Section 4 Environmental Resources

(Tables E-9 and E-10). All mercury concentrations were below the laboratory detection limit. Copper concentrations exhibited no spatially significant pattern in 1999, but concentrations were significantly greater in the lower river areas during 2001 (Table E-10). Three of the twelve copper concentrations at Station 1B were above the North Carolina action level of 7 µg/L during 1999 (Appendix E.2). South Carolina uses copper concentrations of 2.9 and 3.8 µg/L, respectively, for calculation of chronic and acute aquatic life toxicity for discharge permit limitations (SCDHEC 1976). Copper concentrations exceeded the acute level in 16 samples from South Carolina waters during 1999 and five samples during 2001 (total sample size during each year equaled 48) (Appendix E.2). Elevated copper concentrations were cited as an impairment of aquatic life use in the river at South Carolina Highway 34 (SCDHEC 2002b).

4.4 Aquatic Resources

4.4.1 Fishery Resources

4.4.1.1 Fishery Management Activities

Fishery management studies conducted by the NCWRC on Lake Tillery and Blewett Falls Lake since the 1960s have primarily assessed the largemouth bass and crappie populations (Tatum 1960; Van Horn et al. 1981, 1986; Chapman 1983; Van Horn and Jones 1990). These studies were primarily designed to determine abundance, size, and age structure, young-of-year recruitment, and relative body condition of these sport fishes as related to harvest by anglers. Other fishery management activities have focused on the development of white bass fisheries within the reservoir-tailwater systems and a put-grow-and-take stocking program to develop striped bass fisheries within both reservoirs.

The NCWRC has stocked several species of sport fish in Lake Tillery and Blewett Falls Lake since the 1950s to enhance the reservoir sport fisheries and angler utilization (Tatum 1960; NCWRC 1966). Eight species have been stocked in Lake Tillery and included channel catfish, striped bass, white bass, bluegill, redear sunfish, largemouth bass, northern pike, and walleye. Of these species, only northern pike and walleye failed to develop viable populations. Smallmouth bass have been reportedly caught on occasion by anglers from Lake Tillery based on anecdotal
conversations with anglers. These smallmouth bass most likely migrated out of the Uwharrie River where the species was stocked previously by NCWRC. In Blewett Falls Lake, stocked fish species included largemouth bass, bluegill, reedear sunfish, flathead catfish, walleye, white bass, and striped bass. Walleye stocking was unsuccessful in 1954, but white bass and striped bass stocked in 1954 and 1959, were deemed successful. Threadfin shad, blueback herring, gizzard shad, and flathead catfish were also stocked by the NCWRC during the 1950s and 1960s in the Yadkin-Pee Dee River chain of lakes and, in some instances, have moved downstream in the reservoir-river system. All of these species currently have reproducing populations in Project waters.

The NCWRC managed Lake Tillery as a “Trophy Largemouth Bass Lake” from January 1978 until January 1982. During that time, the harvest of largemouth bass was restricted to eight fish per day with a size limit of ≥ 450 mm. The management objective was to increase the average size of adults and thereby create a “trophy fishery”. During January 1982, the largemouth bass creel restriction was changed to a ≥ 350 mm size restriction with the stipulation that two fish of any size could be included in the eight-fish-per-day creel limit (Chapman 1983). The NCWRC concluded from these studies that angling pressure was sufficient in Lake Tillery to alter the largemouth bass size structure; however, no creel data were available to estimate actual catch and harvest rates of largemouth bass or other sport fishes.

The NCWRC published The North Carolina Black Bass Management Plan during 1993. This plan provides direction for managing largemouth bass populations throughout the state, including the project reservoirs (NCWRC 1993). Several strategies were outlined in the plan, most notably habitat protection, angler creel restrictions to manage age and size structure, angler use feedback on management strategies, and management of fish stocking activities in reservoirs that is compatible with the plan’s objectives. The NCWRC currently has a creel restriction of 5 largemouth bass per day with a minimum size limit of 356 mm (14 inches) for the Yadkin-Pee Dee River chain of lakes, including both project reservoirs (NCWRC 2002a).

During the spring (April 15-May 15), Progress Energy has a voluntary agreement with the NCWRC to hold the lake elevation of Lake Tillery as constant as practicable during the largemouth bass spawning season.
The NCWRC has also regulated angler harvest of crappie populations in Lake Tillery and Blewett Falls Lake, with a size restriction of \( \geq 203 \text{ mm} \) (8 inches) and a 20 fish-per-day creel limit. This regulation was implemented during July 1991. Similar creel regulations have also been imposed by the NCWRC on other hydroelectric reservoirs upstream in the Yadkin River system (NCWRC 2002a). The management goal of this regulation is to maintain quality crappie populations in the reservoirs.

Striped bass populations within both reservoirs are currently maintained by the NCWRC with annual stocking. The NCWRC management objective is to maintain a put-grow-and-take striped bass fishery in both reservoirs (NCWRC 1995). The striped bass that have been utilized in this stocking program were derived from Roanoke River, North Carolina, parental stock (Rulifson and Laney 1999). For the period from 1967 to 1997, the NCWRC stocked over four million striped bass fingerlings into the Yadkin-Pee Dee River chain of lakes. During 2002, the NCWRC stocked 1- to 2-inch striped bass fingerlings at rates of five fish per acre in both reservoirs (NCWRC 2002b). The creel restrictions are eight fish per day with two fish less than 406 mm (16 inches).

Management of migratory fish species (American eel, American shad, Atlantic sturgeon, shortnose sturgeon, hickory shad, herring, and striped bass) in North Carolina or South Carolina is under jurisdiction of the National Marine Fisheries Service (NMFS) and the Atlantic States Marine Fisheries Commission (Beal 2000; Stirratt 1999, 2000a, 2000b). The SCDNR and NCWRC regulate harvest of migratory and resident warmwater fish species in the Pee Dee River below the Blewett Development.

Recreational harvest of American shad and striped bass in the Pee Dee River North Carolina waters is permitted in both states with creel limits of 10 fish per day with no size restriction. For striped bass, the creel limits are 3 fish per day and fish must be \( \geq 18 \text{ inches} \) total length in North Carolina waters. South Carolina permits a recreational harvest of 10 striped bass per day with no size restrictions.
Commercial gill netting harvest for American shad and herring is permitted in South Carolina waters of the river by the SCDNR. The commercial netting season for American shad occurs from February 1 to April 30 and from February 15 to April 15 for herring. The NCWRC banned commercial gill netting activities in North Carolina waters, effective July 2002. Prior to the ban, commercial gill netting for American shad was permitted in North Carolina.

No harvest of Atlantic or shortnose sturgeon is permitted in either state. A recovery plan has been prepared by the NMFS for shortnose sturgeon (Acipenser brevirostrum), a federally listed endangered species (NMFS 1998). The plan outlines several steps for recovery of this species, which includes establishing listing criteria for specific river populations and protection and restoration of populations and habitat respective to key life stage requirements.

The river below Lake Tillery has also been rated by the NPS as having an Outstandingly Remarkable Value (ORV) designation for fish (NPS 2001). This rating is provided to rivers that are nationally or regionally an important producer of resident and/or anadromous fish species. Of significance is the presence of wild stocks or habitat and/or federal- or state-listed (or candidate) threatened, endangered, or sensitive species (NPS 2001).

4.4.1.2 Historical Studies

Investigations of the fishery resources in the Yadkin-Pee Dee River Basin date to the 1800s (e.g., Mills 1826; Cope 1870; Jordan 1889; Stevenson 1897, 1899; Smith 1907). These early investigations surveyed populations of resident and migratory fish species. The NCWRC conducted an extensive survey and classification inventory of the Yadkin River and tributaries during the early 1960s (Tatum et al. 1963). Fishery resources of the basin were also described in an inventory assessment during a comprehensive water resource basinwide assessment conducted by the U.S. Fish and Wildlife Service (USFWS) during 1980 (Dunn 1980). The NCDWQ has performed recent assessments on the health of fish communities in the tributaries of the Yadkin-Pee Dee River (NCDWQ 1998, 2002a). APGI provided a contemporary characterization of the fish communities present in its hydroelectric reservoirs (High Rock Lake, Tuckertown Reservoir, Narrows Reservoir, and Falls Reservoir) located upstream of the Progress Energy hydroelectric project (APGI 2002).
Initial studies by the NCWRC of the river basin, including the project reservoirs, began during the late 1940s and early 1950s (North Carolina Stream Sanitation Committee 1953; Fish 1968; NCWRC 1966, 1982; Chapman 1976, 1983; Van Horn et al. 1981, 1986, 1991; Duval 1988; Van Horn and Jones 1990; Chambers 1993). As a result of greater recreational focus and use, both reservoirs’ fishery resources have been more extensively studied and managed than the fishery resources in the tailwater reaches below both developments.

The North Carolina Stream Sanitation Committee (1953) summarized early NCWRC studies in its water pollution survey report.

"Fishing is quite extensive throughout the basin. In addition to game fishing in the lakes and streams of the mountains, the power lakes on the main stem of the Yadkin River are used by many fishermen. The North Carolina Wildlife Resources Commission reports that a large variety of fish are to be found in the waters of the basin. It is reported that a few trout, small mouth bass, rock bass, along with a variety of pan fish, are found in the waters of the extreme upper part of the basin while the fish population through the central portion consists of largemouth bass, crappies, bream, and catfish. In the lower portion of the basin, crappies, catfish, and a few largemouth bass are caught. During the spring, rockfish (striped bass) are found in the main stem of the Yadkin River below the Blewett Falls Reservoir. Some carp and suckers are also found in the streams throughout the lower portion of the basin, but are not reported to be in large quantities."

The report also stated that fishing was usually good in Lake Tillery with white perch, bass, and catfish the main species caught. Fishing was extensive in Blewett Falls Lake and associated backwaters with crappie and catfish caught along with a few largemouth bass. Fishing was described as not as good below Blewett Falls Lake due to the predominance of carp and catfish.

Tatum et al. (1963), conducted a synoptic rotenone sampling of the Pee Dee River below the Blewett Development, approximately 4 miles north of the South Carolina state line, during July 1961. Sixteen fish taxa were collected and the dominant species included brown bullhead (49 percent of the numerical sample composition), gizzard shad (38 percent), unidentified redhorse species (3 percent), white catfish (3 percent), and redbreast sunfish (1 percent). Fishing pressure was described as light to moderate within this reach.
Progress Energy has conducted fishery surveys of Lake Tillery and Blewett Falls Lake and the Pee Dee River. The Pee Dee River fish community in the vicinity of Old Sneadsboro and near Wallace, South Carolina, downstream of the Blewett Development, was examined during power plant siting studies in the late 1970s (CP&L 1980a, 1980b). An inventory of the composition, abundance, and distribution of fish was conducted in 1986 (CP&L 1987), and the influence of water level fluctuations on the reproductive success of largemouth bass in Lake Tillery was investigated in 1989 (Crutchfield 1989). Reservoir and tailwater fishery surveys were also conducted during the 1992-1993 period (CP&L 1993, 1995).

The 1992-1993 Progress Energy surveys concluded that fishery resources in both reservoirs had not changed substantially since the late 1950s. Fish populations in both lakes consisted of gizzard and threadfin shad, sunfishes (*Lepomis* spp.), largemouth bass, white perch, and catfish. Smallmouth buffalo was also a dominant species in Blewett Falls Lake. Biomass per acre (kg/hectare) of two major sport fishes, bluegill and largemouth bass, were typical of southeastern reservoirs in Lake Tillery. However, biomass of these species was lower than the range of expected values in Blewett Falls Lake. Young-of-year recruitment of both species in each lake was considered good during these assessments. In the immediate tailwater area below the Blewett Development, gizzard and threadfin shad, bluegill, largemouth bass, and longnose gar were the dominant species. Migratory species—American eel and American shad—were also collected in smaller numbers from this area.

The South Carolina Department of Natural Resources conducted fishery assessments of the lower Pee Dee River, South Carolina, from 1993 to 1996 (Crochet and Sample 1996; Crochet and Black 1997). The study showed over 90,000 angling hours were expended on the lower Pee Dee River with most anglers targeting catfish species. Blue catfish, a nonnative species, and bluegill were the dominant species in angler creels. Flathead catfish, another dominant nonnative species during the 1995 survey, was not very abundant during later surveys. Crochet and Black (1997) recommended no active management for the nonnative blue catfish based on the abundance of catfish in angler creels and electrofishing samples coupled with the good size structure.
Bulak et al. (1998) evaluated the age and growth of flathead catfish from the Pee Dee River compared to several other large river systems in South Carolina. Flathead catfish, which established a reproducing population within the river by 1981, had slower growth rates than the Edisto River; a river system where the species was more recently introduced in 1986.

