hydrilla and water hyacinth and thereby help control the spread of these exotic invasive plants, but they may also consume the native aquatic plants that the SCDNR is attempting to restore in the littoral zone. Although the project reservoirs could serve as seasonal foraging grounds for manatees, human activity in the impoundment is incompatible with the manatee, thus the animals need to be prevented from migrating further upstream. Two manatee fatalities have been documented in Santee Cooper Project waters (of a total of five recorded deaths in South Carolina). Although the cause of one was unconfirmed, there is evidence that manatees have difficulty exiting the lock before the onset of colder water temperatures in the lake and likely die due to cold stress. The South Carolina Wildlife & Marine Resources Department identified two issues associated with manatees in the lock: the inability of manatees to exit the lock and the lake and return to warmer waters during the winter, and the configuration of exit culverts used to drain the lock that can trap and drown the manatee.

SCPSA has worked in coordination with SCDNR to provide measures to protect the manatee within the Pinopolis lock. In 1994, SCPSA implemented structural modifications to the Pinopolis lock as part of a scheduled lock valve rebuild. It included installing a grate at the entrance to each filling and emptying port located within the lock chamber to prevent manatees that enter the lock from becoming entrained in the chamber port during the emptying process. In addition, an operational procedure that establishes guidelines for operating the lock to prevent injury or upstream passage of manatee into Lake Moultrie was incorporated into the overall facility procedures. Lock operators are trained in the procedures, which include notifying SCDNR of any reported manatee sightings (SCPSA, 2004b).

Installation of manatee exclusion devices and modified lock operations reduces the potential for manatees to access the impoundment. These measures, however, would not entirely eliminate the potential for manatees to enter the lock and become stranded in the project lakes and experience mortalities during the winter months. Therefore, the project is likely to adversely affect the endangered manatee.

Bald Eagle

The bald eagle is a federally listed threatened and state listed endangered species in South Carolina. The bald eagle is a year-round resident in the project area.

Bald eagles' diet consists mainly of small mammals, waterfowl, sea birds, fish, and carrion. Nest sites are chosen for their proximity to water bodies such as coasts, rivers, and lakes. Nests are generally constructed in super-canopy trees such as pines, cottonwoods, oaks, and beech. Bald eagles have been reported to breed in riparian locations around Lakes Marion and Moultrie. There have been 33 separate nest sites observed in the project area between 1977 and 2002 (Mead & Hunt, 2005). The survey documented 18 nesting pairs using lands close to the lakes.

SCPSA and the agencies and interested parties propose and recommend species management plans for RTE species, including the bald eagle.

Our Analysis

The current management plans provide for the protection of RTE habitat, directly or indirectly, in the project area. The Santee Cooper Natural Area Management Plan states that appropriate measures will be taken to protect and preserve rare or endangered species, and that potential areas may support or are capable of supporting bald eagle nesting or roosting sites shall be promoted and managed for the species (SCNAMP, 2003). This would include preserving riparian habitat along the project shoreline, in particular, and preservation of dominant canopy trees that are preferred nesting and perching sites for bald eagles.

Protection of eagle habitat is also included in other land management plans implemented by SCPSA. SCPSA abides by federal regulations relating to forest management practices near eagle nest trees, which require buffer zones around nest trees during timber sales. Other means that protect nest sites include current erosion control measures that are in place for more than 96 percent of the undeveloped shoreline. Such measures minimize shoreline erosion related to reservoir fluctuations, which can threaten potential nesting, roosting, or perching trees (SCPSA, 2003a). Because of the ongoing and proposed measures to protect eagle habitat and the large amount of habitat available in the vicinity of the project lakes, we conclude that continued operation of the project is not likely to adversely affect the bald eagle.

Effects on State Listed Threatened and Endangered Species

Spotted Turtle

The Spotted turtle is listed as a threatened species in South Carolina, and it ranges from southern Maine along the Atlantic coastal plain with a westward band through Maryland into southern Michigan and Ontario. Spotted turtles are small, occurring in a variety of aquatic habitats ranging from shallow, muddy-bottomed streams, to marshy meadows and bogs, to vernal, woodland ponds. Spotted turtles are very poor swimmers and therefore are almost always found in shallow water habitats including calm, emergent wetlands along lake fringes, Carolina Bays, and forested wetlands. As a semi-aquatic species, they utilize both aquatic and upland, forested habitats during the course of their lifecycle. This species diet includes tadpoles, earthworms, fish, crustaceans, salamanders, and a variety of insects. This species was last collected about 6 miles south of Jordan, South Carolina, in 1955 (Mead & Hunt, 2005).

Spotted turtles need undisturbed, forested uplands in proximity to aquatic habitat to complete their life cycle. SCPSA's Natural Area Management Plan provides some protection to shoreline wetlands, which may provide aquatic habitat for spotted turtles. The Santee NWR also provides aquatic habitat for spotted turtles. In addition, habitat management plans for RTE species are recommended by the agencies and interested parties.

Our Analysis

As discussed previously, spotted turtles are a semi-aquatic species and require both aquatic and upland, forested habitats during the course of their life cycle. As such, they are susceptible to certain land management practices that disrupt the forest floor, as well as project operations that affect wetlands. Because spotted turtles go dormant under leaf litter and debris during the high temperature periods of the summer months, and lay their eggs in loose soil during the breeding season, ground clearing activities, logging, and recreation such as hiking can destroy eggs, nests and adults. Vehicular traffic from project operations and recreation may injure or kill turtles traveling across roads during dispersal. Finally, high visibility of turtles to the general public may lead to illegal harvesting of individuals, which is a significant threat to this species across its range. Additionally, habitat loss, particularly draining and filling of wetlands, is a concern for this species. Drawdown of the lakes during the winter may dewater wetlands and expose dormant turtles that use these areas.

Effective habitat management for this species requires sufficient baseline knowledge on their distribution and habitat use in the project area. Development of a habitat management plan would provide a coordinated mechanism for collecting, compiling, and mapping information about spotted turtle populations in the project area. This information would help identify resource-use conflicts from proposed construction, maintenance activities, and other sources of disturbance. It would also help guide

decision-making on the type of mitigation measures required to reduce or prevent adverse affects of project operations on this species.

For spotted turtles, conducting early spring surveys when basking turtles are most easily seen would provide a means to locate populations and identify habitat to be included in a habitat protection plan. Once habitat areas that support or potentially support spotted turtles has been identified, the habitat management plan could provide SCPSA and the other cooperating property owners with specific measures to protect and/or enhance the habitat for this species.

Savannah Lilliput

The Savannah lilliput is a federal species of concern and listed as state endangered in South Carolina. The Savannah lilliput is a small freshwater mussel that historically ranged from the Altamaha River system in Georgia to the Neuse River system in North Carolina (Johnson, 1970). The Savannah lilliput was originally identified within Lake Marion (Clarendon County) on November 5, 1962. A survey conducted on June 3, 2004, along an approximate 20-meter reach of the shoreline in Lake Marion in the vicinity of Santee State Park revealed 7 Savannah lilliput (Letter from Timothy Hall, Field Supervisor, FWS to Magalie Salas, Secretary, FERC, January 31, 2005). The majority of Savannah lilliput were within 1 to 1.5 feet of the water surface.

SCPSA's 2005 mussel study documented 17 freshwater mussel species present in the project area. In addition to Savannah lilliput, seven other species of federal concern were found, including: Carolina lance mussel (*Elliptio angustata*), Roanoke slabshell (*Elliptio roanokensis*), Carolina slabshell (*Elliptio congaraea*), Eastern pondmussel (*Ligumia nasuta*), tidewater mucket (*Leptodea ochracea*), yellow lampmussel (*Lampsilis cariosa*), and Rayed pink fatmucket (*Lampsilis splendida*).

Our Analysis

Lake level drawdowns have the potential to dewater mussel habitat and expose mussels. However, mussels can experience short-term exposure without adverse effects and can move into wetted habitat, if drawdowns occur gradually, as they do under the existing guide curve. Implementation of the year-round full pool, as proposed by the agencies, would limit the amount of habitat that would normally be exposed due to drawdowns and would reduce the risk of stranding during reductions in water levels.

Mesohabitat characteristics, such as water depth and velocity, also define the habitat suitability for aquatic life present in the Santee and Cooper Rivers and are determined by river flow. While flows and mesohabitat characteristics are variable within any river system, they can change rapidly due to the operation of the project, such as fluctuations on the Cooper River that occur during generation at the Jefferies station. Aquatic life, such as mussels, that cannot respond to these rapid changes may be affected due to disruption of important life history requirements or due to the lack of persistent habitat that may reduce overall habitat suitability compared to gradual flow fluctuations.

Additionally, the amount of wetted area varies based on flow, and rapid flow reductions that reduce the wetted area may strand organisms with low motility such as mussels.

Higher minimum flows at Santee dam, included in the agency alternative and the DSA, would increase the amount and quality of available mussel habitat over existing conditions on the Santee River. Habitat quality would be improved by increasing the exchange rate of water over mussel beds occurring in areas protected from high water velocity (*e.g.*, areas behind shoals). Higher minimum flows would also increase flow into side channels and behind the shoals which would increase the habitat value of these areas.

3.3.4.3 Unavoidable Adverse Effects

Continued operation of the project would result in some unavoidable adverse effects on listed species. Fluctuations in project releases would continue to affect use of habitat by the shortnose sturgeon in the Santee and Cooper rivers. Ineffective upstream and downstream fish passage facilities for sturgeon at all project facilities would continue to fragment sturgeon habitat in the Santee and Cooper rivers, and continue to expose sturgeon to entrainment mortality during passage through the project powerhouses. Bald eagle and red-cockaded woodpecker would continue to be exposed to some human disturbance and disruption of some suitable habitat. The project dams and exclusion devices will impede manatees attempting to migrate upstream to potential seasonal foraging areas, however, manatees could still gain access to the project lakes, potentially be stranded, and experience stress or mortalities.

3.3.5 Recreation Resources

3.3.5.1 Affected Environment

The Santee Cooper Project includes an estimated 179,990 acres of land and water resources with two reservoirs – Lakes Marion and Moultrie – having a combined surface area of about 160,000 acres. There is an estimated 450 miles of shoreline and over 40 miles of dams and dikes associated with the project. The affected environment includes Lakes Marion and Moultrie, about 75 miles of the Santee River downstream to the Atlantic Ocean, and about 41 miles of the Cooper River to Charleston Harbor.

The Santee Cooper region (also known as “Santee Cooper Country”) is a recreation and tourist destination, accounting for about $245 million in tourism revenue in 2003 (SCPRT, 2003) and receiving over 3 million visitor days annually (SCPRT, 2002). Boating and angling are the dominant water based activities at the project with renowned catfish, bass and crappie fisheries (see section 3.3.2, *Aquatic Resources*). Water-based activities at the project are complimented by land-based recreation activities including hiking, camping, hunting, bicycling, golfing, and tennis. During the past several decades, there has been significant growth in the population in Santee Cooper Country, about 13 percent from 1990 to 2004 (US Census, 2005), which is expected to continue in the future (see section 3.3.8, *Socioeconomic Resources*).