4.4.1.3 Fishery Resources - Progress Energy Fisheries Surveys (1998-2002)

Progress Energy has recently (1998-2002) collected fisheries data to characterize the fishery resources in the Project area. Sampling methodology for the surveys as well as sample location maps are provided in Appendix D. Figures and tables prepared from the results of these surveys are provided in Appendix F. Progress Energy is proposing to establish an RWG with stakeholders in the spring of 2003 to review these data. Progress Energy believes these data characterizes existing conditions at the Project. The RWG will discuss, and as appropriate, identify areas where additional surveys by Progress Energy may be required to address specific Project operational effects on aquatic resources provided there is reasonable evidence of a Project impact.

**Sampling Methods**

The sampling methodology for fisheries surveys at the Project is provided in Appendix D. The fisheries surveys included: (1) biweekly migratory and resident fish spawning surveys below the Blewett Development from March through June of 1998 and 1999; (2) biweekly resident fish spawning surveys in the Tillery Development tailwaters from March through June of 2000; (3) seasonal surveys of tailwaters fisheries, with emphasis on resident fish species, below the Blewett Development during 1999 and 2001 and below the Tillery Development during 2000; (4) cooperative, multi-agency intensive surveys for rare redhorse species (robust redhorse and Carolina redhorse) of these tailwater reaches during the spring months from 2000 to 2002; (5) reservoir fishery surveys of Blewett Falls Lake in 1999 and 2001 and Lake Tillery in 2000; and (6) intensive spring survey of largemouth bass, sunfish species, and redhorse species in Blewett Falls Lake during April 2002.
Results and Discussion

Precipitation and stream flow were generally above normal during the first half of 1998 due to an El Niño weather pattern. However, for the remainder of 1998 through 2002, precipitation and streamflow were below normal due to drought conditions experienced in the Yadkin-Pee Dee River Basin. Lake levels, however, were generally within one foot of full pool elevation in Lake Tillery and with two feet of full pool elevation in Blewett Falls Lake for the majority of the period during the environmental surveys.

Fish taxa composition records were compiled from Progress Energy data collected at the Project since 1986 (Table F-1). The number of collected taxa varied by sampled location relative to physiographic province (Piedmont Plateau, Fall Line, and Coastal Plain provinces), habitat type (reservoir vs. riverine environments), watershed drainage area size, fish movement patterns, and employed sampling methods and effort. Fish diversity was greatest (84 taxa) from the Pee Dee River reach below the Blewett Development followed by Blewett Falls Lake (59 taxa), the Pee Dee River reach below the Tillery Development (50 taxa), and Lake Tillery (46 taxa).

The greater number of taxa present in the river reach below the Blewett Development reflected both the presence of several migratory and mobile, euryhaline species that were not collected above the dam (i.e., American shad, hickory shad, sea lamprey, striped mullet, Atlantic needlefish, southern flounder, and hogchoker), and the fact that this reach also reflects changes in the fish community as river habitat transitions from the piedmont to coastal plain physiographical regions (e.g., spotted sunfish, Santee chub, redfin pickerel, eastern mudminnow, brook silverside, flier, and bluespotted sunfish).

Several taxa were only collected from one or two locations. Robust redhorse (*Moxostoma robustum*)—a rare native sucker species, bigmouth buffalo—a nonnative sucker, and grass carp—a nonnative herbivorous species were only collected from the river reach below the Blewett Falls Development. Highfin carpsucker (*Carpiodes velifer*), a rare sucker species, was only collected from Blewett Falls Lake and the river reach below the Blewett Development. Carolina redhorse (undescribed *Moxostoma* species), another rare sucker species, was collected from Lake Tillery, Blewett Falls Lake, and the river reach below the Blewett Falls Development. American eel, a migratory species, was collected from Blewett Falls Lake and both river reaches...
but not from Lake Tillery. Smallmouth buffalo, a nonnative species, was also present in both river reaches and Blewett Falls Lake but absent from Lake Tillery. Common carp, another nonnative, were also absent from Lake Tillery during the 1992 and 2000 studies. Brassy jumprock was collected from Lake Tillery and the two river reaches below the hydroelectric developments. Bowfin was collected from the river reaches but not from the project reservoirs. Taillight shiner was only collected from Blewett Falls Lake. Striped bass-white bass hybrids were collected from both river reaches but not the project reservoirs. The presence of this hybrid suggested either natural hybridization was occurring between striped bass and white bass populations or there was downstream movement from a stocked source in the river basin.

Nonnative, introduced species are prevalent in Project waters (e.g., blue catfish, smallmouth buffalo, common carp, threadfin shad, red shiner, and grass carp) and often dominated the fish community at a particular location. Of the 91 taxa collected from the four sampled locations, 15 of these taxa were non-natives based on distributional records given in Menhinick (1997a) and Fuller et al. (1999).

**Lake Tillery Fish Populations**

**Species Composition**

Lake Tillery supports a good warmwater sport fishery for largemouth bass, crappie, striped bass, white bass, white perch, catfish, and panfish (*Lepomis* spp.). Gizzard shad, threadfin shad, white perch, bluegill, largemouth bass, redear sunfish, pumpkinseed, redbreast sunfish, white catfish, and yellow perch dominated the fish community in Lake Tillery during 2000 (Tables F-6 to F-8). Forty fish taxa were collected during the 2000 study with most taxa represented by the sunfish (Centrarchidae), bullhead catfishes (Ictaluridae), and sucker (Catostomidae) families (Table F-1). Overall, 46 fish taxa have been collected by Progress Energy biologists from the lake since 1986 (Table F-1).

**Species Abundance and Community Composition**

The electrofishing reservoir-wide total mean catch rates were 156 fish/hr with a weight of 28.7 kg/hr (Table F-6). Numerically dominant species, as defined by five percent of the reservoir
wide total mean catch, were bluegill, yellow perch, largemouth bass, pumpkinseed, gizzard shad, redbreast sunfish, and redear sunfish. By weight, largemouth bass, gizzard shad, white catfish, and redear sunfish were the dominant species.

The gill net reservoir-wide total mean catch rates were 48.9 fish/24 hours with a weight of 11.6 kg/24 hours (Table F-7). White perch and gizzard shad — open-water species — dominated gill net catches throughout the reservoir. White perch accounted for 47 percent and 78 percent of the reservoir mean weight and number per 24 hours, respectively. White perch was a dominant species in gill net catches in the APGI’s hydroelectric reservoirs located upstream of Lake Tillery (High Rock, Tuckertown, Narrows, and Falls Reservoirs), although threadfin shad tended to be the dominant shad species in the more eutrophic reservoirs, High Rock and Tuckertown (APGI 2002). White perch are prolific in Lake Tillery and other Yadkin Reservoirs and large schools are often observed feeding on shad at the reservoir surface during the summer. White perch introductions into reservoirs have often resulted in rapid expansion of populations, stunting of growth, increased competition for food sources with other species, and predation on other species (Schaefer and Margraf 1987). White perch were most likely present during the impoundment of the Yadkin-Pee Dee reservoirs based on accounts given by the NCWRC from the late 1950s (Tatum 1960; NCWRC 1966).

The electrofishing and gill netting total mean catches were generally lower in Lake Tillery compared to the upstream APGI hydroelectric impoundments (High Rock, Tuckertown, and Narrows Reservoirs) and the downstream Blewett Falls Lake (Tables F-9 to F-12; APGI 2002 [see Table 4-2]). Only Falls Reservoir had lower catch rates. Differences in catch rates were expected given the relative inter-reservoir differences in biological productivity, retention times, water clarity, and habitat. Generally, the more eutrophic reservoirs — High Rock, Tuckertown, and Blewett Falls — had greater total catch rates and dominance by predominantly planktivorous insectivorous species, such as gizzard shad, threadfin shad, and bluegill. Falls Reservoir is a small run-of-river facility with a short retention time and generally low biological productivity, and catch rates were the lowest in that impoundment (APGI 2002). Given these factors, the electrofishing and gill netting catch rates for Lake Tillery were within the expected range for a reservoir of moderate biological productivity with a short hydraulic retention time.
Electrofishing catch rates of largemouth bass were fairly uniform throughout the Lake Tillery (16-23 fish/hour with overall mean of 19 fish/hour) and comparable to catch rates from High Rock, Tuckertown, Narrows, and Falls Reservoirs (15 to 22 fish/hour) (APGI 2002). Electrofishing catch rates of largemouth bass were slightly lower in Blewett Falls Lake (3-28 fish/hour with a reservoir-wide mean of 16 fish/hour for 1999 and 2001, combined data) but still comparable to Lake Tillery and the upstream impoundments (Tables F-9 and F-10).

Total fish mean density and biomass estimates from cove rotenone sampling during 2002 were 17,331 fish/ha and 169.7 kg/ha, respectively (Table F-8). The mean density and biomass estimates were lower than estimates for 1992 from the reservoir, the NCWRC estimates for the 1980s from Narrows Reservoir, and Progress Energy estimates for Blewett Falls Lake during 1993, 1999, and 2001 (Tables F-8, F-13, and F-14; Figure F-1). However, the Lake Tillery estimates during 1992 and 2000 were greater than mean estimates (5,198 fish/ha and 89 kg/ha) from cove rotenone samples collected by the NCWRC during the 1956 through 1959 period (Tatum 1960).

The dominant species in cove rotenone samples by mean density were bluegill, threadfin shad, redear sunfish, and pumpkinseed (Table F-8 and Figure F-1). The biomass mean estimate was comprised mainly of bluegill, gizzard shad, redear sunfish, threadfin shad, and white catfish. A similar dominance pattern was observed in cove rotenone samples collected from the lake during 1992 (CP&L 1993). Tatum (1960) reported that *Lepomis* spp., gizzard shad, white perch, white catfish, and white crappie were the most numerically abundant species in cove rotenone samples collected during the 1956 through 1959 period. Gizzard shad, *Lepomis* spp., white perch, and white catfish were the most abundant species by biomass during this same period.

Gizzard and threadfin shad comprised 28 percent of the total fish mean biomass, which was lower than estimates (usually 40 percent to 60 percent) of the relative contribution of shad to the total fish mean biomass in other southeastern impoundments (Grinstead et al. 1978; Davies et al. 1982). The contribution of shad to total mean biomass in Lake Tillery was comparable between 1992 (26 percent) and 2000. Shad contributed 44 percent to 51 percent of the total biomass in Blewett Falls Lake during 1999 and 2001 and 46 percent of the total mean biomass in Narrows Reservoir during the 1980s (Tables F-13 and F-14; Figure F-1). Shad abundance has been
positively correlated with chlorophyll a concentrations, and hence, biological productivity in southeastern reservoirs (Siler et al. 1986; Rodriquez and Olmsted 1994). The abundance of shad, as well as other species, in Lake Tillery was influenced by the moderate biological productivity.

Bluegill constituted 29 percent of the total mean biomass estimate which was comparable to the 1992 reservoir estimate for this species (26 percent) and Davies et al. (1982) observation that bluegill contributed up to 20 percent of the total biomass in southeastern mainstream impoundments. Additionally, the bluegill biomass estimate was greater than Jenkins’ (1975) biomass estimate of 20.7 kg/ha for 144 southeastern U.S. reservoirs. Bluegill comprised a smaller portion of the total fish biomass when compared to more productive lakes—Narrows Reservoir and Blewett Falls Lake—where shad were dominant in the fish communities (Tables F-13 and F-14; Figure F-1). Bluegill comprised between 14 to 16 percent of the total mean biomass in these shad-dominated reservoirs.

The mean biomass of largemouth bass was 7.9 kg/ha and comprised approximately 4.7 percent of the total mean biomass (Table F-8). Black basses, including largemouth bass, typically constitute five percent of the total biomass in southeastern impoundments (Davies et al. 1982). The biomass estimate was also slightly less than the estimate of 10 kg/ha for black basses from 170 southeastern United States reservoirs (Jenkins 1975). Biomass of largemouth bass was less than five percent in cove rotenone samples collected from Blewett Falls Lake and Narrows Reservoir where shad dominated the fish communities (Figure F-1).

**Size Structure, Reproductive Success, and Body Condition**

Length-frequency histograms for the major prey and sport fishes in electrofishing, cove rotenone, or gill net samples showed multiple size classes present for most species, and the presence of young-of-year fish indicating good reproductive success in 2000 (Figures F-2 to F-4). Bluegill, largemouth bass, and threadfin shad showed good reproductive success in 2000 as evidenced by the number of young-of-year present in cove rotenone samples (Figure F-3). The gizzard shad population was comprised mainly of older adults and reproductive success of this species may have been affected by competitive interactions with threadfin shad.
Proportional stock and relative stock density values were calculated for major prey and sport fishes (Figures F-2 and F-4). The proportional stock density (PSD) is defined as the number of fish ≥ minimum quality length) number of fish ≥ minimum stock length x 100 (Anderson and Neumann 1996). Relative stock density (RSD) is defined as the number of fish ≥ preferred length) number of fish ≥ minimum stock length x 100. Minimum stock, quality, and preferred lengths are equivalent to 20 to 26 percent, 36 to 41 percent, and 45 to 55 percent respectively of the world record length for a particular species (Gabelhouse 1984).

The PSD and RSD values were within acceptable ranges for redear sunfish, largemouth bass, black crappie, and white perch as cited in Anderson (1980) and Anderson and Newman (1996). Largemouth bass PSD values between 40 and 70 and RSD values between 10 and 40 are indicative of a balanced population (Anderson 1980; Anderson and Neumann 1996). Bluegill PSD and RSD values were variable by sampling method (Figures F-2 and F-3). The bluegill PSD value calculated from electrofishing samples was within the accepted range for a balanced population (20 to 60). The low cove rotenone PSD and RSD values reflected the predominance of young-of-year individuals in the sample. Small sample sizes for blue catfish and channel catfish made it difficult to make meaningful conclusions on the size structure, although there appeared to be few large, quality-size individuals present in the reservoir. The large PSD value for gizzard shad reflected the lack of smaller, young-of-year individuals in the population during 2000.

Relative weight ($W_r$) values, an index of body condition, were greater than 90 and near the optimal value of 100 for channel catfish and blue catfish (Figure F-5). The largemouth bass mean $W_r$ was 90, which was slightly below the range of 95 to 100 often considered optimal for management purposes of this species (Murphy et al. 1991). The bluegill mean $W_r$ value also was below optimal and suggested high inter- and intra-specific competition for available food sources within the reservoir. The PSD, RSD, and $W_r$ values for white perch indicated the presence of quality-size fish in the reservoir even with an existing large population.

In summary, fish species composition and dominance patterns in Lake Tillery have been similar over the past 50 years, when considering the reservoir’s moderate biological productivity, the natural aging of the reservoir, and the introductions of other species into the community over
time (e.g., threadfin shad, striped bass, flathead catfish, and blue catfish). Community composition and dominance patterns were similar between 1992 and 2000 although the total fish density and biomass estimates were lower in 2000. Reproductive success of the major prey and sport fishes was good during 2000 with multiple size classes present. The size structure and body condition of most major sport fishes was within or just below the desired ranges.

**Blewett Falls Lake Fish Populations**

*Species Composition*

Gizzard shad, threadfin shad, blue catfish, smallmouth buffalo, bluegill, channel catfish, and largemouth bass were dominant species in the reservoir (Tables F-6 to F-11; Figure F-1). In particular, native and nonnative planktivorous or benthivorous feeding fish species-bluegill, threadfin shad, blue catfish, and smallmouth buffalo-were very prevalent in the fish community. Despite the dominance of a few species, the reservoir had a diverse fish community (Table F-1). Fifty-two taxa were collected from the reservoir during 1999 and 2001 with Centrarchidae, Cyprinidae, and Catostomidae families representing most taxa. Species composition may have been influenced, to some extent, by fish movement to and from the river reach located above the reservoir. The NCWRC (1966) reported 30 taxa from the reservoir during fishery surveys in the late 1950s and early 1960s, and most of these taxa were represented in Progress Energy contemporary surveys.

*Species Abundance and Community Composition*

The electrofishing reservoir-wide total mean catch rates ranged from 216 to 227 fish/hr with weights of 36.5-41.4 kg/hr during 1999 and 2001 (Tables F-9 and F-10). Numerically dominant species, as defined by five percent of the reservoir-wide total mean catch, for both years were bluegill, threadfin shad, gizzard shad, largemouth bass, and smallmouth buffalo. By weight, largemouth bass, gizzard shad, white catfish, and redbear sunfish were the dominant species.

The gill net reservoir-wide total mean catch rates ranged from 62.6 to 65.4 fish/24 hours with weights of 8.1-13.5 kg/24 hours (Tables F-11 and F-12). Threadfin shad, blue catfish, gizzard shad, black crappie, white perch, and gizzard shad were the most numerically abundant species.
Blue catfish, black crappie, channel catfish, and gizzard shad comprised most of the weight. White perch, a dominant species in gill net catches in the upstream hydroelectric reservoirs, was not very abundant in Blewett Falls Lake, comprising less than 10 percent by number and weight. Conversely, blue catfish was very abundant in Blewett Falls Lake with greater catch rates than the other upstream reservoirs (< 2 fish/24 hours) (Table F-7; APGI 2000).

Productivity of the fish community in Blewett Falls Lake and the upper Yadkin-Pee Dee hydroelectric reservoirs reflected the nutrient availability, trophic status, available cover and habitat types, and retention times of each reservoir. The electrofishing and gill netting numerical total fish mean catch rates were ranked in decreasing order for the Yadkin-Pee Dee River reservoirs, including Blewett Falls Lake, and are presented in Table 4-2.

![Table 4-2](image)

**TABLE 4-2**

<table>
<thead>
<tr>
<th>Electrofishing Total Fish Mean Catch</th>
<th>Gill Netting Total Fish Mean Catch</th>
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<tbody>
<tr>
<td><strong>Reservoir</strong></td>
<td><strong>Number fish/hr</strong></td>
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<td>Narrows</td>
<td>251</td>
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<td>Blewett Falls</td>
<td>222</td>
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Generally, the more biologically productive reservoirs produced greater total fish catch rates with bluegill, shad, or white perch the dominant species depending upon the sampling method.

Electrofishing annual mean catch rates of largemouth bass in Blewett Falls Lake were 13 and 18 fish/hour during 1999 and 2001, respectively, and were comparable to catch rates from Lake Tillery and other upstream reservoirs (15-22 fish/hr) (Table F-6; APGI 2000). Largemouth bass catch rates were significantly greater (P < 0.001) in the lower and middle reservoir areas as compared to the headwaters area. Catch rates of largemouth bass were also significantly greater (P < 0.001) in the winter, spring, and fall months reflecting inshore/offshore movements related to temperature preferences, feeding, and spawning.

Total fish mean density and biomass estimates from cove rotenone sampling during 1999 and 2001 were very high and reflected the reservoir’s eutrophic characteristics (Tables F-13 and F-14; Figure F-1). These estimates were greater than the 1993 reservoir estimates and the Lake
Tillery estimates in 1992 and 2000. The Blewett 1999 and 2001 estimates were comparable to the NCWRC 1980s estimates from Narrows Reservoir. The NCWRC also conducted rotenone sampling at Blewett Falls Lake during 1956 through 1959 and in 1965 (NCWRC 1966). The NCWRC density estimates during 1956 through 1959 were 1,284 to 23,857 fish/ha and 9,701 fish/ha in 1965. Biomass estimates during this same period were 35 to 236 kg/ha and 109 kg/ha, respectively. Given these results, Blewett Falls Lake overall fish production has apparently increased through time, and these increases were largely driven by shad production (Figure F-1). Varying periods of reservoir retention time during low vs. high flow years may influence nutrient uptake and assimilation by algae and subsequently young-of-year recruitment dynamics in reservoirs, particularly for shad.

Cove rotenone samples reflected the predominance of shad and bluegill in the reservoir by number and weight. Smallmouth buffalo also comprised a large portion of the fish biomass (Tables F-13 and F-14). There has been a shift towards greater shad dominance in the fish community when the composition was compared from 1993 to 2001 (Figure F-1). The relative contribution of bluegill to total fish density and biomass has remained similar among years. The NCWRC (1966) reported shad contributing about equal percentages of the total density (31 percent) and biomass (34 percent) during rotenone sampling in 1965. Bluegill comprised 13 percent and 15 percent to the total biomass and density estimates, respectively. During the 1993 Progress Energy sampling, shad comprised 26 percent and 53 percent of the density and biomass estimates, respectively. Bluegill comprised about equal percentages (12 to 13 percent) of these same respective estimates. In 1999 and 2001, shad comprised 81 percent of the combined total mean density and 49 percent of the total mean biomass. However, the percent contribution of bluegill to total mean density (16 percent) and total mean biomass (15 percent) was similar to previous investigations. Relative contributions of shad biomass to total fish biomass were with the expected range for southeastern reservoirs (40 to 60 percent) while bluegill was slightly less than the average value (20 percent). Total bluegill biomass, however, greatly exceeded the southeastern average of 20.7 kg/ha reported by Jenkins (1975).

The biomass estimates of largemouth bass were highly variable by year. During 1999, the biomass estimate of 5.1 kg/ha was less than 10 kg/ha reported by Jenkins (1975) for southeastern United States impoundments. In contrast, the biomass mean estimate in 2001 (23 kg/ha) was
approximately twice the southeastern average. The biomass estimates of largemouth bass were consistently even across sampled transects during 2001. Given the dominance of shad and smallmouth buffalo, the contribution of largemouth bass biomass to total fish biomass was less than five percent during both years.

*Intensive Spring 2002 Survey*

Intensive electrofishing conducted during April 2002 also showed bluegill was the predominant sunfish species in the reservoir (Table F-15). Largemouth bass catch rates ranged from 16 to 33 fish/hr with an overall reservoir mean of 27 fish/hr. The reservoir wide mean catch of largemouth bass was approximately twice the mean values observed with quarterly electrofishing which reflected the amount of sampling effort and the inshore movement of spawning largemouth bass during the spring (Tables F-9 and F-10).

Bluegill and largemouth bass catch rates were significantly greater catches (P < 0.001) in the lower and middle reservoir areas (below Grassy Islands complex) than the upper reservoir (above Grassy Islands complex). Spatial differences in fish abundance probably reflected the relative habitat conditions and prey availability within the reservoir. The upper reservoir was shallow with more semi-riverine conditions, and algal productivity (as indicated by chlorophyll *a* concentrations) was significantly lower in this area. The substrate tended to be alluvial in this upper area and cover types included emergent vegetation and woody debris. In the middle and lower reservoir, there was more woody debris and hard bottom substrate (sand, boulders, cobble, and gravel) suitable for protective cover and spawning for sunfish species.

Three adult Carolina redhorse were collected during the study from the upper reservoir area near the river-reservoir transition area (Tables F-2 and F-15). Two fish were collected from the main reservoir while one fish was collected from the side channel located on the east side of the reservoir. These fish were not in spawning condition.

Length-frequency histograms showed multiple size classes present for bluegill, largemouth bass, and redear sunfish indicating successful reproduction in past years (Figure F-6). Yearling largemouth bass (< 200 mm) comprised 24 percent of the entire reservoir sample while yearling bluegill (< 80 mm) comprised 25 percent of the total sample. A large percentage of the
largemouth bass population was within the 250 to 430 mm size class (10 to 17 inches) and 27 percent of the population was of harvestable-size (≥ 356 mm or 14 inches). The largemouth bass PSD and RSD values were within acceptable ranges considered for balanced populations (Figure F-6). Larger, preferred-size fish ≥ 380 mm accounted for 21 percent of the total number of largemouth bass. The bluegill PSD was within the acceptable range (20 to 60) for a balanced population; however, few large fish were present which is typical for this species in large impoundments. The redear sunfish PSD and RSD values were within acceptable ranges although the sample size was small. Relative weight (W_r) values for redear sunfish and bluegill indicated below average body condition (Figure F-6). The largemouth bass W_r was slightly below the optimal fishery management range of 95 to 100 but considered to be within an average range for warmwater reservoirs.

Size Structure, Reproductive Success, and Body Condition

Multiple size classes were observed for major prey and sport fish species indicating successful reproduction through time (Figures F-7 to F-10). Reproductive success of each species varied by year. Largemouth bass produced a good year class during 1999, which should sustain the fishery for the next several years (Figure F-8). Largemouth bass reproductive success was lower during 2001. Bluegill produced good year classes during 1999 and 2001 with large numbers of young-of-year present in cove rotenone samples (Figure F-8). Threadfin shad reproductive success was good during both study years while gizzard shad produced a strong year class in 2001 (Figure F-7).

The PSD, RSD, and W_r values varied widely depending upon the species (Figures F-7 to F-11). Largemouth bass PSD values from cove rotenone samples were within the balanced range during 1999 and 2001 (Figure F-8). The largemouth bass RSD value was with the acceptable range during 1999 but slightly lower in 2001. Relative weights of largemouth bass were considered average (89 to 90).