Existing Recreation Sites

There are multiple private, commercial and public recreation sites at the Santee Cooper Project that provide various facilities such as fishing piers, boat launches, swimming areas, scenic overlooks, playgrounds, picnic areas, and camping. Within the Santee Cooper region there is a national forest, a wildlife refuge, several parks (both county and state), and other areas of recreational significance (figure 6, Appendix 4). In addition, there are five wildlife areas, four visitor centers, 14 hunting areas, and over 100 miles of hiking trails (table 16). Other regional recreation opportunities exist at Manchester State Forest, Congaree Swamp National Monument, and Poinsett State Park, generally located northwest of the project and outside of the project boundary (SCPSA, 2004a).

The Francis Marion National Forest, comprising over 250,000 acres, is located on the southeast shore of Lake Moultrie and has camping and picnic areas, rifle ranges, a visitor center, and various hiking, biking, ORV and interpretive trails (USFS, 2005). The Santee NWR is located on the northern shore of Lake Marion. The refuge has several hiking trails, unpaved biking trails, picnic facilities, a boat ramp, and fishing access on over 15,000 acres (FWS, 2006). There are five additional wildlife areas at the Santee Cooper Project provided by SCPSA: Santee Cooper Wildlife Management Area (WMA) and Bird Island at Lake Marion, Sandy Beach and Stoney Bay at Lake Moultrie, and Old Santee Canal Park (SCPSA, 2004a).

Of the seven parks in the project area, one is a state park, four are county parks located on Lake Marion, and two, Overton and Old Santee Canal Park, are managed by SCPSA. Santee State Park covers 2,496 acres. The park provides two boat launches, 30 cabins, 163 campsites, and numerous access sites. The park has a visitor center, tackle shop, and a meeting center. Day use facilities include six picnic shelters, two tennis courts and a bike trail (SCPRT, 2005). SCPSA has developed and partnered with local county governments to provide four recreational parks on Lake Marion: Taw Caw Park, Rimini Landing, Indian Bluff Recreation area, and Spiers Landing (SCPSA, 2004a; Trail-O-Dex, 2006).

SCPSA owns and operates three recreation sites at the Santee Cooper Project: the Somerset Recreational area, Overton Park, and Old Santee Canal Park (figure 6, Appendix 4 and table 16). In addition, Robert H. Cooper 4-H camp is a SCPSA area that is maintained by Clemson University (SCPSA, 2004a).

There are 27 public boat ramps located on Lakes Marion and Moultrie including those located at the four county parks and Santee State Park, 20 of which are provided by and managed by SCPSA. One site, Eutaw Springs Landing is cooperatively managed by SCPSA and SCDNR. Duck Pond Landing was provided by SCPSA to Berkeley County, who is responsible for its management, as well as management of Dennis Landing and Spiers Landing. Lakes Marion and Moultrie are also home to 30 commercial marinas, 26 of which provide public boat launching facilities with 16 marinas charging a fee for boat launching. In addition, public boat launches are available at the Hickory Top Hunting

Area, managed by SCPSA, and at 16 other commercial operations, such as campgrounds and waterfront restaurants, 11 of which charge a fee for boat launching. There are also numerous public and private access areas providing fishing and swimming access to the lakes (SCPSA, 2004a; Santee Cooper Country, 2005).

Several trails traverse the project area. The Palmetto Trail is a multi-use recreational trail that, when finished, will extend 425 miles across the state of South Carolina from Oconee State Park to north of Charleston. Existing sections of the Palmetto Trail traverse the Santee Cooper Project. The Lake Marion Passage extends 25 miles from Mill Creek County Park along the northern shore of Lake Marion and crossing at the I-95 bridge. The Santee and Eutaw Springs Passages connect the Lake Marion Passage with the Lake Moultrie Passage and covers 29 miles from the town of Santee to the Diversion canal. The Lake Moultrie Passage extends 26 miles along the northern shore of Lake Moultrie and offers four primitive campsites (SC State Trail Program, 2005).

Lake Moultrie and Lake Marion also have a substantial number of commercial operations that support recreation on the lakes. In addition to the 30 marinas on the lakes, there are over 40 camping areas and seven organization campgrounds such as Robert H. Cooper 4-H Camp, the Coastal Carolina Council of the Boy Scouts of America, and Big Brothers Campground. There are also 24 sites providing cottage and cabin rentals, as well as, numerous resorts, hotels, and motels, some of which provide boat ramps and other recreational facilities (SCPSA, 2004a).

Table 16. Recreation sites at the Santee Cooper Project. (Source: Trail-O-Dex, 2006; SCPSA, 2004a)

Site Name	Picnicking	Hiking	Bicycling	Camping	Lodging	Sightseeing/ Wildlife Watching	Swimming	Bank Fishing	Dock Fishing	Boat Launch	Hunting	Store/Concession	Visitor's/Education Center	Restrooms	Playground/Sports Fields	SCPSA Administered Site
Lake Marion																
Santee National Wildlife Refuge																
Bluff Unit	●	●				●		●					●	●		
Cuddo Unit	●	●	●			●		●		●			●			
Dingle Pond Unit		●				●										
Pine Island Unit		●	●			●		●								
Santee State Park	●	●	●	●	●		●	●		●		●	●	●	●	
Indian Bluff Park	●							●	●	●				●	●	
Taw Caw Park	●	●				●		●		●				●	●	
Spiers Landing																
Sumter County Park (Rimini Landing)																
Eutaw Springs Battleground		●						●								
Public Boat Launches																
Low Falls Landing						●		●	●	●		●				●
Stump Hole Landing								●	●	●						
C. Alex Harvin, III Landing (Birch Branch)								●	●	●						●
John C. Land, III Landing				●				●		●		●				●

Site Name	Picnicking	Hiking	Bicycling	Camping	Lodging	Sightseeing/ Wildlife Watching	Swimming	Bank Fishing	Dock Fishing	Boat Launch	Hunting	Store/Concession	Visitor's/Education Center	Restrooms	Playground/Sports Fields	SCPSA Administered Site
(Borrow Pit)																
Log Jam Landing									●	●						●
Cathead										●						●
Calhoun Landing										●						●
Rowland Landing										●						●
Rimini Landing									●	●						●
White Oak III										●						●
Eutaw Springs Landing										●						
Sparkleberry										●						●
Wilsons Landing										●						●
Hunting/Wildlife Management Areas																
Santee Cooper Wildlife Management Area		●				●				●						●
Bird Island Wildlife Management Area		●				●					●					●
Eutaw Springs		●				●					●					●
Hickory Top		●				●				●	●					●
Bluefield		●				●					●					●
Shuler		●				●					●					●
Upper Santee Swamp		●		●		●					●					●
Islands		●				●					●					●
Camping Areas																
Clarke Island Camping Area				●												●

Site Name	Picnicking	Hiking	Bicycling	Camping	Lodging	Sightseeing/ Wildlife Watching	Swimming	Bank Fishing	Dock Fishing	Boat Launch	Hunting	Store/Concession	Visitor's/Education Center	Restrooms	Playground/Sports Fields	SCPSA Administered Site
Church Island Camping Area				●												●
Sixteen Island Camping Area				●												●
Persanti Island Camping Area				●												●
Trezevants Camping area				●												●
Santee Dam Tailrace																
Santee River Campground				●												●
Diversion Canal																
Diversion Canal and Santee Cooper Aquaculture Center	●	●				●					●		●	●		●
Lake Moultrie																
Francis Marion National Forest																
Canal Recreation Area	●	●	●			●								●		
Public Boat Launches																
Thornley Forest II Landing										●						●
West Dike										●						●
White Point Beach (Mac Flood Landing)										●		●				●
Russellville										●						●

Site Name	Picnicking	Hiking	Bicycling	Camping	Lodging	Sightseeing/ Wildlife Watching	Swimming	Bank Fishing	Dock Fishing	Boat Launch	Hunting	Store/Concession	Visitor's/Education Center	Restrooms	Playground/Sports Fields	SCPSA Administered Site
General Moultrie II										●						●
Catfish Landing										●						●
Duck Pond										●	●					●
Hunting/Wildlife Management Areas																
Sandy Beach Wildlife Management Area		●	●	●		●										●
Dennis Wildlife Center	●	●				●	●									
Hatchery Waterfowl Management Area		●	●			●		●	●	●	●					●
Greenfield		●				●					●					●
Porcher		●				●					●					●
Halls		●				●					●					●
North Dike				●							●					●
Pinopolis Dam Tailrace																
William H. Dennis Landing								●		●						
Old Santee Canal Park	●	●				●		●	●	●		●	●	●		●
Biggins-tail Race Landing (William Dennis Landing)										●						●
Wadboo Creek				●							●					●
Rediversion Canal																
Rediversion Canal		●	●			●										

Recreation Use

The Santee Cooper region supports more than 3 million visitor days each year (SCPRT, 2002). According to the most recent Form 80 recreation report submitted by SCPSA to the Commission in 2003, the Santee Cooper Project supported the following estimated recreation days (includes resident and visitor recreation days):

- Daytime annual total recreation days = 17,173,000
- Nighttime annual total recreation days = 9,101,700
- Daytime peak weekend average = 302,640
- Nighttime peak weekend average = 160,399

Visitation to the region contributes significantly to the local economy. Visitors spent over $245 million in "Santee Cooper Country" in 2003 (SCPRT, 2005). The lake fisheries contribute significantly to total recreation expenditures in the region. According to creel surveys conducted by SCDNR, anglers spent $1.9 million on fishing trips to the Diversion canal and $10.2 million on trips to Lake Marion in 1998 (SCPSA, 2004a). Currently, these lakes hold world-record channel catfish (58 pounds) and state-records for largemouth bass (16.2 pounds), black crappie (5 pounds), and chain pickerel (6.4 pounds) (Santee Tourism, 2006). Other fish species found in the Santee Cooper Lake System include striped bass, bream, white bass, blue catfish, white crappie, bluegill, and shell cracker. Many nationally-renowned bass tournaments held at the lakes such as BASS and BFL (Santee Basin, 2006).

Overall, most project-related public recreation sites appear able to accommodate current levels of recreational use with boat launches around the lakes experiencing just over 50 percent use capacity on weekends during the recreation season. The same is true for picnic areas, visitors' centers, and scenic overlooks. Camping sites typically had the highest percent use capacity with tent sites, trailer sites, group camps and cottages averaging about 70 percent use capacity. Other sites such as parks, trails, playgrounds and access areas experienced less than 50 percent use capacity on average (SCPSA, 2003b).

SCPSA's Boating Access Facilities Master Plan was published in 1992. This effort reviewed existing public boating access facilities and provided individual concept plans for improvements to meet anticipated usage through the year 2010. These improvements were reported to result in a net gain of 17 boat ramp lanes and 763 parking spaces for vehicles with trailers, which was reported to accommodate an estimated 90 percent of the expected public recreational demand in the year 2010.

Lakes Marion and Moultrie are also utilized by private landowners from shoreline properties and by patrons of marinas and other commercial establishments providing access, such as resorts. The number of docks located on the lakes was recently estimated to be about 2,660, including both private and commercial docks. Furthermore, the

number of boats registered in the five-county area has been steadily increasing. Boat registrations for Santee Cooper Country have increased from almost 31,000 in 1995 to well over 36,000 in 1999 (SCPSA, 2004a).

Water Levels

Water levels in Lake Marion and Moultrie are managed according to the Lake Marion rule curve (see section 3.3.1, *Water Resources*). During the peak recreation season, water levels at Lake Marion are 75.0 feet NGVD by March and are generally held between 75.0 and 76.0 feet NGVD (full pool elevation) until mid-October. Fall lake elevations are generally drawn down from mid-October to mid-January, with a targeted elevation of just over 72.0 feet NGVD. Spring fill begins in mid-January bringing lake levels back up to 75.0 feet NGVD by mid-March. Water levels at Lake Moultrie, which is hydrologically linked to Lake Marion by the Diversion canal, are typically between 0.2 and 1 foot lower than Lake Marion (SCPSA, 2004a). Water level fluctuations do occur; however, lake levels have been at or above full pool elevation over 75 percent of the time between March and October since 2004 (see section 3.3.1, *Water Resources*).