Bluegill PSD values from cove rotenone samples were within the acceptable range during 2001 but not during 1999 (Figure F-8). The RSD values for bluegill were low and reflected the large number of small individuals present in the population. Bluegill relative weight was low during
both years and indicative of low body condition and high competition for food resources. Redear sunfish also had low $W_r$ mean values (Figure F-11).

Black crappie exhibited PSD values above the acceptable range (30 to 60) due to a large number of intermediate-size fish in the population. However, the black crappie RSD values also indicated a large number of quality-sized fish in the population (Figure F-10). Black crappie $W_r$ mean values were near optimal indicating good growth and body condition. The abundant shad prey base in the reservoir benefited this species (Figure F-11).

The blue catfish, channel catfish, and white perch populations were comprised mainly of smaller individuals and few quality-size fish were present in the reservoir. Blue catfish $W_r$ mean values were less than 90 suggesting overpopulation and stunting of growth rates, possibly from competition for available food resources (Figure F-11). The $W_r$ mean values for channel catfish and white perch ranged from 90 to 93 and were considered average.

The few collected striped bass during 2001 were near optimal body condition and exploiting the shad prey base. Smallmouth buffalo body condition was low in both years.

In summary, Blewett Falls Lake supported a very productive, warmwater fish community that reflected the eutrophic conditions of the reservoir. The fish community was dominated by the planktivorous and benthivorous feeding species-shad, bluegill, blue catfish, and smallmouth buffalo. Shad dominance within the fish community has apparently increased over time and may reflect changes in algal productivity, particularly in lower flow years when there may be greater nutrient uptake and assimilation within the reservoir. Body condition and population size structure for these species suggested high competition for available food resources in the reservoir. Despite the dominance of these few species, the reservoir had a fairly diverse fish community as demonstrated by the taxa richness.

The reservoir supported reasonable sport fish populations for largemouth bass and crappie as demonstrated by the catch rates, size structure, and body condition. Largemouth bass biomass estimates in 2001 were twice the expected biomass for a southeastern reservoir. Young-of-year recruitment for largemouth bass appeared to be variable. A good year class was produced during
1999, which should help sustain the fishery over the next several years. Electrofishing catch rates of largemouth bass were comparable to the upstream hydroelectric reservoirs although the rates were on the lower end of the range of values. Largemouth bass body condition was below the optimal range for fishery management purposes but still considered to be average. The black crappie population, in particular, was of good quality. A large number of harvestable-size fish were present with good body condition, presumably a reflection of the abundant shad prey base. The few striped bass that were collected also exhibited good body condition indicating they were exploiting the abundant shad prey base.

_Tailwater Fish Populations Pee Dee River Reach from the Tillery Development to Blewett Falls Lake_

**Species Composition**

The number of taxa collected during fishery surveys conducted in 2000 was slightly greater in the immediate tailwaters area (38 taxa at Transect 1 excluding the unidentified fish) as compared to the downstream mid-reach station (31 taxa at Transect 12) (Table F-16). The notable differences were the collection of several bullhead catfish, sucker, and sunfish taxa at Transect 1. Flathead catfish and blue catfish were only collected at the downstream station (Tables F-5 and F-16). Bullhead catfish species were only collected at Transect 1 in the absence of flathead catfish, even when taking into account differences in sampling effort (i.e., no gill nets used at Transect 12). Smallmouth buffalo, an omnivorous feeding generalist, was prevalent throughout this river reach.

_**Intensive Biweekly Spawning Surveys**_

Water temperatures ranged from 9.1° to 23.8°C in the immediate tailwaters and 11.9° to 25.4°C at the downstream mid-reach area during the March through June 2000 study (Figure F-12). The immediate tailwaters area was slightly cooler and differed by 0.6° to 5.6°C between the two transects during the study period. DO concentrations decreased from approximately 11 mg/L to 4-6 mg/L as a function of changes in oxygen solubility with warming of water temperatures and discharge of oxygen-deficient hypolimnetic lake waters through the power plant. The DO concentration at Transect 1 (3.8 mg/L) was below the state water quality standard on June 28, the
last week of the study. Turbidity was usually low except for an elevated value of 130 NTU that occurred at Transect 12 during the third week of March following a high precipitation and inflow event from the Rocky River. This value was 2.6 times the state water quality standard of 50 NTU.

Mean velocities measured in the water column ranged from 1.1 to 2.6 feet/sec at Transect 1 and from 0.1 to 1.6 feet/second at Transect 12 (Figure F-13). The greater velocities at Transect 1 reflected the proximity of the powerhouse discharge, the amount of power generation, and the channel gradient. Mean velocities at Transect 12 decreased to less than 0.5 feet/second during baseflow conditions encountered in May and June.

Dominant species at Transect 1 during March through June period were gizzard shad, smallmouth buffalo, threadfin shad, longnose gar, and white perch (Tables F-17 and F-18). At downstream Transect 12, dominant species were gizzard shad, smallmouth buffalo, common carp, threadfin shad, blue catfish, and channel catfish. Common carp and catfish species were more prevalent at Transect 12.

Seventeen species were ripe, mature, or spent indicating reproductive activity within the reach. Table 4-3 shows sequencing of fish in spawning condition, as indicated by the presence of fish in reproductive condition, in the river reach by sample date:

<table>
<thead>
<tr>
<th>TABLE 4-3</th>
<th>FISH COLLECTED AT TILLERY TAILWATER IN SPAWNING CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gizzard shad</td>
<td>*</td>
</tr>
<tr>
<td>Threadfin shad</td>
<td></td>
</tr>
<tr>
<td>Common carp</td>
<td>+</td>
</tr>
<tr>
<td>Quillback</td>
<td></td>
</tr>
<tr>
<td>Brassy jumprock</td>
<td></td>
</tr>
<tr>
<td>Shorthead redhorse</td>
<td></td>
</tr>
<tr>
<td>Smallmouth buffalo</td>
<td>+</td>
</tr>
<tr>
<td>Channel catfish</td>
<td></td>
</tr>
<tr>
<td>Bluegill</td>
<td></td>
</tr>
<tr>
<td>Redbreast sunfish</td>
<td></td>
</tr>
<tr>
<td>Pumpkinseed</td>
<td></td>
</tr>
<tr>
<td>Warmouth</td>
<td></td>
</tr>
<tr>
<td>Largemouth bass</td>
<td></td>
</tr>
<tr>
<td>Striped bass</td>
<td></td>
</tr>
<tr>
<td>White bass</td>
<td>*+</td>
</tr>
<tr>
<td>White perch</td>
<td></td>
</tr>
<tr>
<td>Yellow perch</td>
<td>*+</td>
</tr>
</tbody>
</table>

Symbols denote presence at a particular transect * = Transect 1 and + = Transect 12.
More sexually mature species were observed in the immediate tailwaters area (Transect 1) than the downstream mid-reach area (Transect 12). The presence of sexually mature fish also showed a seasonal progression based on water temperatures for spawning of a particular species. Sexually mature white bass, striped bass, white perch, and yellow perch were present in the tailwaters from early March through mid-April. Striped bass and white bass most likely migrated out of Blewett Falls Lake or the lower river reach, as these species were not collected by June. Common carp and smallmouth buffalo had prolonged spawning periods as noted by the presence of sexually mature individuals from March through June. Other sucker and sunfish species were observed in April through May.

Reproductive activity, as measured by larval densities, was greater at Transect 1 than Transect 12 (Table F-19; Figure F-15). Ten larval fish/egg taxa were collected at Transect 1 from March through June. The dominant taxa were blueback herring, threadfin shad, gizzard shad, white perch, and yellow perch (Table F-19). Seven larval taxa were collected downstream at Transect 12 and dominant taxa were carpsuckers/buffalo species (*Carpiodes/Ictiobus* spp.) and white perch. No white bass larvae or striped bass eggs or larvae were collected at either transect. The total larval mean density at Transect 1 was an order of magnitude greater than the total mean density at Transect 12.

Total larval densities peaked during April through late May at Transect 1 (Figure F-4). Blueback herring and white perch larval densities peaked during mid-April while gizzard shad/threadfin shad peaked during mid- to late May. Total larval densities peaked in during mid-April at Transect 12, as a result of a pulse of carpsucker/buffalo larvae. Larval densities had declined to low levels at Transect 12 by the third week of May (Figure F-15).

The presence of blueback herring larvae at Transect 1, and to a lesser extent, at Transect 12, suggested larvae were likely produced in Lake Tillery and passed through the hydroelectric plant or over the dam to downstream areas. Few adult blueback herring were collected at either transect during the spawning assessment or intensive shocking for redhorses in May. Moreover, blueback herring were not collected during the resident fish survey (Tables F-20 and F-21).
Although no white bass larvae were collected during ichthyoplankton sampling, the population inhabiting this river reach and Blewett Falls Lake has been self-sustaining. This species was introduced during the 1960s by the NCWRC. White bass were observed in NCWRC fishery sampling of Blewett Falls during 1965 and during Progress Energy studies in 1986 and 1993. Fish (1968) reported white bass during creel surveys and noted the good fishing for this species in the reservoir. The striped bass population in the river reach and Blewett Falls Lake is managed by the NCWRC as a put-grow-and-take fishery and sustained through annual stocking, therefore, spawning is not expected.

**Resident Fish Survey**

Species dominance within the fish community differed by river reach location. In the immediate tailwaters reach, smallmouth buffalo, gizzard shad, longnose gar, and largemouth bass were dominant species by number and weight (Tables F-20 and F-21). The dominance patterns shifted downstream at Transect 12 with common carp and catfish—predominantly detritivorous and benthivorous feeding species—more prevalent. Gizzard shad, common carp, channel catfish, and smallmouth buffalo were the numerically dominant species. By weight, common carp, gizzard shad, smallmouth buffalo, channel catfish, and blue catfish were dominant.

The shift in species dominance may have reflected the changes in fish habitat (e.g., temperature regime, river channel substrate, and velocities) and/or food availability downstream of the Rocky River confluence (see Section 4.4.2, Benthic Invertebrates). Visible sedimentation was evident at this station, which most likely was deposited mainly from Rocky River inputs over time. Upstream of the Rocky River confluence, the substrate was cleaner with more cobble, gravel, and boulders visible due to the high velocities and associated scouring with releases from the hydroelectric plant, and lack of sediment loading.

Although there were differences in community composition, there were no significant spatial or temporal differences in total fish mean number per hour or weight per hour between Transects 1 and 12 (Figure F-15). No statistical differences occurred in the number of fish taxa collected between transects during 2000. However, more fish taxa were collected in May, August, and November than in February (Figure F-15).
Average sizes of common carp, smallmouth buffalo, channel catfish, redbreast sunfish, and bluegill were greater at Transect 1 than at Transect 12 (Table F-22). The average size of gizzard shad was larger at Transect 12. Length ranges indicated multiple size class present for most species indicating successful reproduction over years. Young-of-year and yearling fish were collected for gizzard shad, threadfin shad, redbreast sunfish, bluegill, and largemouth bass.

Body condition was near optimal for common carp, blue catfish, channel catfish, flathead catfish, and largemouth bass, as indicated by $W_r$ values (Table F-22). The body condition of gizzard shad, smallmouth buffalo, and bluegill was below average.

*Tailwater Fish Populations - Pee Dee River Reach Below the Blewett Development*

*Species Composition*

The number of taxa collected throughout the reach ranged from 47 (Transect 6) to 57 (Transects 1 and 2) (Table F-23). Generally, a greater number of taxa were collected in the immediate tailwaters and the downstream transect located at U.S. Highway 1 at Cheraw, South Carolina. The fewest taxa were collected at the mid-reach area, Transect 3, located below South Carolina Highway 15/401 and the lower most area, Transect 6, located below U.S. Highway 701 near Yauhannah, South Carolina. Species differences were related to changes in habitat and the fish community composition as the river transitioned from the Fall Line to Lower Coastal Plain physiographic provinces (e.g., pirate perch, flier, spotted sunfish, and southern flounder). Several species were present throughout the entire river reach (e.g., American eel, longnose gar, gizzard shad, common carp, eastern silvery minnow, fieryblack shiner, blue catfish, flathead catfish, channel catfish, bluegill, largemouth bass, black crappie, and striped mullet).

*Migratory Fish Surveys*

Intensive biweekly sampling was conducted during 1998 and 1999 for a migratory fish survey and resident fish spawning. Each year was distinctly different in hydraulic regimes and water quality characteristics (Figures E-1, F-16, and F-17). River flows exceeded the long-term monthly average during the 1998 spring spawning period due to the El Niño weather pattern.
The river flow was below normal during the spring of 1999 and only one high flow event (early May) occurred during the March through June study period.