SCPSA maintains a flow of 500 to 600 cfs in the Santee River, a maximum weekly average of 4,500 cfs in the Cooper River, and excess flows are passed into the Rediversion canal via the St. Stephen hydroelectric station, with a minimum flow of 5,600 cfs at St. Stephen during the fish passage season, March through May. SCPSA also operates the Pinopolis lock for both boat passage and fish passage (see section 3.3.2, *Aquatic Resources*).

Currently six, 8-minute lock operations are conducted for fish passage daily during fish passage season, typically early February to late April or early May, depending on water temperatures. Locking is also conducted for navigational purposes on an as needed basis for boat navigation year-round during daylight hours and varies depending upon boat traffic. An estimated 1,235 locking events are conducted for fish and boat passage from February to September, resulting in a total requirement of 21,000 acre-feet of water. Locking events have a negligible effect on lake levels as the total combined storage capacity of the project is 529,000 acre-feet and the project receives over 11 million acre-feet of inflow annually (NHI, 2004).

The two most popular water-based recreation activities at the project are angling and boating (SCPSA, 2004a). The peak recreation season extends from April to September, when the existing guide curve targets an elevation of 75.5 feet. Although the project experienced extended drought conditions from 2000 to 2002, lake levels were at or above 75.0 feet from April to September 85 percent of the time from 2003 to 2005. Angling, from both shore and boat, occur year round (Santee Tourism, 2006). In April and May, when lake elevations are targeted for summer elevations, bass and crappie are most active. Winter drawdown also contributes to angler success as fish congregate in

deeper waters (Santee Tourism, 2006). Boating and angling access is available at all times of the year, regardless of lake level.

Conclusions from the 2003-2004 small boat navigation study indicate that for the typical baseflow from Santee dam (600 cfs), boating can be difficult in the Santee River between Santee dam and the Rediversion canal, especially above the Route 52 Bridge. Portaging and difficult boat passages occur during low water conditions such as droughts. The St. Stephen Project provides a backwater influence on this section of the river during the spring months, which increases river stage and contributes to navigability (Normandeau, 2005b).

The small boat navigation study indicated that a flow of 1,000 cfs would be sufficient to meet all SCDNR navigation guidelines at study site, Riffle 4, located about 15 miles downstream of Santee dam. Boat passage at study site, Riffle 5, located about 20 miles downstream of the dam, was provided by an existing constructed canal at a flow of 900 cfs, providing a channel that was 2 ft deep and 12 to 15 ft wide. A flow of nearly 1,300 cfs was necessary in this section to meet all SCDNR guidelines for navigability (Normandeau, 2005b).

Recreation Management

SCPSA has several programs which guide the management of recreational resources in the project area. All of these plans are components of SCPSA's existing CLMP and are discussed in detail below.

SCPSA has developed a land use classification system for project lands. Classified "recreation" lands include areas that currently provide or are reserved for future recreation opportunities. Activities prohibited on these lands include intensive forest management and agricultural uses, as well, as private residential development. SCPSA also has classified "natural areas" which are lands and waters having recreational importance, among others. These areas are preserved from development but allow low impact, non-motorized recreational uses such as hiking, fishing, and wildlife watching. SCPSA has identified and classified 205 sites as "natural areas," ranging in size from 0.5 to 700 acres, including islands, wetlands, and bluffs. Likewise, areas designated as "forested" are managed as multiple use, allow low-impact recreational activities, and are available to recreational development, if conditions warrant.

SCPSA also has in place a Lake Zoning Plan, which was implemented in 1980, that provides information on boating regulations, including "No Wake" zones, and water quality issues. The Lake Zoning Plan designates waters as one of four management zones: No Wake, Restricted, Unrestricted, and Aquatic Natural Areas. Boating is prohibited in restricted areas, either permanently or seasonally, to accommodate other recreational uses, such as swimming, and project control structures and wildlife habitats.

3.3.5.2 Environmental Effects

The project vicinity offers a wide range of recreational opportunities. As most recreational use of the project is attributed to boating and angling, project operations with respect to lake levels and downstream flows can directly affect navigation, safety, access and quality of the experience and can indirectly affect aquatic habitat, which has implications to angling activities.

With respect to support facilities for these activities, among others, data (SCPRT, 2004) indicate that most visits to the area are attributed to South Carolina residents. Some existing recreation facilities are approaching capacity (SCPSA, 2003b) and accommodations for future use levels will need to be addressed.

Effects of Project Operations on Access, Navigability, and Existing and Future Recreation Sites

Several operational measures have been proposed by SCPSA, the agencies and other stakeholders, which may have ramifications for access and navigability.

Lake Levels and Navigation

SCPSA proposes to maintain lake levels according to the existing guide curve as described in see section 3.3.1, *Water Resources*. As a result, the proposed action does not constitute a change from existing conditions with respect to lake levels. SCPSA also proposes to increase the number of locking events to a minimum of six per day as well as implement attraction flows, for fish passage at Pinopolis lock.

Agencies and interested parties have recommend an alternative to the existing guide curve such that full pool elevation would be extended to include the months of December through February. As discussed in *Water Resources*, lake levels are currently targeted between 75.0 and 76.0 feet NGVD from mid-March through mid-October. Since lake levels already target at least 75.0 feet NGVD by mid-March, full pool would essentially be held from December through mid-October of every year under this recommendation, with only a brief fall drawdown occurring from mid-October to the end of November. Agencies and interested parties also recommend a decrease in locking operations to preserve lake levels.

The DSA includes a provision to remove snags and stumps from Jack's Creek in order to clear a public marked navigation channel providing access to Lake Marion.

Our Analysis

Proposed Action

Under the existing guide curve, the lake level in Lake Marion is maintained at about 75.5 feet during the peak recreation season of April to September, with the lake level of Lake Moultrie typically maintained between 0.2 and 1 foot lower than Lake

Marion (SCPSA, 2004a). Although the project experienced extended drought conditions from 2000 to 2002, lake levels were at or above 75.0 feet from April to September 85 percent of the time from 2003 to 2005. Continued implementation of the guide curve would maintain existing conditions, which contributes to the 17 million recreation days supported by the project, and would not increase or decrease the effects of project operations on recreational access and navigability. The formalization and potential increase in locking events for fish passage is not expected to have a significant effect on lake levels (see sections 3.3.1, *Water Resources*, and 3.3.2, *Aquatic Resources*).

Agency and Interested Party Alternative

The agency recommendation to provide higher lake levels beginning in December is not expected to provide significant additional benefits to lake access and navigability because the extended full pool elevations fall outside of the peak recreation season, April through September. This alternative would provide higher water levels in the winter, which would have the potential to enhance winter angling and waterfowl hunting opportunities. In addition, CCL and American Rivers recommend similar adjustments to the guide curve to achieve full pool earlier, in order to allow improved public access to Upper Santee Swamp during typical draw down. Although not specific in level, duration, and schedule, it is assumed that this recommendation would be addressed by the revised rule curve recommended by agencies described above. As such, the effects on navigation and access are expected to be the same; some enhanced access to Upper Santee Swamp and improved opportunities for waterfowl and other game hunting in the winter. However, as previously discussed, this would occur outside the peak recreation season and thus would not likely provide significant overall benefits to recreational access and navigability. Furthermore, elimination of the spring drawdown would not provide sufficient storage for flooding flows, which could have significant consequences to erosion, aquatic and terrestrial habitats, and cultural resources. As discussed in section 3.3.1, *Water Resources*, locking operations do not significantly affect lake levels, even during the peak recreation season.

DSA Alternative

The development of a new navigational channel through Jack's Creek would involve removing snags from the river channel and setting channel markers for identification. Jack's Creek is located adjacent to the Santee NWR and flows into Lake Marion. Steven's Creek connects Jack's Creek to Lake Marion and traverses between Santee NWR owned property. According to FWS, significant amounts of boat traffic use Steven's Creek as a "shortcut" to the lake causing disturbances to Santee NWR waterfowl. Because Jack's Creek is deeper and located adjacent to but not within the Santee NWR, a navigation channel in this area has the potential to alleviate disturbances to waterfowl and wildlife while providing a better and safer navigation channel to boaters. However, creation of a channel in Jack's Creek may not reduce the boat traffic

experienced in Steven's Creek. In addition, a formal, marked channel in Jack's Creek may increase overall use in that area, which is within proximity of the Santee NWR. If the creation of a channel in Jack's Creek does not alter use of Steven's Creek and in fact, attracts additional users to the area, disturbances to waterfowl and wildlife could still occur.

Downstream Flows

SCPSA proposes to provide continuous flows at St. Stephen (5,600 cfs from February 1 until April 15th), a continuous minimum flow of 500 cfs at Santee dam, a weekly average flow of 4,500 cfs at Jefferies station, and increased locking operations at Pinopolis lock for fish passage.

Several agencies and interested parties recommend an alternative minimum flow regime that has the potential to affect recreational use of the Santee River. The alternative minimum flow regime is described in detail in section 3.3.1, *Water Resources*, and would involve an increase in minimum flows below Santee dam to 1,600 cfs, or to 25 to 30 percent of inflow, less obligations to Jefferies and St. Stephen, which would remain unchanged. The agency and interested party alternative also includes an Adaptive Management Program to assess the effectiveness of the recommended flow regime for navigation, among other goals.

The DSA also includes an alternative Santee River minimum flow of 1,200 cfs during the peak recreation season (Memorial Day to Labor Day) with higher flows (2,400 cfs) during the fish spawning season of February through April, along with additional fish attraction flows at Pinopolis lock.

Our Analysis

Proposed Action

SCPSA is proposing to formalize its recent voluntary practice of providing a minimum flow of 5,600 cfs from the St. Stephen station from February 1 to April 15th. Providing this flow into the Rediversion canal would result in improved navigation in the Santee River downstream of the Rediversion canal compared to existing license conditions. However, this improvement would occur outside of the peak recreation season. In addition, the two sites on the Santee River identified as having navigational issues would not appreciably benefit from the fish passage flow at St. Stephen because these sites are upstream of the confluence with the Rediversion canal, although some backwater effects occur upstream of the confluence from higher flows out of St. Stephen.

Locking events between February and September, for fish and boat passage, result in downstream intermittent flows ranging from 400 to 1,500 cfs. Because these flows are intermittent and only occur during drafting of the Pinopolis lock, there are no discernable effects on downstream recreation activities. Although SCPSA is proposing to formalize

fish passage locking operations at a minimum of 6 per day, these locking events would essentially be the same as current frequencies and durations and would not result in changes in navigation, safety, access, or recreational opportunities on the Cooper River.

Agency and Interested Party Alternative

The increase in minimum flows downstream of Santee dam recommended by agencies and interested parties would be beneficial to downstream recreation. The Small Boat Navigation Study, conducted in 2004, modeled the instream flows necessary to achieve SCDNR navigation criteria at two locations identified as having navigational issues. A minimum flow of 1,600 cfs would be more than sufficient to meet SCDNR criteria, which would be met with a flow of 1,300 cfs. Because agency recommended flows to the river are based on percentage of inflows and could actually exceed 1,600 cfs, these higher flows could result in conditions that would be more hazardous to navigation. Higher velocities and turbulence/eddies may present safety issues with respect to navigation for some types of smaller boats. Higher flows, however, would likely benefit fisheries in the bypassed reach (see section 3.3.2, *Aquatic Resources*), which would have direct positive effects on angling opportunities in the river.