The temperature regimes also differed in both years (Figure F-16). The spring of 1998 was cooler and wetter and, subsequently, river temperatures gradually warmed during the study period. Water temperatures rose above 15ºC throughout the river by the week of March 30 and reached above 20ºC by the week of May 11. In contrast, river temperatures warmed quickly during 1999 and reached 20ºC by the week of April 12, approximately one month earlier than in 1998.

DO concentrations generally exhibited a spatial gradient with greater DO concentrations in the upstream areas (Transects 1 and 2) as compared to downstream areas (Transects 3, 4, 5, and 6). (Figure F-16). A DO sag was observed in the lower river (Transects 5 and 6) during the weeks of May 25 and June 8 of 1998 with DO concentrations ranging from 3.7-4.9 mg/L. The DO concentrations ranged from 5.8-7.1ºC at the other upstream stations on these same dates. This sag was likely caused by DO deficient water naturally draining from blackwater swamps and creeks as the river flows dropped after rainfall ceased in May.

Turbidity levels were greater and more variable during 1998 as a result of the greater river flows (Figure F-17). Turbidity levels were less variable during 1999 with values usually 20 NTU or less throughout the river. Values greater than 50 NTU were observed in the upper river during the week of March 16, 1998, after a flood event when river flows ranged from approximately 60,000 to 80,000 cfs (Figure E-1).

Five species of migratory fish-American shad, American eel, blueback herring, hickory shad, and striped bass-were documented utilizing the Pee Dee River reach below the Blewett Development for reproductive purposes during 1998 and 1999 (Tables F-24 to F-31). American shad, blueback herring, hickory shad, and striped bass are anadromous species whose adults return upstream from the sea to reproduce. The American eel is a catadromous species whose adults leave the river system to spawn in the Sargasso Sea and young then return to natal rivers to grow into adults. Sea lamprey, a parasitic anadromous species, was also collected at Transect 1 during 1999 (Table F-25).
American shad - American shad was the most abundant of the migratory species collected during 1998 and 1999. Electrofishing catch rates of American shad were significantly greater (P < 0.001) in the immediate tailwaters area, Transect 1, as compared to other transects located downstream over both years (Tables F-24 and F-25). Therefore, the remainder of the results and discussion of catch rates will focus on Transect 1.

American shad ranked in the top five most abundant species collected at Transect 1 during the 1998 and 1999 biweekly studies. Mean catch rates for electrofishing and gill netting in 1998 were approximately twice the 1999 catch rates. However, there was no statistical difference (P = 0.24) in annual catch rates between years. Gill net mean number and weight catch rates at Transect 1 were 8.7 fish/24 hours weighing 8.3 kg in 1998 and 2.4 fish/24 hours weighing 2.0 kg in 1999. Electrofishing mean catches were 13 to 29 fish/hour and 11 to 24 kg/hour during 1998 and 1999 (Tables F-24 and F-25). American shad electrofishing catch rates for the Pee Dee River were greater than the average spring catch rate of 6.4 fish/hour (peak catches of 14 to 18 fish/hour) reported for the uppermost station located on the Roanoke River, North Carolina, during a migratory fish assessment conducted in 1996 (Knutzen 1997).

No biweekly surveys were conducted during 2000 and 2001; however, electrofishing mean catch rates for American shad were obtained in the vicinity of the tailwaters area during intensive electrofishing for robust redhorse in both years (Tables F-3 and F-4). American shad catch rates ranged from 15 to 20 fish/hour, and the species was the first or second most numerically abundant species collected during these studies. Mean catch rates were comparable to the 1999 biweekly estimate but less than the 1998 estimate.

American shad catch rates at Transect 1 varied by sample week within a particular year as fish migrated up the river into the vicinity of the tailwaters area (Figure F-18). The peak catches during 1999 were also approximately one-half of the 1998 peak catches. Most American shad were caught in both years from the end of March through mid-June. During 1998, electrofishing catch rates peaked during the week of April 13 (66 fish/hour) with subsequent smaller peak catches during the weeks of May 11 (52 fish/hour) and June 8.
Water temperature during these weeks ranged from 16.7°C to 24.3°C (Figure F-16). The catch curve during 1999 was lower and without pronounced peaks as observed in 1998 (Figure F-18). The peak catches occurred during the weeks of May 10 (28 fish/hour) and May 24 (26 fish/hour). Water temperatures were warmer during 1999 and ranged from 20.0°C to 22.7°C during peak catch weeks (Figure F-16). Walburg and Nichols (1967) reported most American shad spawning usually occurs between 13 to 20°C.

American shad ranged from 327 to 567 mm during 1998 and from 284 to 555 mm during 1999, combining all data from sampled transects (Figure F-19). Three prominent modal lengths were observed in the spawning population during 1998 at 405, 445, and 505 mm. During 1999, modal peaks were more frequent ranging from 425 to 515 mm. Fish collected during intensive electrofishing survey during 2000 and 2001 had similar size ranges. Modal lengths were 445 and 455 mm in 2000 and 2001, respectively (Figure F-20). The size range of spawning American shad in the Pee Dee River was similar to Roanoke River population during 1996 where lengths ranged from 365 to 576 mm (Knutzen 1997).

Males in the spawning population were smaller at a given age than females (Tables F-32 and F-33). The age composition of the spawning populations during 1998 and 1999 was similar. Males ranged in age from two to six years while females ranged from three to six years (Table F-32). The majority of males and females in the spawning population were three to five years of age. The oldest fish were mostly females. Mean length at age estimates for both sexes was also consistent between 1998 and 1999. Age structure of spawning American shad in the Pee Dee River was consistent with studies conducted along the eastern U.S. seaboard. American shad usually mature by ages three to six with some males maturing by age two in more southern latitudes (Jenkins and Burkhead 1993). Typically, fewer repeat spawners occur in American shad populations in the more southern U.S. populations with most adults spawning only once in rivers south of Cape Hatteras, including the Pee Dee River (Leggett and Carscadden 1978; Jenkins and Burkhead 1993).

The historical spawning migration range for American shad of the Pee Dee River appeared to be near Wilkesboro, North Carolina, approximately 451 miles inland according to an anecdotal historical account by Stevenson (1897) and a historical range map in National
Oceanic and Atmospheric Administration historical photograph archives (NOAA 2002). However, it is unclear what the extent of the American shad migration to this historical area was over time, particularly in naturally occurring drought years when shad ascension through the Narrows Canyon (at present day Narrows Dam) would have been difficult. Stevenson also reported the migration limit in 1896 was at the Grassy Island area, 242 miles from the sea, and only one American shad was reported for that location and year. This migration limit dates before the construction of hydroelectric projects on the river. Stevenson also indicated that intensive overfishing was the single most important factor impacting the inland range of American shad in the 1800s (Stevenson 1897, 1899).

**Blueback Herring** - Blueback herring had relatively low abundance during 1998 and 1999 with mean electrofishing catch rates #4 fish/hour and gill net catch rates < 1 fish/24 hrs (Tables F-24 to F-27; Figure F-18). The abundance of sexually mature fish was slightly greater in 1998. Knutzen (1997) reported blueback herring had low abundance in the Roanoke River with an average electrofishing spring catch rate of 1.4 fish/hr with a peak catch of 8.4 fish/hr. The abundance of blueback herring in the Pee Dee River was greater in 1998 than 1999. Most adults were collected at Transects 4, 5, and 6 in the lower Coastal Plain area of the river. A small number of adults in spawning condition (mature or ripe) were collected in the upper river at Transects 1 and 2. Eighty-seven percent of spawning adults (n = 52) were collected in the lower Coastal Plain reach extending from Transect 4 to Transect 6 during 1998 and 1999. These results suggested the lower reach of the river (from Florence area to below Yauhannah, South Carolina) was the most utilized spawning area for this species with the upper river of lesser importance. Additionally, it is unclear whether the adults observed in the vicinity of the Blewett Development are true migratory fish or resident fish that emigrated out of Blewett Falls Lake.

Most fish were collected in March and April when water temperatures ranged from 9.3°C to 21.6°C. Electrofishing catch rates peaked at 26 fish/hour at Transect 5 during the week of March 16 in 1998 and 4 fish/hour on the week of March 29 in 1999. Water temperatures during these peak catches were 10.9°C and 14.2°C during 1998 and 1999, respectively. In contrast, peak catches at Transect 1 were 3 fish/hour in 1998 (weeks of March 30 and April 13) and 2 fish/hour in 1999 (weeks of April 12 and 26) (Figure F-18).
The size distributions were similar during 1998 and 1999 with fish ranging from 225 to 295 mm (Figure F-21). A few smaller fish were observed in 1998 (225-240 mm). There was a pronounced modal peak at 270 mm during 1998; however, in 1999, the size classes were more evenly distributed (Figure F-21). Most sexually mature adult fish were three and four years old, and females were slightly larger than males at a given age (Tables F-32 and F-33). All sexually mature females were greater than 250 mm, which was consistent with observations on the Roanoke River blueback population during 1996 (Knutzen 1997).

Scant information exists on the extent of upstream migration limits for blueback herring in the Pee Dee River Basin. Cooke and Welch (2000) reported from a historical account given by Mills (1826) that herring (most likely blueback herring) appeared to have ascended the Waccamaw and Pee Dee Rivers, portions of the Lynches and Black Rivers and possibly the Little Pee Dee River. Mills (1826) reported blueback herring as far upstream as Darlington County, South Carolina, where the fish was in great abundance in Louder’s Lake.

Blueback herring have been stocked by the NCWRC and currently have populations in all Yadkin-Pee Dee River reservoirs although the reservoir populations appeared to be low compared to the other planktivorous clupeids, gizzard shad and threadfin shad. It is unknown what river parental population was utilized for stocking or whether genetic/behavioral differences exist in the landlocked vs. migratory sea run populations.

- **Hickory shad** - Hickory shad was not very abundant in catches during 1998 or 1999 (Tables F-24 to F-25). Most adults in spawning condition (mature or ripe) were located in the lower river reaches in the middle to lower Coastal Plain regions (Transects 4, 5, and 6) during both years. No hickory shad were collected in the immediate tailwaters area; however one adult was captured at Transect 2 (Cheraw, South Carolina) just below the Fall Line zone during February quarterly sampling in 1999. Hickory shad usually spawn in main river channels, tributaries, sloughs, and flooded swamps in freshwater tidal to lower river reaches from February to May (Jenkins and Burkhead 1993). All sexually mature fish were collected during February (quarterly sampling) or March (biweekly sampling) of 1998 and 1999 when water temperatures ranged from 9.3º to 21.6ºC.
The few adult fish that were collected ranged from 337 to 469 mm (Figure F-22) and 2 to 5 years of age (Tables F-32 and F-33). Jenkins and Burkhead (1993) reported hickory shad generally mature at 3-5 years of age with a few fish of both sexes as young as two years old.

- **Striped bass** - Striped bass were not very abundant during the spring spawning periods from 1998 to 2001 (Tables F-3, F-4, F-27 to F-30; Figure F-18). There were no apparent spatial or temporal differences in striped bass catch rates throughout the river as shown by electrofishing or gill net catch rates. Of the few fish collected at Transect 1, the abundance of adults in spawning condition was the greatest during May of both years (Figure F-18). Water temperatures during May 1998 ranged from 20.3°-24.8°C and from 20.0°-22.7°C in May 1999. Spawning of striped bass in the Roanoke River, North Carolina, occurred from 14°-24°C with the optimal range from 16° to 21°C with most spawning occurring prior to June (Hassler et al. 1981; Knutzen 1997). The presence of hybrid striped bass-white bass in this river reach during fishery studies indicated the potential for backcrossing with fertile striped bass, if these hybrids were also fertile (Tables F-24 and F-26).

Length-frequency histograms showed similar size distributions during both years ranging from 182 to 872 mm during 1998 and from 168 to 921 mm during 1999 (Figure F-23). The majority of fish in spawning condition ranged 350 to 600 mm with a few large individuals present. Spawning condition males ranged from 2 to 6 years old and females ranged from 2 to 10 years old (Tables F-32 and F-33). The oldest fish present in the samples were females (8 to 10 years old), which was consistent with other studies of striped bass (Jenkins and Burkhead 1993; Kornegay 1997). The young, sexually immature fish present during both years (< 250 mm) suggested that some stocked striped bass had emigrated from Blewett Falls Lake and inhabited the immediate tailwaters area.

The upstream migration limit of striped bass was most likely near the Fall Line zone of the Pee Dee River based on the species life history characteristics and accounts given from Virginia waters by Jenkins and Burkhead (1993). The abrupt change in river gradient in the Narrows Canyon would have made striped bass migration past this natural barrier difficult. Cooke and Welch (2000) reported one historical account given by Mills (1826) that said
striped bass ascended the Pee Dee River to present day Marlboro County, South Carolina. The striped bass population in the Pee Dee River is most likely a near-shore coastal population that does not undergo extensive oceanic migrations. Populations south of Cape Hatteras rarely undergo extensive coastal migrations (Jenkins and Burkhead 1993).