In addition to the two sites evaluated for navigability relative to SCDNR criteria, there are three recreation sites downstream of Santee dam that have the potential to be affected by increases in minimum flows. Wilson's Landing has a boat launch and bank fishing area that may be partially inundated under higher flows or experience higher water velocities, thereby potentially affecting safe access to the river. The Bluefield WMA, which provides hunting opportunities on 788 acres, and the Santee River Camping Area are also downstream of the dam, adjacent to Wilson's Landing. The Bluefield WMA and Santee River Campground may be affected by higher water levels if shorelines within the WMA and campground are inundated under higher flows, or are subjected to higher water velocities and erosion. This may negatively affect safe access and opportunities for waterfowl hunting.

Generally during average water years, there are sufficient inflows to the project to accommodate a minimum flow of 1,600 cfs year round below Santee dam, with relatively minor deviations. Although a minimum flow of 1,600 cfs would improve navigation for that section of the Santee River between Santee dam and the Rediversion canal, dry years would not have sufficient inflows to accommodate such a recommendation. The Adaptive Management Program would allow for a clear definition of the ecological and navigational objectives for downstream flows, allowing Santee Cooper to identify whether or not these objectives are being met, and allow for an alternative flow regime in the event that these objectives are not being met. The program would provide a means to identify alternatives during dry years when downstream flow obligations and objectives for recreation and aquatic habitat are difficult to meet.

DSA Alternative

The increase in minimum flows downstream of Santee dam included in the DSA would also benefit downstream recreation by alleviating navigational issues associated with flows less than 1,000 cfs in the bypassed reach. The Small Boat Navigation Study (2004) identified a flow of 1,000 cfs as providing sufficient inundation for through navigation of the Santee River downstream of the dam, with a minimum flow of 1,300 cfs required to meet all SCDNR guidelines for boat passage. A minimum flow of 1,200 cfs would be adequate for boat passage and would be close to meeting all SCDNR criteria, while seasonal flows of 2,400 cfs would be more than sufficient to accommodate navigation. As with any of the minimum flow alternatives, flows could actually exceed the minimums during periods of high inflows, resulting in potentially unsafe or hazardous conditions, but those flows would typically be beyond the control of SCPSA.

As with the increased minimum flows proposed by the agencies and interested parties, Wilson's Landing, Bluefield WMA, and Santee River Campground may be affected by higher water levels if shorelines are inundated under higher flows and/or are subjected to higher water velocities. This may negatively affect access, safety, and opportunities for water-based and shoreline recreation at these sites.

Generally during average water years, there are sufficient inflows to the project to accommodate a minimum flow of 1,200 cfs from May through January and 2,400 cfs from February through April below Santee dam, with relatively minor deviations. Although this minimum flow regime would improve navigation and fish habitat in the bypassed reach, dry years would not have sufficient inflows to accommodate such flows.

The proposed increased attraction flows at Pinopolis lock are unspecified in the DSA and therefore, the precise effects of any such increased flows can not be predicted. However, it is unlikely that these flows would exceed the typical discharge from the lock (the agencies' initial recommendation was for an attraction flow of 600 cfs), and would therefore have little effect on navigation, access, or recreation on the Cooper River downstream of Pinopolis lock.

Adequacy of Public Access to the Project

Cordell et al. (2004) reports that, "Population has been, is, and will be the major driver of outdoor recreation growth in this country." National trends of participation in outdoor recreation show significant increases in camping (37.9 percent), boating (31.8 percent), and fishing (27.7 percent) between 1995 and 2001 (Cordell et al., 2004). Participation in other types of outdoor activities exhibit similar trends.

The population of the counties around the lakes increased by 11.1 percent between 1990 and 2000 and is projected to increase by about another 21.7 percent by the year 2025 (SCBCB, 2005). If participation in recreation increases at the same rate, an

increase in demand for recreation sites would be expected in the future, including those sites which are estimated to be approaching capacity under current use levels.

Shoreline Management Plan

SCPSA has several management plans and practices in place that have the potential to affect existing and future recreational use of the project, both positively and negatively. The existing CLMP serves as SCPSA's guiding document for managing recreational use of the project lands and impoundments. Contained within the CLMP are management plans for various land use classifications identified under the CLMP such as "recreation," "natural areas," and "forest management areas." The CLMP also contains SCPSA's Lake Zoning Plan which provides boating regulations and management guidance.

Agencies and interested parties recommend the development and implementation of a comprehensive shoreline management plan. This plan would undergo a review and update process every 10 years.

Our Analysis

SCPSA would continue to manage Santee Cooper project lands and recreational use of project waters through its CLMP. Existing permitting and shoreline management programs contained in the CLMP could affect recreation resources in the project area. The existing permitting program includes provisions for regulating the construction and maintenance of shoreline access facilities such as docks, ramps, boathouses, etc. These regulations ensure that venues of access are provided in a safe manner and do not represent obstacles to navigation.

The existing CLMP also has the potential to protect the scenic views around the lake, such as through provisions for set back and buffer zones for lands designated as "residential" and requirements for the consideration of visual resources in permitting structures on lands classified as "commercial" (see section 3.3.6, *Land Management and Aesthetic Resources*). Maintaining the aesthetic quality of the project shoreline can contribute positively to the recreation experience.

As many of the typical measures of a shoreline management plan are contained within SCPSA's existing CLMP, the development and implementation of a new shoreline management plan would not constitute a significant change over existing land and recreation management conditions at the project. However, there are no provisions for periodic review and update of the CLMP, with exception of the Lakes Zoning Plan and Shoreline Erosion Control Plan contained within the CLMP. Furthermore, the CLMP currently lacks outreach efforts and programs that qualify as public education undertaken by SCPSA. Informing the public of how and where project resources may be used is an important means of managing public access.

To the extent that "recreation" and "natural areas" lands are available for future recreational uses and development, recreation at the project could be enhanced by providing new opportunities or opportunities in additional locations. Although the Lake Zoning Plan contained within the CLMP restricts boating activities in certain areas of the lakes, other recreational activities such as swimming, fishing, and hunting either directly or indirectly benefit from such restrictions by providing enhanced opportunities, limiting user conflicts, protecting aquatic and terrestrial habitats, and improving boater safety.

Recreation Management Plan

SCDNR recommends review and periodic update of a project Recreation Management Plan (RMP), in consultation with appropriate state and federal agencies. An RMP would identify and provide for future public access to project lands and waters in order to accommodate population growth, commercial businesses, tourism, development and changing recreation patterns of use.

Our Analysis

Planning for future recreational needs is not specifically addressed by any existing SCPSA management documents, including the CLMP, though lands that can potentially be developed for future recreation sites are classified under this document. Future recreation needs are also not addressed specifically for the Santee Cooper Project area in the South Carolina SCORP. An RMP would provide a method for monitoring public access needs over time and, in coordination with required FERC Form 80 filings, consider trends in use, multiple types of use (e.g., camping, swimming, sightseeing, boating, fishing, etc.) population growth, and development. Results could be used to identify and plan for future access and facility needs.

Although the SCDWRM and USCG are responsible for the enforcement of boating regulations on the lake, an RMP would compliment SCPSA's Lake Zoning and Public Safety Plan. The RMP could provide a means for utilizing this information to manage access to the lake and the river such that future development is located in appropriate areas and at appropriate levels. This would benefit both recreationists and resources by permitting development in areas of lower recreational use density that can accommodate the additional public and/or private access, and prohibiting further development in locations where boater density is heavy and safety issues are of concern. Although SCPSA has no control over where boaters go once they are on the water, dispersing access to the water would be expected to somewhat alleviate density constraints in some areas.

Additional Recreational Facilities

In addition to existing management plans, SCPSA proposes to provide an additional classroom at Old Santee Canal Park; provide additional picnic shelters and paved parking at Overton Park; construct a two-lane boat launch at Richard Landing at

White Point (currently under construction); and install aluminum mooring piers at Thornley (including any required excavation), Low Falls, Calhoun, and Biggins.

SCDNR also recommends several recreational improvements, in addition to those proposed by SCPSA. SCDNR recommends improved bank fishing access and parking on the Diversion canal, in the Pinopolis dam tailrace, below Wilson dam, the Duck Pond Access off Highway 6, and the Old Highway 301 causeway and bridge; an additional boat navigation channel across Lake Marion; and enhanced channel markers.

The Forest Service has recommended the designation of Polly-Cantey Bay as a "natural area" under the existing CLMP. Under this classification, this section of Lake Marion would be subject to development restrictions and limited public access, among other protections. The DSA also includes recreation improvements to Santee NWR. Specifically, the DSA includes a provision for the expansion of an elevated photo blind/bird observation structure on the Wrights Bluff nature trail.

Our Analysis

The above actions together would enhance and maintain recreation opportunities in the project area and enhance the capacity of the project overall to accommodate increasing use levels in the future. To the extent that "natural areas" are available for low impact recreation, recreational opportunities in the project area would be enhanced by additional lands available for such activities. We address the additional recreation facilities recommended by the SCDNR, Forest Service, and FWS in section 5.0, *Conclusions and Recommendations*.

3.3.5.3 Unavoidable Adverse Effects

Shoreline development, and its impacts on recreation access and use at the project, would continue, but would be regulated and limited somewhat by the provisions of the CLMP.

3.3.6 Land Management and Aesthetic Resources

3.3.6.1 Affected Environment

The project extends about 57 miles from the confluence of the Wateree and Congaree rivers through the Santee River floodplain to the southeastern end of the project near the village of Moncks Corner. The project includes about 400 miles of shoreline on the two lakes, and islands comprising about 2,700 acres lie within the two lakes. The project area includes about 19,989 acres of lands.

Under SCPSA's CLMP, there are currently six different categories of land use, and three areas that have been designated for different proposed uses in the project area.

Land use categories include Residential, Commercial, Recreation (quasi-public), Natural (including islands), Forest Management, and project lands. More than one-half of the lands within the project are designated as Forest Management, over one-fifth of the lands within the project are designated Natural areas, and nearly ten percent of the lands within the project are designated Recreation (actual and proposed) areas. As a result, over 83 percent of the lands within the project are either undeveloped or minimally developed.

SCPSA also leases lands for both residential and recreational uses. Within the project boundary, SCPSA holds 40-year leases on seven residential subdivisions. In addition, SCPSA holds leases to 44 other residential subdivisions that border the project and has 30-foot buffer strips within the project boundary. Lots within the residential subdivisions are offered for public sale on a first-come, first-serve basis. Within the seven subdivisions located entirely within the project boundary, there are 429 individual lots and 14 public access areas. In addition to the residential subdivisions, SCPSA leases 49 commercial sites to Public Recreational Use Area Operators on both lakes. SCPSA has also placed a permanent nondevelopment conservation easement on about 2,600 acres of its Wadboo Creek property adjacent to the Cooper River and conveyed the easement to the Lord Berkeley Conservation Trust in 2002.