- **American eel** - American eel, a catadromous species, was common in springtime and seasonal electrofishing catches throughout the river from 1998 to 2001 (Tables F-3, F-4, F-24, F-25, F-28, and F-29). electrofishing catch rates of American eel (juvenile or yellow stage) were greater in the upper river areas (Transects 1 and 2) and mainly comprised of young eels (< 200 mm) immigrating into the river during the spring months (Tables F-24 and F-25; Figure F-24). Mean catch rates of this species was similar throughout the river in 1998 or 1999. However, electrofishing catches of this species were probably, to a certain extent, lower than the actual abundance. Eels were not very susceptible to this sampling method (pulsed DC current), and it was extremely difficult to capture them in the electrofishing field. Many eels were observed at all transects that were not captured during sampling. The electrofishing catch rate for this species averaged 4 to 5 fish/hour at Transect 1 during March through June of both years (Tables F-24 and F-25). Catch rates of young-of-year American eel (elvers) were low during 1998 with peak catches of 6 fish/hour (weeks of March 2 and May 11 and 25). Catch rates of elvers at Transect 1 were greater during 1999 and peaked during the weeks of May 10 and June 7 (12 and 20 fish/hour, respectively) with water temperatures ranging from 20.0º to 25.1ºC. Five out migrating adult silver American eels were observed in electrofishing catches during November 1999 at Transects 2, 3, 4, and 5. The lengths of these adults ranged from 455 to 655 mm. Water temperatures during sampling ranged from 11.7º to 16.5ºC.

Length-frequency distributions varied by year with fish lengths ranging from 100 to 710 mm (Figure F-24). There were distinct pronounced modal lengths of fish in the 290, 330, and 490 mm size classes in 1998, although sample sizes were small. Modal lengths of size classes were not distinct in 1999. A large percentage of eels in both years ranged from 220 to 400 mm. Young eels contributed a smaller percentage of the population in 1998 (15 percent) as compared to 1999 (30 percent).
Small numbers of immature juveniles were collected in Blewett Falls Lake and in the river reach from the reservoir to the base of Tillery Dam during the 2000 and 2001 fishery studies. No American eels were collected in Lake Tillery or the upstream portion of the river basin suggesting the reach below Tillery Dam was the current migration limit of this species (Table F-1; Tatum et. al. 1963; CP&L 1987, 1993, 1995; Jenkins and Burkhead 1993; APGI 2002).

Moser et al. (2001) conducted a 1998 through 1999 study of the infestation rates of the exotic nematode parasite *Anguillicola crassus* in North Carolina waters, including the Pee Dee River below the Blewett Development. This nematode was first documented from an eel collected in Winyah Bay, South Carolina, during 1995. Heavy infestations of this swim bladder parasite have caused some deleterious effects in European eel populations. The intensity of infestation and percent occurrence in eels was substantially higher in North Carolina waters than reported for the Chesapeake Bay and Hudson River. Overall, in North Carolina waters, 52 percent of the eels were infected with an intensity rate of 3.9 nematodes/eel. In the Pee Dee River, 26 percent of the eels were infected with an intensity rate of 2.0 nematodes/eel. There were no statistical differences in infected eels relative to location or sampled month within the Pee Dee River. The investigators speculated that overall eel fitness might be affected in areas where prevalence and intensity of infection was the highest (Albemarle Sound drainages). The role that this parasite may play in affecting fitness of migrating American eels in the Pee Dee River is presently unknown.

**White Bass** - White bass is a resident sport fish of importance that makes upstream migratory movements within freshwater tributaries for spawning. The species is nonnative to the Yadkin-Pee Dee River and was introduced by the NCWRC into the basin during the 1960s. This species was collected mainly in the immediate tailwaters vicinity at Transect 1 during 1998 and 1999 (Tables F-24 to F-27). Electrofishing mean catches ranged from 3 to 4 fish/hour during the spring spawning period (Tables F-24 and F-25). In 1998, the electrofishing peak catch of white bass (11 fish/hour) occurred during the week of April 13 when the water temperature was 16.7°C (Figure F-18). Two peaks of white bass abundance (10 fish/hr) occurred in 1999 during the weeks of March 15 and April 12 at water temperatures of 9.6° and 18.2°C, respectively. Based on the presence of sexually mature fish
and water temperature data, spawning may have occurred from early April to late May in both years. White bass spawn at temperatures ranging from 15º to 17ºC (Rhode et al. 1994; Jenkins and Burkhead 1993).

White bass ranged from 95 to 452 mm during 1998 and 1999 with most fish in spawning condition greater than 250 mm (Figure F-25). The age of white bass ranged from two to six years old, and most females were larger than males at a given age (Tables F-32 and F-33).

**Larval Fish Survey**

A total of 28 taxa of larvae and eggs, including unidentified larvae/eggs, were collected in the river reach during 1998 (Table F-34). The number of taxa collected during 1999 was slightly lower (23 taxa, including unidentified larvae/eggs were collected) (Table F-35). Most of the collected taxa were resident species. Larvae or eggs of migratory species—American shad, blueback herring, hickory shad, and striped bass—were observed during 1998 and/or 1999.

Total larval mean densities exhibited a defined spatial pattern during 1998 with the greatest mean densities in the upper reach areas, Transects 1, 2, and 3 (Table F-34 and Figure F-26). During 1999, the spatial pattern was not as explicit due to the large number of *Carpiodes/Ictiobus* spp. (carpsucker/buffalo species) larvae observed at Transect 4 during April and May (Table F-35 and Figure F-27). The total numbers of taxa collected at each transect also varied by year but more taxa were collected at Transect 1 during both years.

Dominant taxa varied by transect and year (Tables F-34 and F-35). *Alosa* spp., American shad (eggs and larvae), blueback herring, *Carpiodes* spp. (carpsucker species), *Carpiodes/Ictiobus* spp., gizzard shad, *Dorosoma* spp. (gizzard or threadfin shad), striped bass eggs, black crappie, and unidentified larvae/eggs were the dominant taxa, depending upon the transect.

Spatial and temporal patterns of selected larval densities varied greatly depending upon the sequencing of reproductive events for a particular species, as mediated by water temperatures and river flows (Figures F-26 and F-27). Water column mean velocities were generally greater during 1998 due to the high river flows associated with the El Niño weather pattern.
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(Figure F-13). Mean velocities were lower in 1999, usually 1.0 feet/second or less on the larval fish sampling dates.

Total densities peaked at Transect 1 during the last week of May in 1998 and 1999 due to the large number of blueback herring encountered that week (Figures F-26 and F-27). Total larval densities at the other transects peaked during from late March until mid-June depending upon the river location. During 1999, the timing of total larval density peaks throughout the river was similar to 1998 except for Transects 5 and 6 where peak densities occurred two to four weeks later (Figure F-27). There were two high peak densities of *Carpiodes/Ictiobus* spp. observed at Transect 4 during the weeks of April 12 and May 10 with the number of larvae ranging from 70,000 to 90,000/m³. Pronounced peaks of this taxa group were not observed at the downstream areas (Transects 5 and 6) on these same dates.

*Resident Fish Survey*

Resident species composition (taxa richness) and abundance varied depending upon the location within the river reach and sampled year (Tables F-24 to F-31; Figures F-28 and F-30). Generally, the electrofishing total number of taxa, total fish mean number/hour, and total fish mean weight/hour was greater at Transect 1 than downstream areas (Figures F-28 to F-29). There were a greater number of taxa collected at Transect 1 in 1999 (P < 0.001); however, there was no significant difference in the number of taxa observed among transects during 2001 (P = 0.17) (Figure F-28).

The number of taxa (in parenthesis) collected with electrofishing was spatially ranked in 1999 as follows: Transect 1 (29) > Transect 2 (28) > Transect 3 (24) > Transect 4 (23) > Transect 5 (15). During 2001, the number of taxa by transect ranked as follows: Transect 1 (27) > Transect 2 (25) = Transect 3 (25) > Transect 5 (22) > Transect 4 (20). The gill net data were not utilized in this comparison due to uneven sampling at some transects, particularly at Transects 2 and 3, where heavy vegetation fouling prevented sampling on some dates during both years.

The electrofishing total mean number and weight were usually greater at Transect 1 than the other transects during 1999 and 2001 (Figures F-29 and F-30). There was a transect-by-month
interaction for total mean number/hr for 1999, which precluded discussion of significant differences among transects. General trends, though, showed greater catch rates at Transect 1. Total mean number and weight, as well as taxa richness, were also greater in the February, May, and November as compared to August (Figures F-28 to F-30).

Species dominance also exhibited spatial differences (Tables F-24 to F-31). Gizzard shad and longnose gar were dominant species throughout the river reach. Sunfish and sucker species (e.g., bluegill, redbreast sunfish, largemouth bass, smallmouth buffalo, silver redhorse, and shorthead redhorse) were more abundant in the upper reach (Transects 1 and 2) while blue catfish, flathead catfish, and common carp became more predominant in the lower reach (Transects 4 and 5). Common carp and blue catfish were also dominant species within or just below the tailwaters area (Tables F-3, F-4, and F-24 to F-31). Shiner species (e.g., eastern silvery minnow and whitefin shiner) were occasionally dominant species at various transects, but there was no explicit distributional pattern for this family within the river reach. The distribution patterns of sunfish, particularly *Lepomis* spp., suggested predation by large catfishes might have affected these species populations in the lower reach.

Species composition and dominance patterns from this study were comparable to results from a SCDNR (Crochet and Black 1997) fishery assessment of the South Carolina portion of the river reach during the 1994 through 1996 period. Forty-seven fish taxa were collected with electrofishing by the SCDNR from six reaches extending from the Piedmont Fall Line Zone to the Lower Coastal Plain region. Bluegill, blue catfish, longnose gar, whitefin shiner, eastern silvery minnow, largemouth bass, smallmouth buffalo, and common carp were the most numerically abundant species in electrofishing species. Blue catfish, common carp, smallmouth buffalo, and longnose gar were the dominant species by weight.

Tables F-36 and F-37 show summary length and weight statistics for major resident fish species collected with electrofishing during 1999 and 2001. A range of size classes was present for most species and there were few obvious differences in size ranges among transects. American eels were of a smaller average size at Transect 1 compared to other transects due to presence of more elvers in this area. Because the electrofishing sampling technique is size-selective against smaller fish (Reynolds 1996), conclusions about the young-of-year abundance in the river reach
were not possible (Tables F-36 and F-37). However, a few general observations were noted in the presence and absence of young fish. Few young-of-year were collected with the exception of gizzard shad, flathead catfish, and American eel. Gizzard shad young-of-year were more often observed in samples from Transect 1 while flathead catfish young were more often observed at Transect 5. A few young-of-year American shad were collected at Transects 1, 4, and 5 during both years.

Relative weights \( W_r \) varied depending upon the species and given sample size (Figures F-31 to F-34). Channel catfish, blue catfish, and shorthead redhorse generally had \( W_r \) values near optimal throughout the river reach in 1999 and 2001. The high \( W_r \) values for shorthead redhorse at Transect 1 were likely related to the presence of more rotund fish in spawning condition at that transect during the spring months. The \( W_r \) values for bluegill and largemouth bass were variable depending upon transect and year. Largemouth bass had optimal \( W_r \) values at Transect 1 during both years indicating fish in good body condition. The \( W_r \) values for largemouth bass were below optimal at other transects although sample sizes were small. Gizzard shad, longnose gar, and smallmouth buffalo exhibited below optimal \( W_r \) values throughout the river reach in both years. There were no obvious inter-annual differences in body condition of examined fish species.

4.4.1.4 Rare, Threatened, and Endangered Fish Species

A search was made of the North Carolina Natural Heritage Program (NCNHP), North Carolina State Museum of Natural Science (NCMNS), and South Carolina Natural Heritage Program (SCNHP) records for the presence of rare, threatened and endangered species inhabiting the Project reservoirs or associated tailwaters reaches (Menhinick and Braswell 1997; LeGrand et al. 2001). Additionally, fishery surveys were recently conducted to search for rare, threatened, and endangered (RTE) species. Location of RTE species found in the Project area are indicated in Appendix G.