Regional Land Use Plans

Each of the five counties that border on Lakes Marion and Moultrie has planning and zoning departments that exercise some degree of regulatory authority over land use. In none of these counties, however, are there land use classifications, zoning overlays, or management districts that are oriented specifically toward the lakes. Instead, lands that border on either Lake Marion or Lake Moultrie are integrated into the county's overall zoning system.

Lake Moultrie lies entirely within Berkeley County. The largest portion of the land that abuts the project boundary in Berkeley County has been designated as Flex 1, which is defined primarily as an agricultural use area. Other uses that may be permitted within these areas include recreation, institutional (schools, churches, government offices), and residential. All of these uses, however, are intended to supplement the agricultural use of the area rather than supplant it. Other zoning designations surrounding Lake Moultrie include residential (single family, manufactured home, and large-scale multifamily), exempt government, and general commercial.

Calhoun, Clarendon, Orangeburg, and Sumter Counties border Lake Marion, and only Sumter County has zoning maps available. Based on these maps, the entire area within Sumter County that borders on Lake Marion is zoned for agricultural conservation. According to the Sumter County Comprehensive Land Use Plan map, the area bordering on Lake Marion is designated as Conservation Preservation.

Current Management of Project Lands

SCPSA currently uses several documents to guide land use management of project lands. The CLMP is an overarching document that defines the different categories of land uses at the project, outlines the principal land use issues, identifies the publicly-accessible recreation areas and boat launch sites, and outlines the general permitting policies. In addition, there are documents that provide more specific guidance for particular land use categories: Natural Area Management Plan, Forest Management Plan, Shoreline Erosion Control Plan, Lakes Zoning Plan, and the Santee Cooper Lakes Boating Access Facilities Master Plan.

SCPSA's Inspection and Compliance Program was initiated in 1976 as a way to comply with regulations and policies developed by the Corps, the Commission, other state and federal agencies, and SCPSA itself. The permitting program is aimed at two different categories of developments: land-based and water-based. The land-based permit requirements are focused upon the SCPSA subdivisions, described above, and call upon applicants within the subdivisions to submit plans for the construction of new buildings and structures, and improvements or modifications to existing structures. This includes provisions for permanent residences, mobile homes (where they are permitted), accessory buildings, and fences. The subdivisions and the individual lots are governed by restrictive covenants and easements attached to the deeds. These covenants provide for the type and minimum size of buildings that may be erected on the lots, and the minimum required setback (30 feet from the streets and, if applicable, 75 feet from the maximum elevation of the impoundment). Moreover, these covenants require of the lot owners that they have any plans for new buildings, or improvements to existing buildings, reviewed by SCPSA, including both site plans and building plans.

Permits for new construction within the SCPSA subdivisions as defined in the CLMP also include provisions for erosion control and vegetative buffers. While not defined in the CLMP, the Natural Areas Management Plan notes that rip-rap and vegetation are the preferred methods for erosion control. In addition, the permit regulations require that, when applicable, no tree above 20 inches in height or above 8 inches in diameter will be removed within 30 feet of the shoreline, unless it is diseased, dead, or damaged. Above this 30-foot vegetative buffer zone, no trees are to be removed without specific approval from SCPSA. SCPSA is obligated to consider the effect of any tree removal on scenic, aesthetic, and environmental values.

The water-based permit regulations require land-owners to secure approval for the construction of new piers and docks, boat ramps, marine railways, retaining walls, bulkheads, boathouses, and boatlifts, and for any proposed dredging operations. These requests for water-based permits require a review by SCPSA and by the adjoining property owners. In addition, depending on the type of resources that may be affected, the property owner may be required to submit their plans for review by the South

Carolina Institute for Anthropology and Archaeology, FWS, and SCDNR. Finally, permits for dredging or beach nourishment require permits from the Corps and the SCDHEC.

Permit guidelines place size restrictions on all piers and docks and floatation materials, and require a minimum setback from adjoining property lines. In addition, permit guidelines for boat ramps place restrictions on the type of materials that can be used and a minimum set-back from adjoining lots, and require that vegetated wetlands be avoided to the extent possible.

Floodplains

The project is located within the Santee River floodplain. One-hundred year floodplains exist within the banks of the reservoir or close to the project boundary throughout the Santee Cooper Project. Higher incidences of floods are located at the Santee River floodplain immediately downstream of Santee dam, in low wetland areas around Angel's Cove on Lake Moultrie, and on the south shore of Lake Marion east of the village of Eutaw Springs.

Aesthetics

Aesthetic resources at the project are focused on the shoreline of the lakes. The project contains about 400 miles of shoreline on the two lakes. The two lakes are surrounded by swamps, minor ridges, and Carolina Bays. Much of the lake shores are undeveloped and are typically wooded.

Shoreline development on the two lakes is limited, with a mix of residential subdivisions, commercial buildings (including marinas), and boat launches. Much of the residential development has taken place on the coves of the downstream portion of Lake Marion and on selected shorelines of Lake Moultrie, while the bulk of the commercial development is located on the downstream portion of Lake Marion and the upstream portions of Lake Moultrie. Given the relatively level terrain, much of the southern portion of Lake Moultrie consists of the dikes that help to form the lake, and those dikes drop off significantly from the shoreline.

Downstream of the project dams are the Santee and Cooper rivers. Both rivers have relatively little development within the project area. Moreover, the Cooper River receives enough water to maintain its visual sense of a river. The Santee River, however, receives relatively little water, resulting in a much smaller than normal channel width. This effects the aesthetic character of the Santee River portion of the project.

The aesthetic quality of the lake is affected by shoreline modifications such as boat docks, ramps, and seawalls and breakers and by residential and commercial development near the shoreline, along with the loss of vegetative cover. Reservoir levels also significantly influence the aesthetic experience of visitors. SCPSA has policies

regulating land use at the project that guide its operation for both hydroelectric power generation, recreation, and flood management. Although the applicant has not developed any formal visual criteria with respect to shoreline management, aesthetics are an implicit component of the various land management plans.

3.3.6.2 Environmental Effects

Effects of Project Operations on Land Use

Land Management Plan

SCPSA currently manages land within the project under the terms of CLMP, with subsidiary documents that provide specific guidance for particular types of land or land use issues. SCPSA has proposed to alter the CLMP to address areas identified as potential habitat for protection for rare, threatened, and endangered species within the project boundary.

Our Analysis

The CLMP, with its subsidiary land management plans, was included in the application for new license and is comprehensive as it was presented. As described more fully above, the documents address the various types of land uses within the project and actions that are appropriate within each type. The plans have not yet, however, been formally reviewed by the appropriate state and federal agencies.

Polly-Cantey Bay on Lake Marion

The FWS recommends that the Polly-Cantey Bay on Lake Marion be designated as a Natural Area under SCPSA's land-use classification system. Polly-Cantey Bay is located adjacent to the Dingle Pond Unit of the Santee NWR, and as a wading bird rookery is connected to FWS' mission to manage lands for migratory waterfowl.

Our Analysis

Classification of Persanti Island and Polly-Cantey Bay as a Natural Areas would make them subject to development restrictions and limited public access. Land use practices for Natural Areas restricts development, dredging or excavation, but encourages measures to enhance wildlife habitat, prevent erosion, and limit human-caused degradation. Such restrictions would reduce the land available for development, but would provide protections for wildlife as discussed in sections 3.3.3, *Terrestrial Resources*, and 3.3.4, *Threatened and Endangered Species*.

Persanti Island

The FWS recommends that the habitat on Persanti Island be actively managed to maintain, protect, and enhance the endangered red-cockaded woodpecker clusters.

Our Analysis

Persanti Island already is identified in the Natural Area Management Plan as a Natural Area. The recommendation by FWS includes only the addition of active management of the island, not a change in its classification, thus no effect on land use is expected.

Shoreline Management Plan

Agencies and interested parties recommend that a comprehensive shoreline management plan be updated every ten years. Among the CLMP and associated documents, only the Shoreline Erosion Control Plan includes a reference to review and, if necessary, revision every five years.

Our Analysis

Many of the measures typically included under a shoreline management plan are contained within SCPSA's existing CLMP, therefore development and implementation of a shoreline management plan would not constitute a significant change over existing land management practices at the project. While the Shoreline Erosion Control Plan contains a provision for updates every five years, there are no provisions for periodic review and update of the CLMP. Revising the CLMP and related programs, in consultation with resource agencies, could include a provision to allow for an adaptive approach to future land use activities at the project. A shoreline management plan could also provide for outreach efforts and programs that qualify as public education to actively inform the public of how and where project resources may be used and manage public access.

Many of the measures typically included under a shoreline management plan are contained within SCPSA's existing CLMP, therefore development and implementation of a shoreline management plan would not constitute a significant change over existing land management practices at the project. While the Shoreline Erosion Control Plan contains a provision for updates every 5 years, there are no provisions for periodic review and update of the CLMP. Developing a shoreline management plan, which incorporates the CLMP and related programs, could include a provision for an adaptive management approach to future land use activities at the project. A shoreline management plan could also provide for outreach efforts and programs that qualify as public education to actively inform the public of how and where project resources may be used and manage public access.

Effects of Project Operations on Aesthetic Resources

The minimum flow releases that SCPSA proposes to provide, and those that agencies and interested parties recommend, are designed primarily to improve aquatic habitat, water quality, and recreational navigability. However, such flows could affect the aesthetic qualities of the Santee River.

Our Analysis

SCPSA has not developed any formal visual criteria with respect to shoreline management under the existing CLMP. However, aesthetics are an implicit component of the various land management plans for Lakes Marion and Moultrie. Adherence to the CLMP and its subsidiary plans would help to maintain an appropriate balance on the shoreline aesthetics and restrain developments that would detract from the visual setting of the lakes.

The aesthetic qualities of the Santee and Cooper rivers downriver of the project are not specifically considered under the existing land management programs. Flow releases through Pinopolis dam on the Cooper River and the Santee dam on the Santee River are not regulated for aesthetic purposes. However, enough water is released from Pinopolis dam to maintain the Cooper River in a fully watered state, which helps to preserve its aesthetic qualities of the river downstream. A relatively low amount of water is currently released from Santee dam into the 37-mile bypassed reach of the Santee River between the dam and the Rediversion canal, compared to the historical flow of the river. Under the current releases from Wilson (Santee) dam, the Santee River bypassed reach has the characteristics of a much smaller river, and much of the original shoreline of the river has been covered by dense shoreline vegetation that has been allowed to encroach on the channel.

The proposed and recommended higher minimum flows would result in a more "bank-full" appearance for the bypassed reach, potentially improving the aesthetic qualities of the reach. Likewise, maintaining water levels at the normal "full-pool" levels in the impoundments during the winter months would provide a more "full-lake" appearance than during the existing winter drawdown. However, eliminating the drawdown would limit the ability of the project to accommodate higher levels of inflow typical of later winter and early spring as discussed in section 3.3.1, *Water Resources*.

3.3.6.3 Unavoidable Adverse Effects

None.

3.3.7 Cultural Resources

3.3.7.1 Affected Environment

Project History Overview

In 1926, the Federal Power Commission issued a 50-year license for a proposed small hydroelectric plant to be constructed in conjunction with a proposed steamship canal between the Santee and Cooper rivers. In 1934, Congress passed a bill to finance the project, and the state of South Carolina passed enabling legislation the same year that created the Santee Cooper Project. Using funds through the Public Works

Administration, work on the much-enlarged hydroelectric project began in 1938. The original project was completed in 1942, but in 1950 the Santee Spillway Hydroelectric Station was added (Mead & Hunt, 2003).

Archaeological Resources

The APE for cultural resources consists of the project boundary, including the easement that exists around the project, varying in size from 30 to 75 feet above full pool elevation of both Lakes Marion and Moultrie. Bailey and Baluha (2003) noted that 94 previously recorded archaeological sites lay within the APE. Many of these previously recorded sites were identified by amateur archaeologists, who frequently provided only minimal location information. Most of the previously identified archaeological sites are located on landforms that overlook water, such as ridges, ridge-noses, interstream divides, terrace edges, and bluffs. These 94 sites include 60 that contained exclusively pre-contact sites, 10 that contained exclusively post-contact sites, and 24 that had either multiple components or whose age was not determined.

Only 28 of the 94 archaeological sites had been evaluated in terms of the National Register of Historic Places (National Register) prior to Bailey and Baluha (2003). Three of these sites are listed on the National Register, 1 is eligible, 12 are potentially eligible, and 12 are not eligible. The remaining 66 sites had not been evaluated for the National Register.

The combined shoreline of Lakes Marion and Moultrie and the shoreline of the various islands in the two lakes contain about 400 miles. Of this, about 111 miles are developed for residential, commercial, or industrial uses, or are occupied by dams or dikes; these areas have a low potential to contain archaeological resources given the soil disturbance. Bailey and Baluha (2003) conducted a sample survey of 96 miles of shoreline, which represents 33 percent of the undeveloped shoreline and islands; much of this surveyed area was within the Santee NWR.

Bailey and Baluha (2003) revisited and verified the locations of 7 of the previously identified sites, and recorded 50 new archaeological sites and 10 isolated finds. Of the 50 new sites, 18 were located in areas that have experienced erosion. These sites were not evaluated for eligibility to the National Register, as the level of survey that would be required to make such an assessment would require surveying lands that are on private property outside of the project boundary.

Above-Ground Resources

The APE for above-ground resources includes those buildings and structures that are outside the project boundary but that are historically and operationally part of the functioning of the project. Several above-ground resources have been evaluated for the National Register. In 1989, during an archaeological survey of Berkeley County, the Jefferies powerhouse and the Pinopolis lock were recommended eligible for the National

Register. In addition, the Cooper River Historic District initially included the Jefferies powerhouse, Pinopolis lock, and tailrace canal as contributing elements. However, the district boundary has since been revised to exclude the Santee Cooper Project.

Mead & Hunt (2003) evaluated the above-ground resources that are associated with the development of the project. Its report recommended the creation of a Santee Cooper Hydroelectric Project Historic District. The following components contribute to the eligibility of this district:

- Pinopolis dam
- Jefferies powerhouse
- Pinopolis lock
- West dam
- West dike
- East dam and East dam extension
- Santee North dam
- Santee South dam
- Diversion canal
- Tailrace canal
- East dike
- North dike
- Auxiliary buildings
- Santee dam
- Santee Spillway Hydroelectric Station
- Santee spillway
- Lake Moultrie
- Lake Marion

The survey concluded that the Jefferies Steam Plant is not eligible for the National Register. In addition, the Atlantic Coast Line Railroad Lift Bridge, which spans the tailrace canal near Pinopolis lock, is eligible for the National Register.

Areas of Tribal Concern

The archaeological record indicates that the area through which the Santee and Cooper rivers flow has been inhabited by Native Americans for nearly 10,000 years. There was a very clear and strong presence of Native Americans in the inner coastal plain of South Carolina when European explorers first entered the region and it continued well into the period of European settlement. This presents a well-justified traditional connection on the part of Native American groups to the land that includes the project area.

Under the terms of section 106, the Commission is obligated to seek out any federally recognized Indian tribe that can demonstrate a traditional cultural or religious connection to land under its jurisdiction and to involve it in the decision-making process. Traditionally, the applicant has consulted with the Catawba Indian Nation, based in Charlotte, North Carolina, and in turn the Catawba Indian Nation has expressed an interest in the project area. While no changes are being proposed that would adversely affect any archaeological resources, the Catawba Indian Nation is expected to have an interest in the continued operation of the project and its potential to affect cultural resources. On September 27, 2004, in a letter to the Bureau of Indian Affairs, the Commission announced that it intended to consult with the Catawba Indian Nation.

Under the requirements of section 106, the Commission will continue to seek consultation with the Catawba Indian Nation in the development of the PA and the HPMP.

3.3.7.2 Environmental Effects

Section 106 of the NHPA (16 U.S.C. 470 et seq.), (as amended), requires the Commission to take into account the effect of any proposed action on properties listed in, or eligible for listing in, the National Register within that project's APE. If the Commission determines that the undertaking may have adverse effects on properties listed in or eligible for listing in the National Register, the Advisory Council on Historic Preservation (Advisory Council) must be afforded the opportunity to comment on the undertaking. Section 106 also requires consultation with any Indian tribe that may attach cultural, religious, or aboriginal ties to the project area.

For the purposes of analyzing effects in this draft EIS, the APE for the Santee Cooper Project is (a) lands enclosed by the project boundary as delineated in the existing license, as well as associated structures that are functionally, historically, structurally, or spatially connected to the project; (b) upland areas included within the upland easement held by the applicant, as described above; and (c) lands or properties outside the project boundary where project operation, recreational development, habitat improvement projects, or other project-related development or use may cause changes in the character or use of historic properties, if any historic properties exist.

In this section, we highlight the particular management measures that SCPSA and agencies and interested parties propose to prevent or otherwise address any potential project-related adverse effects on cultural resources within the project's APE. We also provide our own analysis on what measures would ensure that project-related effects on historic properties would be adequately resolved for the term of a new license.

Effects on Properties Included in or Eligible for Inclusion in the National Register

Archaeological and historic sites in areas that experience human interaction, development, and other disturbances are vulnerable to erosive effects of pedestrian and other traffic and ground disturbance, as well as the effects of unauthorized artifact collectors. Recommended measures to reduce or mitigate these effects are discussed below.

SCPSA proposes to manage historic properties by implementing a Programmatic Agreement (PA) among the Commission, the SHPO, and the Advisory Council. Implementation of the PA would be accomplished through the development of an HPMP for the management of historic properties with the Santee Cooper Project's license boundary. The PA would also include procedures for the interim management of historic properties at the project during the period between the issuance of a new license and the approval of the HPMP. The HPMP would be based on the existing cultural resources surveys that were completed as part of the licensing process (Bailey and Baluha, 2003; Mead & Hunt, 2003) in consultation with the SHPO.

Documents filed with the application for new license include statements from the SHPO regarding the content of the proposed HPMP. These comments included a SHPO recommendation that the HPMP include a monitoring program for erosion, looting, etc. The monitoring program would include both eligible and potentially eligible archaeological sites that are identified now or in the future, and, with the proper training, could be completed by personnel that are already completing monitoring activities for other purposes.

Our Analysis

The development and implementation of an HPMP and PA for the general management of historic properties would have a beneficial effect upon historic properties along the shoreline of Lakes Marion and Moultrie. The PA would obligate SCPSA to consider effects on historic properties when evaluating additional developments at the project proposed either by SCPSA or requested through the land management permitting process. The HPMP would provide operational guidance to SCPSA staff in implementing the requirements of the PA. The inclusion of a monitoring program in the proposed HPMP, as recommended by the SHPO, would have a beneficial effect upon archaeological sites by identifying threats and appropriate protective measures on a regular schedule.

As requested by the Bureau of Indian Affairs and required under section 106 of the NHPA, the Commission would continue to seek consultation with the Catawba Indian Nation in the development of the PA and the HPMP.

Effects of Project Operations and Land Management Practices on Historic and Cultural Resources

Because archaeological sites are often found immediately adjacent to water bodies, including lakes and rivers, bank and shoreline erosion can affect historic properties at hydropower projects. Project operation contributes to water level fluctuations within the impoundment and in the rivers downstream of the project. Water-level fluctuations, in turn, contribute to erosion.

Continued operation of the project could have an adverse effect on archaeological resources as a result of project-induced shoreline and riverbank erosion, construction activities for the installation of fish passage structures, and the construction of any project-related recreational facilities. Erosion constitutes one of the most significant threats to historic properties associated with hydroelectric projects, particularly those operated in a peaking or semi-peaking mode. Bailey and Baluha (2003) identified both new and previously known archaeological sites within the project boundary. As noted, 18 of 50 newly found archaeological sites were in areas that are subject to on-going erosion.

Project lands are currently managed by SCPSA under its permitting and land use management plans contained within its CLMP. Management of lands within the project boundary could have an adverse effect on known and unidentified historic properties as a result of shoreline development and construction activities. However, the incorporation of historic properties into the planning and permitting process could have a beneficial effect on historic properties that lie along the shoreline through discovery and protection of significant sites.

Lake Levels and Downstream Flow Regime

SCPSA proposes to manage lake levels as it has historically. Therefore, effects on cultural resources from the proposed action would be the same as those discussed above. SCPSA proposes and agencies and interested parties recommend several operational modifications to downstream flows that have the potential to affect cultural and historic properties. SCPSA proposes to provide continuous flows of 5,600 cfs at St. Stephen from February through April, additional attraction flows at the Pinopolis lock, and to increase locking operations for fish passage. Several agencies and interested parties including the CCL, American Rivers, and SCDNR recommend an alternative flow regime of 5,600 cfs provided continuously at St. Stephen from March through April, and flows at Santee dam based on a percentage of inflow, with a year round minimum of 1,600 cfs. Likewise, the DSA includes an alternative minimum flow regime at Santee dam which varies from 1,200 cfs to 2,400 cfs, during the fish passage season.

Our Analysis

According to the alternative downstream flow regime recommended (see section 3.3.1, *Water Resources*), only a portion of the inflow to Lake Marion would be released into the Santee River through either Wilson dam or the St. Stephen station. These minimum flows, under normal conditions, would be relatively constant and may not completely fill the original banks of the Santee River; thus the potential for erosion to sites that had previously not been subject to Santee River flow would be minimal. The risk of erosion would come only with a rapid fluctuation of river levels both up and down. Because the project is not operated in a peaking mode at Santee dam, rapid fluctuations from project operations would not be expected to occur. If an alternative flow regime is implemented, any rapid river level fluctuations would generally come from natural causes such as spring flooding events. The proposed increased downstream flow regime would have no effect on historic properties.

For the lower Santee and Cooper rivers, given the lack of information on the effects of project operations on erosion in the lower rivers, it is unclear whether erosion resulting from project operations has historically affected archaeological sites in these areas.

Lower Santee River Archaeological Survey

The Forest Service, which manages the Francis Marion National Forest to the southeast of the project along the Santee River, recommends that SCPSA provide an inventory of archaeological sites along the Santee River channel and adjacent areas downstream of the project, and address the effects of Santee River flow alterations to those sites. The Forest Service recommends that the proposed survey address such sites as Battery Warren, confluences with smaller tributaries, and other known prehistoric and historic settlement areas. Given the number of archaeological sites identified near the edges of Lakes Marion and Moultrie by Bailey and Baluha (2003), the potential for intact archaeological sites near the Santee River is moderate to high. The purpose of this survey would be to identify sites that may be affected by erosion and by changes in use that may result from project operations.

Our Analysis

Archaeologists contracted by SCPSA could work with the archaeological staff at the Francis Marion National Forest and with the South Carolina Institute for Archaeology and Anthropology (SCIAA) to identify and locate known archaeological sites (Phase I survey) along the Santee River downstream of the project.