- **Shortnose sturgeon** (*Acipenser brevirostrum*) - The state and federally endangered shortnose sturgeon has been documented in the Pee Dee River with a collection of a gravid female just below the Blewett Development near U.S. Highway 74 during February 1985.
Atlantic sturgeon (*Acipenser oxyrhincus*) - Atlantic sturgeon is listed as state special concern species in North Carolina waters (LeGrand et al. 2001). Collins and Smith (1997) reported this species from the lower Pee Dee River, South Carolina, and Winyah Bay with last reports in 1981 and 1995, respectively. Two records exist from the Pee Dee River in the vicinity of the Blewett Development. Ross (1997) showed a record of the species in the Pee Dee River, North Carolina, below the Blewett Development, but this collection could not be validated from a review of NCMNS records (personal communication with Dr. Wayne Starnes, NCMNS). One anecdotal record (photograph) was obtained from a commercial fisherman who caught a specimen in 1951 from the Pee Dee River, North Carolina below the Blewett Development at the U.S. Highway 74 Bridge. The specimen was estimated to be approximately 2 m total length with a weight of 48 kg (personal communication with Mr. Jim Clark).

Robust redhorse (*Moxostoma robustum*) - The robust redhorse, a Federal Species of Concern, has been recently collected from the Pee Dee River below the Blewett Development during cooperative multi-agency intensive surveys from 2000 to 2002 (Tables F-1 to F-4; Figure 4-4). Prior to these collections, one specimen was collected during June 1985 from the Pee Dee River, near Old Sneadsboro, North Carolina, approximately 19 km (12 miles) downstream of the Blewett Development (personal communication with Dr. Robert Jenkins, Roanoke College, Salem, Virginia). The species was originally described from a specimen collected by Edward D. Cope during 1869 from the upper Yadkin River above High Rock Lake (Cope 1870). The historical and contemporary occurrence records suggested this species might have inhabited the Yadkin-Pee Dee River from the upper Coastal Plain to upper Piedmont regions of the basin. The species currently has no RTE state status in North Carolina or South Carolina.
Three juveniles were collected from pool/run habitat in the Upper Coastal Plain region of South Carolina during November 2001, May 2002 and October 2002, approximately 39-89 km (24-55 miles) downstream of the Blewett Development (Table F-2). Two adult females were collected on shoal habitat in the Fall Line region during April 2000 and May 2001, at 6 km (4 miles) and 18 km (11 miles), respectively, below the hydroelectric development. Both females were gravid which suggested possible spawning activity was occurring at the collection sites. The estimated age of the specimens ranged from 2+ to 11 years old based on scale analysis by Dr. Robert Jenkins with Roanoke College, Salem, Virginia. No robust redhorse were collected from the river reach between Tillery Dam and Blewett Falls Lake during intensive, spring surveys conducted in May of 2001 and 2002 (Tables F-1 and F-5) or the project reservoirs (Tables F-6 to F-14). Total electrofishing effort expended during these 2000-2002 surveys was 22.5-50.1 hrs in the reach below the Blewett Development and 15.7-17.5 hrs in the reach below the Tillery Development.

The intensive surveys were coordinated with the Robust Redhorse Conservation Committee (RRCC); a multi-agency committee formed to address conservation of this species. The RRCC consists of state and federal resource agencies, power company utilities including Progress Energy, universities, and non-governmental organizations. The RRCC was organized in 1995 under a Memorandum of Understanding (MOU), and Progress Energy has been a member since its inception. The RRCC was formed to identify priority conservation needs and help coordinate restoration efforts for this species throughout its known range in Atlantic Slope Rivers located in Georgia and the Carolinas. The RRCC has been highly successful in achieving conservation goals, research priorities, and restoration of this species in its range through a multi-agency, inter-disciplinary approach. The RRCC meets annually to review conservation goals and prioritize research activities. The RRCC activities are published in annual reports with the most recent data reported by DeMeo (2001). A Yadkin-Pee Dee River Technical Work Group (TWG) of the RRCC was formed during February 2002 to address conservation issues related to the species in the river basin. Progress Energy is an active TWG member. The TWG has met on a regular basis since February 2002.
The actual status of this species in the Yadkin-Pee Dee River remains presently unclear. The presence of gravid females and juvenile fish indicated some level of spawning activity and self-perpetuation of the population was occurring in the river reach below the Blewett Development. No spawning aggregations of males and females have been located on shoal or gravel bar habitat to date. The species is long-lived attaining a maximum age of at least 27 years, so it is possible other individuals are present but remain undetected by conventional fishery sampling methods. The TWG has developed conservation goals and research priorities for the Yadkin-Pee Dee River. Prioritized areas to search for spawning robust redhorse are the Fall Line and upper Coastal Plain reaches of the river below the Blewett Development during 2002 and 2003.

- **Carolina redhorse (undescribed *Moxostoma* species)** - Carolina redhorse, a Federal Species of Concern, is an undescribed sucker species currently known to exist in the Pee Dee River and Cape Fear River drainages. The undescribed status means established professional scientific committees have not officially validated the fish as a formal, distinct species through peer-review of its taxonomic and genetic characteristics. The North Carolina Natural Heritage Program listed the species as “significantly rare” (LeGrand et al. 2001). Significantly rare is defined by the NCNHP as species existing in small numbers within the state and need of further monitoring to determine status. Carolina redhorse does not have RTE State status in either North Carolina or South Carolina.

Fourteen Carolina redhorse were collected from Blewett Falls Lake (10 individuals) and the river reach below the hydroelectric development (four individuals) from 1999 to 2002 (Tables F-1 and F-2). One Carolina redhorse was collected from the headwaters of Lake Tillery during November 2002. No specimens were collected from the river reach below the Tillery Development (Table F-1).

Five other specimens of Carolina redhorse have been documented from 1961 to 1994 from the Pee Dee River just below the Blewett Development to near Florence, South Carolina. One small juvenile was also collected from Mill Creek, a tributary of the Pee Dee River, approximately 19 km (12 miles) downstream of the Blewett Development (personal communication with Dr. Robert Jenkins, Roanoke College, Salem, Virginia).
The exact distributional occurrence and life history requirements for this species, including spawning habitat, are presently unknown. This species may inhabit other mainstem reaches and tributaries of the Pee Dee River, including reservoirs, based on current records and habitat preferences. Sexually mature adults and spawning aggregates of this species have presently not been located within the areas of known inhabitation. Young-of-year, juveniles, and adults were present in Blewett Falls Lake with most specimens collected near woody debris at water depths less than 2 meters, mainly in the upper reservoir headwaters area. These collections indicated the reservoir was providing young-of-year rearing and non-spawning juvenile and adult holding habitat. Adult fish collected in the river below the Blewett Falls Development were found in shallow water (1-2 m depth) either near woody debris in pool habitat (Coastal Plain region) or boulders with cobble substrate in shallow run habitat (Fall Line region). No spawning fish were collected from either location. The specimen collected in Lake Tillery was collected in shallow water habitat (2-3 meters in depth) with boulder/cobble substrate and woody debris. It is unknown whether the specimen inhabited the lake on a year-round basis or whether it may have migrated into the lake from the Uwharrie River.

- **Highfin carpsucker (*Carpiodes velifer*)** - The highfin carpsucker is listed as a state special concern species by the NCNHP. This species was collected by Progress Energy in Blewett Falls Lake during 1986 (2 adults from Transect D) and from the Pee Dee River in Chesterfield County, South Carolina, below the Blewett Development in 1977 (1 adult male). One ripe male in spawning condition (414 mm, 1000 g) was collected in the immediate tailwaters below the Blewett Development during April 1999 indicating possible reproductive activity (Table F-1). No other records of this species exist in the Yadkin-Pee Dee River Basin (Menhinick 1997b). Accounts of this species given by Menhinick (1997a) and Fuller et al. (1999) indicated this species might have been introduced into the Yadkin-Pee Dee River basin.
4.4.2 Benthic Invertebrate Resources

4.4.2.1 Historical Review of Benthic Invertebrate Studies Conducted at Project Reservoirs and Associated Tailwater River Reaches

Few detailed studies exist of the benthic invertebrate communities associated with the Project reservoirs and downstream tailwaters. The NCDWQ has performed benthic invertebrate sampling of tributaries associated with Project waters as part of its basinwide assessment program. These assessments rated the health of streams (Poor, Fair, Good, and Excellent with additional inter-classification scores such as Good-Fair) based on a biotic bioclassification protocol developed by the agency (NCDWQ 1998, 2001, and 2002a). Major tributaries that were assessed by the NCDWQ during 2001 included the Uwharrie River, Clarks Creek, Brown Creek, Rocky River, Little River, Mountain Creek, Cartledge Creek, and Hitchcock Creek. Bioclassification ratings ranges from Good-Fair (Clarks and Hitchcock Creeks) to Excellent (lower Uwharrie River). The lower reach of the Rocky River received a Good bioclassification rating during 2001.

The NCDWQ also previously sampled the Pee Dee River below the Blewett Development at U.S. Highway 74 Bridge on September 11, 1985 and July 23, 1990 (personal communication with Mr. Dave Lenat, NCDWQ). The river was rated “Good-Fair” on both sample dates.

The NCWRC, NCDWQ, and the North Carolina Department of Transportation (NCDOT) have conducted directed searches for mussel and snail species in the mainstem and tributaries of the Pee Dee River in the vicinity of the project (personal communication with Ms. Judith Ratcliffe, NCWRC). These surveys included the reach of the Pee Dee River below the Blewett Development from 1987 to 2001.

The SCDHEC has also performed benthic invertebrate bioclassifications of major tributaries of the Pee Dee River in the Coastal Plain area of the river. These assessments have been used in river basin assessments (SCDHEC 2001). The SCDHEC has not conducted any bioclassifications of the mainstem Pee Dee River in South Carolina.
4.4.2.2 Benthic Invertebrates – Progress Energy Survey Results

Progress Energy has recently performed surveys for benthic invertebrates. The sampling methodology for the benthic invertebrate surveys at the Project are given in Appendix D. Benthic invertebrate data and figures are located in Appendix F. The benthic invertebrate surveys were: (1) quarterly survey of the benthic invertebrate communities at Lake Tillery and Blewett Falls Lake, and (2) quarterly biotic bioclassifications of the aquatic invertebrate communities in both tailwater river reaches below the hydroelectric developments. Additionally, the river mussel fauna, observed during the stream or reservoir surveys, was evaluated to determine the presence of any state or federal RTE species that might inhabit tailwater reaches. These mussel searches were only conducted at the fixed environmental sampling locations.

To ensure consistency in sampling methods and scoring protocol, Progress Energy, NCDWQ, and SCDHEC conducted a joint sampling effort at Transect 3 below the Blewett Development on February 2, 1999. Progress Energy and SCDHEC collected separate samples using the same sampling methods. The NCDWQ assisted in the sample collection. The Progress Energy and SCDHEC scores for the Ephemeroptera, Plecoptera, and Trichoptera (EPT) score, the Biotic Index (BI) values, and the final biotic bioclassification rankings were comparable. Progress Energy and SCDHEC collected the same number of EPT taxa (25) and derived the same EPT score (4.0). The BI values were also similar with a 4.97 for the SCDHEC data and a 4.98 score for the Progress Energy data. The EPT and BI score average was 4.5 for both data sets. The value of 4.5 is a “midpoint” value in ranking classifications, as defined in the scoring protocol. The final bioclassification ranking is based on the rounding protocol outlined in the SCDHEC standard operating procedures. The value is rounded up to “excellent” or down to “good” based on the EPT abundance in the sample. The SCDHEC’s bioclassification rating was excellent while the Progress Energy bioclassification was Good. Thus, the results indicated Progress Energy’s sampling methodology and taxonomic identification of benthic invertebrates were consistent in producing similar bioclassification rankings compared to another independent data set.
**Mussel Collections**

Thirteen mussel taxa were collected by Progress Energy from Project reservoirs and the tailwater river reaches below the hydroelectric developments (Table F-38). These collections included three species currently listed as state Threatened in North Carolina. Specific information regarding these species is presented in the RTE section. Beside the mussel fauna, the nonnative Asiatic clam (*Corbicula fluminea*) was abundant throughout the reservoirs and Project tailwaters.

Surveys conducted by the NCWRC, NCDOT, and NCDWQ found 13 mussel taxa in the Pee Dee River below the Blewett Development from 1987 to 2001 (Table F-39). One aquatic snail species, the gravel elimia (*Elimia catenaria*) was also found in these sampled areas. Twelve mussel taxa were observed near U.S. Highway 74 Bridge, approximately 5.6 km (3.5 miles) below the hydroelectric development. Eight mussel taxa were observed below the Mill Creek confluence near old Sneadsboro, North Carolina, approximately 19 km (12 miles) below the hydroelectric development. Four mussel species (Roanoke slab shell, alewife floater, eastern lampmussel, and eastern pondmussel) are listed as state Threatened in North Carolina while one mussel species (yellow lampmussel) was listed as state Endangered.