Historic Properties Management Plan

To resolve any potential adverse effects arising from project operation, the HPMP, as proposed by SCPSA, would include procedures and measures to address the continued

use and maintenance of properties that are listed or may be eligible for listing on the National Register, and principles and procedures to respond to accidental discovery of cultural resources during project operations.

Our Analysis

As discussed above, the HPMP, as it pertains to the effects of project operations on cultural and historic resources, would ensure that such resources would be accorded proper treatment and, as appropriate, protection, over the term of the license.

Shoreline Management Plan

Under its permitting program, the CLMP does not place any obligations on either SCPSA or the property owner to conduct a survey of cultural and historic resources or preclude development of known sites. The permitting program requires applicants to cease ground disturbance and other development activities in the event that "significant archaeological or paleontological remains" are discovered. The applicant is required to contact the Charleston District of the Corps and the South Carolina Institute of Archaeology and Anthropology (SCPSA, 2003b).

Agencies and interested parties have recommended the development and implementation of a shoreline management plan. This shoreline management plan would undergo a review and update process every 10 years.

Our Analysis

Shoreline management plans generally guide the type and degree of development that may take place within the Commission's project boundary, and stringent planning and management components would benefit any yet to be identified historical and cultural resources through potential development restrictions and protective measures. The CLMP contains provisions to consider cultural resource issues when SCPSA issues permits for the construction of docks, seawalls, and other water-control structures. Furthermore, areas within the project boundary having known or potential cultural resources have been identified and classified as "natural areas." Development in these areas is currently restricted, and only limited public access, vegetative clearing, and forest and land management practices are permitted.

A shoreline management plan would not constitute a change over existing conditions with respect to the protection of existing and unidentified cultural resources. However, there are no provisions for periodic review and update of the CLMP, with exception of the Shoreline Erosion Control Plan which could have direct implications for cultural resources. An ongoing review and reclassification of "natural areas," as well as periodic review and update of other protective measures that have benefits to cultural resources such as erosion control measures would benefit the long-term preservation of such resources.

Recreation Improvements

To improve navigation and recreational resources, SCPSA proposes to install mooring piers at three sites along the lakeshore (Low Falls, Calhoun, and Biggins), and to construct a two-lane boat launch at Richard Landing at White Point. According to the application for new license, SCPSA has already begun construction on the White Point boat launch. Agencies have also recommended improved bank fishing access and parking at five sites. The DSA includes a proposal for enhancement of an elevated bird observation deck in the Santee NWR.

Our Analysis

All of these actions would involve ground disturbance and thus have the potential to affect historic properties. The proposed HPMP would include measures to consult with the SHPO on ground-disturbing actions that have the potential to affect historic properties. If SCPSA has not consulted the SHPO regarding ground-disturbing activities for the White Point boat launch, adverse effects on cultural resources may already be occurring in that area.

Fish Passage

The upstream and downstream movement of fish is accomplished at the Pinopolis dam by means of the navigation lock. Currently, however, there is no fish passage facility at Wilson dam on the Santee River. It is likely that SCPSA would be required under section 18 of the FPA to provide for fish passage at the dam and preliminary section 18 prescriptions are discussed in section 3.3.2, *Aquatic Resources*. The DSA includes fish passage measures that are similar to the preliminary prescriptions and are also discussed in section 3.3.2. Designs have not yet been developed but may include a trap and transport facility below Santee dam that would require a substantial structure adjacent to the dam, and other upstream and downstream fish passage facilities that would require modifications to Santee and Pinopolis dams.

Our Analysis

The construction of these structures has the potential to adversely affect the historic properties, by affecting the physical integrity of the historic fabric of the dams and by affecting the visual and spatial integrity of the setting of the two dams. Details for addressing any adverse effects that may result from construction of the fish passage system would be provided in the HPMP.

3.3.7.3 Unavoidable Adverse Effects

Streambank erosion is a natural process that cannot be totally eliminated without reinforcement of the shoreline, which would be extremely costly and detract from the aesthetic value of the lakes and river, as well as alter shoreline habitats. Adoption and implementation of an HPMP would provide for the phased documentation and protection

of sites, but not totally eliminate the possibility of the loss of some cultural resource materials and sites caused by streambank erosion.

Regardless of the alternative selected and the mitigation measures undertaken, continued operation of the project would affect traditional cultural resources. Facility modifications and new construction would alter some historic structures. Some archaeological sites would be affected by reservoir erosion and possibly by fish passage facilities that cannot be re-sited. These effects would add to the cumulative loss of traditional cultural resources, historic structures, and archaeological sites over time in the project area and downstream to the Atlantic Ocean.

3.3.8 Socioeconomic Resources

3.3.8.1 Affected Environment

Socioeconomic resources associated with the project include the six counties surrounding Lakes Marion and Moultrie (Berkeley, Calhoun, Clarendon, Orangeburg, and Sumter). The affected environment covers about 1,652 square miles in eastern coastal South Carolina, with the primary contributing factors of the socioeconomic environment being population, income, tourism, development and employment.

Demographics and Population

The 2000 population of the region was about 386,600. The population of this five-county region, known as Santee Cooper Country, has grown 11.1 percent from 1990 to 2000 and is projected to grow another 21.66 percent by the year 2025. About 2.5 million people reside within 100 miles of the lakes (SCPSA, 2003b) and more than 1.8 million people visit the area each year (SCPRT, 2004).

The population base of the project area experiences seasonal changes due to the influx of tourists in the summer and, to a much lesser degree, retirees in the winter. Santee Cooper Country, with a resident population of about 387,000, has an estimated virtual population of 394,900 people including visitors (SCPRT, 2001), with the majority of visitation occurring during the recreation season (April through July) (SCPRT, 2004). The retirement population of Santee Cooper Country has grown by 25 percent on average from 1990 to 2000, with Berkeley County having the second fastest retirement population growth at 51.5 percent from 1990 to 2000. The 2000 population of retirement-aged individuals (65 years and older) in the five counties totaled 41,750, about 11 percent of the total population (SCBCB, 2005b).

Employment and Income

Per capita incomes are generally mid-range in comparison with other counties of the state. Incomes in Berkeley and Calhoun counties are higher than for Clarendon, Orangeburg and Sumter counties (US Census, 2006a). Out of 46 counties in South

Carolina, Calhoun and Berkeley counties ranked 15 and 20 in per capita personal income, respectively, in 2003. Sumter and Orangeburg counties ranked 23 and 24, respectively (SCBCB, 2005c). Poverty rates among these counties follow a similar pattern, with Berkeley and Calhoun counties exhibiting lower poverty rates than Clarendon, Orangeburg and Sumter. The percent of individuals living in poverty in 2003 ranged between 11.7 percent (Berkeley County) and 21.3 percent (Clarendon County) (US Census, 2006a). Orangeburg County is ranked 10th and Berkeley County is ranked 41st out of the state counties with respect to the number of individuals living in poverty in 1999 (SCBCB, 2005d).

Unemployment in the project area ranged from a low of 6.1 percent in Berkeley County to a high of 10.2 percent in Calhoun County in 2004. In 2005, trade (including retail sales), transportation and utilities were the economic sectors employing the most people in the Santee Cooper region counties. Manufacturing followed with 21 percent of the total workforce and education and health services with 18 percent.

Santee Cooper Country is an attractive travel destination. It transformed the economy in the immediate area of the lake from a riverside, agricultural-based economy to a lakeside recreation and tourism-based economy, along with the infrastructure to support it (Haley, 2004). Currently, tourism in the project area accounts for about 3 percent of all the state's tourism revenue (TIAA, 2004). The project area sees an estimated 1.8 million visitors per year, 21 percent of which participate in day trips, and the average length of overnight trips to the region is 2.3 days (SCPRT, 2004). Visitors spend about $200 per trip (TIAA, 2004). Recreation and tourism expenditures not only support local businesses, but also contribute to the tax base of the surrounding communities.

The recreation and tourism industry plays a role in employment, and contributes to the financial viability of the lake region. Approximately 2,050 establishments are classified as retail, entertainment, accommodation and food services within the five counties surrounding the lakes (US Census, 2004). These establishments employ about 28,374 people (SCESC, 2006) and contribute about $394 million annually to the payroll in the five-county area (US Census, 2004). Retail trade accounted for 17,792 jobs, 14 percent of the total workforce. Leisure and hospitality businesses, providing recreation and tourism services, accounted for about 8 percent of total employment, in the project area, and was the fourth largest employer overall (SCESC, 2006).

Community Development and Tax Basis

Both the private sector and the state of South Carolina have invested resources in the area to promote and capitalize on the growing tourism industry. There are over 30 commercial marinas on the lakes, as well as a multitude of businesses and commercial operations which support the interests and needs of the visitors and permanent and seasonal residents alike, including resorts, hotels, restaurants, retail, etc.; all providing

employment opportunities and contributing to the economic stability of the area. In addition, there are two state parks, two national forests, and several state conservation areas in Santee Cooper Country (SCPSA, 2004a). Known for its catfish and bass fishing opportunities, Santee State Park is located on the shores of Lake Marion and hosts over 195,000 visitors annually and is the 9th most visited park in the state (SCBCB, 2005f).

Approximately 3,343 acres within the project boundary, about 17 percent of total lands, have been designated for project purposes or for residential and commercial development. The remainder has been designated as "recreational", "natural", or "forest management" areas and, therefore, sees little to no development. Demand for waterfront property continues to be strong and real estate purchases continue to escalate the prices of houses, condominiums, and land around the lakes.

3.3.8.2 Environmental Effects

The socioeconomic resources in the project area are tied to the recreation and tourism industry that has evolved at Lake Marion and Moultrie, to seasonal and permanent lake front commercial and residential development, and to low-cost reliable power generation for the region. Proposed actions that may modify recreational use of the project, affect regional tourism, alter the management of shoreline properties, or increase the cost of power generation have the potential to affect the socioeconomic resources of the project area.

Although SCPSA has made no proposals that pertain directly to socioeconomic resources within the project boundary, many of the proposed measures would have a positive effect on the socioeconomic resources of the counties and communities. SCPSA, agencies and interested parties propose several environmental protection and enhancement measures that would directly and indirectly affect socioeconomic conditions in the project area, both negatively and positively. Measures that are proposed for the protection and enhancement of fish, wildlife, recreation and cultural resources would have a positive effect on socioeconomic conditions by improving recreational opportunities and increasing tourism, thereby providing additional jobs and potentially increasing commercial and residential development in the area.

The cost of implementing such measures has the potential to increase the cost of project power, which would have a negative effect on socioeconomic conditions by increasing consumer electricity rates. The Santee Cooper Project provides part of the capacity for SCPSA's integrated electric system, which serves 134,000 residential and commercial retail customers in Berkeley, Georgetown, and Horry counties and supplies power to the municipalities of Bamberg and Georgetown, over 30 large industrial clients, several rural electric cooperatives, and a US Navy installation.

Effects of Project Operations on Socioeconomic Resources

A key component of the recreation and tourism industry in Santee Cooper Country is the operation of the Santee Cooper Project during the height of the tourism and recreation season in the summer months. If lake levels fluctuate significantly, or are consistently below the normal water levels for the summer months, then recreation and aquatic resources at the lake could be adversely affected, which could translate into reduced levels of use, numbers of tourists, and levels of income generated by the recreation and tourism industry at the lakes and in the region. Likewise, a new minimum flow regime could have socioeconomic implications if it beneficially or negatively contributes to boating, public access, or aquatic and riparian habitat on the Santee and/or Cooper rivers.

Lake Levels and Modified Flow Regime

With the recreation and tourism industry contributing to both the employment and tax base of the five lake communities, proposed actions that would affect recreational use or attractiveness for tourism of the lakes or rivers include lake level management, flow modifications for fish passage and proposed minimum flows.

SCPSA proposes to operate the project according to the existing rule curve; however, agencies and interested parties have recommended extending full pool elevation (75 ft. NGVD) from December through mid-October, with a fall drawdown from mid-October to the end of November. SCPSA also proposes several operational alterations to address fish passage at the project. These are discussed in section 3.3.2, *Aquatic Resources*, and include increased locking operations and formalized minimum flows (5,600 cfs) at St. Stephen from February through April. In addition, as discussed in section 3.3.1, *Water Resources*, agencies and interested parties have recommended a modified rule curve and year round minimum flow of 1,600 cfs at Santee dam and decreased locking at the project to conserve lake levels. The DSA includes a revised minimum flow regime at Santee dam of 1,200 cfs, increasing to 2,400 cfs during the fish passage season, and various fish passage measures, including an attraction flow at Pinopolis lock. These measures are described in greater detail in sections 3.3.1, *Water Resources*, and 3.3.2, *Aquatic Resources.*

Our Analysis

Lake levels at the project have been at or above full pool elevation over 75 percent of the time between March and October since 2004 under current operations (see sections 3.3.1, *Water Resources*, and 3.3.5, *Recreation Resources*). As SCPSA intends to continue operation of the project targeting the existing guide curve, the effects of lake levels on recreation activities, tourism, and shoreline property values under the proposed action would not be any different than existing conditions. The agency recommendation to provide higher lake levels beginning in December is not expected to provide

significant additional benefits to lake access and navigability because the extended full pool elevations fall outside of the peak recreation season of April through September. However, higher water levels in the winter would have the potential to enhance winter angling and waterfowl hunting opportunities, which could result in some increase in recreational use and tourism outside of the peak recreation season and potentially benefit tourism-based businesses and related socioeconomic resources.

As discussed in section 3.3.5, *Recreation Resources*, locking does not significantly affect the maintenance of water levels in the lakes. As a result, either increasing or decreasing the frequency of locking events is not expected to affect shoreline property values or spending on recreation and tourism in the area. Likewise, any changes in fish passage attraction flows are not expected to negatively affect lake levels or water levels downstream of the project. Boating access and opportunities on the lakes are available at all times of the year, irrespective of lake levels. In addition, flows of 5,600 cfs are currently provided voluntarily at St. Stephen during the spawning season, and this measure would not constitute a change from existing operating conditions. These measures are not expected to affect boating and other on-water recreational uses of the lakes and rivers dramatically at the project. To the extent that these measures would improve the fishery at the project, locking and attraction flows may directly benefit angling opportunities, and associated recreational use and tourism, at the project.

An increased minimum flow downstream of Santee dam would have direct benefits to downstream boating opportunities, safety and navigation of the Santee River, particularly above the confluence with the Rediversion canal. To the extent that this measure may improve the attractiveness of the Santee River downstream of the project for recreational boating and other activities, this measure could positively contribute to the tourism industry and related infrastructure within the project vicinity.

Fish Passage and Aquatic Habitat Enhancements

In addition to SCPSA's proposed operating alternatives to enhance fish passage at the project, FWS and NMFS prescribed fish passage facilities at the project to accommodate anadromous and diadromous fish passage. As discussed in section 3.3.2, *Aquatic Resources*, the DSA also includes fish passage measures. In addition, proposed and recommended measures for water quality, fish protection, and aquatic habitat include an adaptive management program for flow alternatives, water quality monitoring and improvements, and a wildlife and aquatic habitat and assessment plan. To the extent that these actions improve the recreational fishery and contribute to recreational use of the project, they may have ramifications for the economy of the region.

Our Analysis

Section 3.3.2, *Aquatic Resources*, provides an in-depth analysis of the recommended fish passage facilities at the project. Fish passage facilities would have

both immediate direct effects and long-term indirect effects on socioeconomic resources in the project vicinity. In the short-term, the agency and DSA alternatives for fish passage would result in direct temporary expenditures on construction labor, goods, and materials. These improvements would result in a temporary increase in employment, wage generation, and economic output in the region. In the long-term, successful operation of the fish facilities would contribute to the growth of the fishery, thereby having indirect effects on the local economy through increased recreational fishing participation.

Low-cost electricity is beneficial to the local economy and the social welfare of the five communities surrounding the project. Costly enhancements have the potential to increase consumer electric rates for those served by Santee Cooper facilities. The proposals for fish passage enhancements include capital investment in passage facilities totaling about $32.9 million, along with associated operational costs. These costs, however, are not expected to dramatically affect SCPSA's ability to maintain consumer electric rates for those receiving power from the project, and even if the proposed enhancements would increase the cost of generation, the project would still provide a relatively low cost source of power compared to fossil fueled generating resources.

Other aquatic resource and water quality enhancements would improve habitat, increase the productivity of the fishery, and contribute to the success of the recreational fishery at the project, thereby contributing to the recreational dollars spent in the project vicinity. Furthermore, an improved fishery could contribute to the attractiveness of the area for seasonal and permanent residence.

Effects of Recreation Opportunities and Land Management on Socioeconomic Resources

Sufficient recreation sites at the project contribute to the success of the project area to attract recreational use by local residents and as a tourism destination. Recreation in the project area, and associated tourism related spending, may level off or even decrease if public access opportunities do not increase with demand. Recreationists may shift use to other areas in response to crowding and limited opportunities. Alternatively, SCPSA's existing undeveloped properties could provide public access to the lakes and rivers in areas where it is otherwise limited by private and commercial ownership; thereby potentially increasing public recreational access and tourism related spending.

Our Analysis

The available number, condition, and capacity of existing public and commercial recreation sites, available recreation opportunities provided by these sites, and adequate associated tourism-based businesses and support facilities have significant effects on the attractiveness of the project as a tourism destination. Likewise, such opportunities and commerce can enhance the attractiveness of the project vicinity for seasonal and

permanent residence, thereby increasing local populations, residential development, and commercial, municipal and industrial infrastructure in the project region.

Property taxes, tied to property values, contribute to the tax base of the project area. Shoreline management policies, such as development restrictions, water quality improvements and wetland and riparian habitat protections, can have both positive and negative effects on waterfront property values. While shoreline management policies, permitting programs, and zoning can have negative economic implications for commercial development and property values, the benefits afforded by these policies and programs in the form of improved water quality, aesthetic appeal, noise reduction, wetlands and habitat preservation, and green space, generate economic gains that generally outweigh losses associated with development constraints (Spalatro and Provencher, 2000). Management of project lands can also have implications for regional economics depending upon the use and allocation of these lands for public access, commercial and residential development, and project operations.

Recreation Enhancements

As discussed in section 3.3.5, *Recreation Resources*, SCPSA proposes several enhancements to existing recreation sites including the installation of aluminum mooring piers and construction of a new two-lane boat launch. Agencies and interested parties have also recommended additional enhancements including improved bank fishing access and navigation channels. The DSA includes improvements to a bird observation structure in Santee NWR.

Our Analysis

To the extent that proposed and recommended improvements would improve the condition of existing recreation sites, increase the capacity of sites to accommodate existing and future potential use, and enhance the attractiveness of the project for local recreationists and tourists, these improvements could have beneficial effects on socioeconomics at the project.

Elements of the proposed and alternative actions that directly affect recreation in the project area and indirectly affect project socioeconomic resources include the various recreational enhancements that pertain to boating and angling access to the lakes. Possible effects on socioeconomic resources resulting from these proposals include direct changes in employment, tax revenue, and local expenditures, as well as indirect influences on the local economy both in the short term for those involved in the construction of these improvements and in the long term as a result of increased local recreational use of the sites and tourism to the area.

The proposed measures would enhance the local economy by attracting more visitors and by improving recreational facilities. However, as measures for recreation

mostly address improvements to and the rehabilitation of existing facilities, it is expected that these improvements would result in little increase in tourism and recreation-related visitation over existing conditions.

At the same time, protection, mitigation, and enhancement measures at the project have the potential to affect the project's ability to continue to provide low-cost, reliable power depending upon the total cost of such measures. Particularly, low-cost power has positive socioeconomic effects on the region's manufacturing, retail trade, tourism, and recreation industries. Furthermore, long-term stable electric rates have the potential to attract new industry to the region. Overall, the proposed measures, with an estimated capital cost of about $600,000, are not expected to have significant adverse effects on social and economic conditions in the area surrounding the projects, although potential electricity rate increases would adversely affect local residential, commercial, and light industrial customers.

Shoreline Management

We analyze components of the proposed action that affect shoreline management and both commercial and residential development which, in turn, have the potential to affect property values and other socioeconomic indicators in the following section. SCPSA's proposed action includes existing policies and permitting programs affecting shoreline management included in the CLMP. These existing programs and policies are described in section 3.3.6, *Land Management and Aesthetic Resources,* and include SCPSA's Natural Area and Forest Management Plans, Shoreline Erosion Control Plan, Lakes Zoning Plan and Boating Access Facilities Master Plan. Agencies and interested parties have recommended that a shoreline management plan be developed and updated every 10 years, which we assume would include, at a minimum, the components of the existing CLMP.

Our Analysis

The proposed revisions to the CLMP would likely include SCPSA's current programs and guidelines for shoreline management and provisions for enforcement, as well as potentially introduce new policies and programs that could affect shoreline development and riparian resources. To the extent that adoption of a revised shoreline management plan would affect property values, the proposed action could result in measurable direct socioeconomic effects, both positive and negative.

Existing and potential future policies that may be included in the CLMP that restrict or limit shoreline development may adversely affect property values. Regulation may deprive a landowner of the opportunity to earn income from future development or to increase the property's value through the addition of amenities to the property, such as

private docks or piers. In addition, reducing shoreline development may be harmful to local labor and businesses (Spalatro and Provencher, 2000).

At the same time, however, development restrictions generate additional amenities to the affected landowners themselves and/or landowners nearby in the form of increased green spaces, view corridors, etc. These benefits associated with shoreline management plans have been found to outweigh the costs associated with constraints on agricultural, residential, commercial, and industrial development; employment losses; and shoreline management plan implementation costs (WADEC, 2003). In addition, environmental benefits and improvements associated with shoreline management policies and programs, such as improved water quality, enhanced wildlife habitats and wetlands, aesthetics, reduced noise pollution, and open space, provide economic benefits to waterfront property owners through increased property values and to local governments and economies through increased tax revenues.

3.3.8.3 Unavoidable Adverse Effects

None.

3.4 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.

3.5 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Our recommended action alternative to relicense 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 altered. There is no major new capacity or construction proposed or recommended that would commit lands or resources in an irreversible manner.

3.6 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

Our recommended alternative for the project is expected to provide an average of 220,847 MWh of energy each year to the region. This long-term energy productivity would extend for at least as long as the duration of a new license. Our recommendations are designed to enhance aquatic and terrestrial habitat, enhance local and regional recreational opportunities, foster sound land management practices, and protect cultural

and historic properties. If the project were operated solely to maximize hydroelectric generation, many efforts to enhance aquatic and terrestrial habitat and recreational opportunities in the project area would be foregone.

With the proposed and existing 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, with our recommended measures, would further many of the goals and objectives identified by agencies and other interested parties.