Combining the Progress Energy and NCWRC data sets, a total of 15 mussel taxa were documented in the Pee Dee River below the Blewett Development since 1987.

Bogan (2002) listed 27 freshwater mussel species that are expected to occur in the Yadkin-Pee Dee River Basin. The following additional 14 mussel taxa, which were not observed in the Progress Energy and NCWRC surveys, are expected to occur in the river:

1. Brook floater (*Alasmidonta varicose*) – North Carolina Endangered
2. Atlantic pigtoe (*Fusconaia masoni*) – North Carolina Endangered
3. Savannah lilliput (*Toxolasma pullus*) – North Carolina Endangered
4. Caolina creekshell (*Villosa vaughaniana*) – North Carolina Endangered
5. Triangle floater (*Anodonta implicata*) – North Carolina Threatened
6. Pod lance (*Elliptio Folliculata*) – North Carolina Special Concern
7. Cape Fear spike (*Elliptio marsupiobesa*) – North Carolina Special Concern
8. Notched rainbow (*Villosa constricta*) – North Carolina Special Concern
9. Carolina lance (*Elliptio angustata*)
10. Box spike (*Elliptio cistaelliformis*)
11. Atlantic spike (*Elliptio producta*)
12. Carolina spike (*Elliptio raveneli*)
13. Lampmussel species (*Lampsillis n.s.*)
14. Florida pondhorn (*Uniomerus caroliniana*)

**Reservoir Benthic Invertebrates**

**Lake Tillery**

A total of 85 benthic invertebrate taxa representing 24 families were collected from the 1-m, 2-m, and 4-m depths in Lake Tillery during 2000 (Table F-40). The benthic community was dominated by chironomids and oligochates (midges and worms), which was typical for reservoir environments (Tables F-40 and F-41).

The dominant taxa varied within the reservoir according to water depth and longitudinal location (Table F-41). Dominant taxa at Station B3 (lower reservoir) included *Ablabesmyia* spp., *A. mallochi*, *Amphichaeta americana*, *Argia* spp., *Bratislavia unidentata*, *Caenis* spp., *Chironomus* spp., and *Cladotanytarsus* spp. A similar dominance pattern occurred at Station F1 (mid-reservoir) except that *A. annulata*, *Arcteonais lomondi*, and *Axarus* spp. were prevalent. At Station H1 in the reservoir headwaters, *Chaoborus* spp. was also a dominant taxa.

A station-by-depth-by-sample date interaction (P < 0.001) precluded discussion of significant spatial or depth differences in total organism densities and taxa richness. General observations, however, indicated a greater number of taxa and total organism densities collected at the 1-m and 2-m depths compared to the 4-m depth (Tables F-40 and F-41). Spatially, total organism densities were slightly greater at the 1-m depth in the middle and upper reservoir areas than the 2-m depth in the lower area (Table F-41). A converse spatial pattern was observed at the 4-m depth (i.e., greater densities in the lower reservoir with lesser numbers in the middle and upper areas). A t-test was performed at 1-m and 2-m depths at the three stations to determine if there
were any depth differences prior to the analysis-of-variance tests for taxa richness and total density. No significant differences existed for these variables between the 1-m and 2-m depths.

Temporal trends in taxa richness and total organism densities were variable (Figures F-35 and F-36). There were no explicit seasonal trends in the taxa richness or total organism densities at the 4-m depth. Total organism densities appeared to decline from February to November; however, the statistical interaction precluded definitive statistical statements concerning this trend.

Benthic invertebrate taxa richness and total organism densities in Lake Tillery were considered in the moderate to high range when compared to reservoirs of similar status. The total number of taxa collected at Lake Tillery was similar to taxa composition at Blewett Falls Lake (Tables F-40 and F-44). However, organism densities were much greater in Lake Tillery compared to Blewett Falls Lake (Tables F-41 and F-45). The total densities of benthic invertebrates in Lake Tillery ranged from 5,793 to 55,348 organisms/m² across depth and station locations. In Blewett Falls, total densities ranges from 5,340 to 12,739 organisms/m². For comparison, total densities of benthic invertebrate in Hyco Reservoir, North Carolina, ranged from 1,881 to 15,859 organisms/m² during a 1990 study. Hyco Reservoir is a piedmont-cooling reservoir for the coal-fired Roxboro Steam Electric Plant (CP&L 1990). The reservoir trophic status ranges from oligotrophy to mesotrophy.

Benthic invertebrate sampling was also conducted in the semi-riverine tailwater section of the upper portion of Lake Tillery just below APGI’s Falls Hydroelectric Plant during 2000. Qualitative stream sampling techniques were used in this tailwater area to sample the benthic community in this area (Transect K). A total of 102 taxa were collected from this transect. No density estimates of benthic invertebrate abundance were obtained. Oligochaetes and chironomids were the dominant taxa in all sampled months (Table F-42). Few stonefly, mayfly, and caddisfly taxa were observed in this area (Table F-43; Figure F-39). Seasonally, a greater number of taxa, including the EPT taxa, were collected in the summer and fall months than the winter (Table F-43).
Blewett Falls Lake

A total of 85 benthic invertebrate taxa representing 17 families were collected from the 1-m, 2-m, and 4-m depths in Blewett Falls Lake during 1999 (Table F-44). Similar to Lake Tillery, the benthic community was dominated by chironomids and oligochates (midges and worms) (Tables F-44 and F-45).

The dominant taxa varied within the reservoir according to water depth and longitudinal location (Table F-44). *Ablabesmyia* spp., *A. annulata*, and *A. mallochi*, chironomids were dominant throughout the reservoir at the sampled depths (Table F-45). Other dominant species included *Amphichaeta americana*, *Arcteonais lomondi*, *Bratislavia unidentata*, *Caenis* spp., *Chironomus* spp., *Cladopelma* spp., *Cladotanytarsus* spp., *Chaoborus* spp., and *Branchiura sowerbyi*.

There was also a transect-by-depth-by sample date interaction (P = 0.05) indicating variable trends in taxa richness and total organism density at the 3-m and 5-m depths at Stations B3, D2, and F3. Station H3 was not included in this factorial analysis-of-variance test. Generally, there was no spatial pattern in taxa richness with respect to water depth. Taxa richness was greater at Station H3 located in the upper reservoir, which may have reflected a habitat edge effect within this riverine-reservoir transitional area. Total organism density was greater at the 3-m depth as compared to the 5-m depth at Stations B3, D2, and F3 (middle to lower reservoir areas). The total organism density at Station H3 in the upper reservoir was lower than densities observed at the 3-m depth in the middle and lower reservoir areas.

Seasonal trends in taxa richness and total organism densities were not consistent with respect to station or depth variables (Figures F-38 and F-39). Taxa richness was variable at the 1-m and 3-m depths over sample months while there was a decline in taxa richness at the 5-m depth from February through November. Total organism density increased during this same period at the 1-m and 3-m depths. There was a decrease in total organism density at the 5-m depth from February through August for Stations B3, D2, and F3. Total organism densities increased during November at Stations D2 and F3 but not at Station B2. Seasonal shifts in total organism densities can be related to maturation and hatching of midge larvae as temperatures increase through the spring and summer months.
Pee Dee River Reach from the Tillery Development to Blewett Falls Lake

A total of 176 benthic invertebrate taxa were collected from the river reach below the Tillery Development (Transects 1, 9, and 12) during 2000 (Table F-42). Taxa richness increased with distance from the immediate power plant tailwaters area, Transect 1. The number of taxa was 71 at Transect 1, 111 taxa at Transect 9 (vicinity of Leak Island and Buzzard Island), and 126 taxa at Transect 12 (North Carolina Highway 109). A similar trend was observed in the number of EPT taxa collected at each transect (Table F-43 and Figure F-39). A consistent seasonal progression was observed at each transect in total taxa richness, as well as the number of EPT, with greater richness in the spring, summer, and fall as compared to the winter. (Figure F-39).

Bioclassification rankings at Transect 1 ranged from Poor during February and November to Fair during May and August (Table F-43 and Figure F-39). At Transects 9 and 12 located below the Rocky River confluence, bioclassification scores were higher and ranged from Fair to Good-Fair depending upon the transect and month. Bioclassification rankings at Transect 12 increased from Fair in February and May to Good-Fair in August and November. Transect 9, although not sampled in February, had rankings of Good-Fair in May and August and Fair in November.

Pee Dee River Reach below the Blewett Development

A total of 316 benthic invertebrate taxa were collected from the river reach below the Blewett Development during 1999 (Table F-46). The total number of taxa ranged from 121 taxa at Transect 1 to 172 taxa at Transect 5, and the number of taxa increased from immediate tailwaters area to the lower Coastal Plain area of the river. Similar results were observed in taxa richness during 2001 with 322 total taxa collected from all transects (Table F-47). A similar spatial pattern also existed for total number of taxa at transects except at Transect 5 where taxa richness was lower than upstream stations, Transects 3 and 4.

The number of EPT taxa was generally greater at Transects 2, 3, 4, and 5 than at Transect 1 during 1999 and 2000 (Tables F-48 and F-49). There were no consistent spatial patterns of greater numbers of EPT taxa at the lower Coastal Plain stations (Transects 4 and 5) as compared
to the Upper Coastal Plain stations (Transect 2 and 3) during either year. Seasonal trends in total taxa and EPT taxa varied with station location and year (Figures F-40 and F-41). Abundance of stoneflies (Plecoptera) was generally greater in February of both years at all transects. This was related to the presence of mature, juvenile instars of several stonefly species that metamorphose in the winter and early spring months to reproduce. There were no discernible changes in mayfly and caddisfly abundance with respect to sampled month.

Bioclassification stream rankings, based on the NCDWQ protocol, ranged from Good-Fair (Transect 1) to Excellent (Transect 5) during 1999 (Table F-48; Figure F-40). The bioclassification rankings were Good-Fair at Transect 1 during all months of 1999, while the downstream transects received Good rankings with the exception of Transect 5. Transect 5 received the Excellent bioclassification ranking during November. The NCDWQ also ranked Transect 1 Good-Fair during assessments conducted on September 11, 1985, and July 23, 1990.

During 2001, there was some shift in bioclassification rankings, but, overall, these rankings were comparable to the 1999 data (Table F-49; Figure F-41). Transect 1 bioclassification rankings declined from Good-Fair to Fair during May and November. No changes occurred in the bioclassification rankings during February and August at this transect. Transects 3 and 4 had some bioclassification rankings change from Good to Excellent between 1999 and 2001 (Tables F-48 and F-49). The bioclassification ranking at Transect 5 during November changed from Excellent to Good between 1999 and 2001. Transect 3 also had the November bioclassification ranking change from Good to Good-Fair between years.

The SCDHEC utilizes the NCDWQ protocol with the exception of the seasonal adjustment of EPT scores based on the presence of winter stonefly species (see Appendix D for description of protocol). Generally, the NCDWQ protocol with the seasonal adjustment will yield a more conservation bioclassification ranking (lower ranking), particularly during February and May, when the last instars of juvenile stoneflies are present prior to adult metamorphosis.

The data from Transects 2, 3, 4, and 5 were scored using the SCDHEC protocol to determine where differences existed in bioclassification rankings. Bioclassification rankings increased from Good to Excellent at Transects 2 and 4 during February 1999 while Transect 2 changed
from Good to Excellent in February 2001. Other transect bioclassification rankings remained unchanged during both years.

4.4.2.3 Rare, Threatened, and Endangered Species

A search was made of NCNHP, NCMNS, and SCNHP records for the presence of rare, threatened and endangered mussel or other aquatic invertebrate species inhabiting the project reservoirs or associated tailwater reaches (LeGrand et al. 2001). Additionally, searches were made for aquatic invertebrate RTE species during the stream and reservoir environmental studies conducted from 1998 to 2002. Locations of RTE species found in the Project area are indicated on figures in Appendix G.

- **Carolina heel splitter** (*Lasmigona decorata*) - The Carolina heel splitter is a federally and state endangered mussel species. This species is a medium-sized mussel reaching about 115 mm in length and has a greenish to brown shell (Keferl 1991). The species was historically found in the Catawba, Pee Dee River, Savannah, and possibly the Saluda drainages in North Carolina and South Carolina but appears to have been extirpated from much of its former range. Currently, four known small populations of this mussel exist in tributaries of the Catawba River, Pee Dee River, and Savannah Rivers.

The Carolina heel splitter appears to have been extirpated from the mainstem of the Pee Dee River for several decades based on current and historical records (USFWS 2002a). One historical record exists for this species (*Lasmigona charlottensis* synonymous with *L. decorata*) from the mainstem Pee Dee River (Richmond County) below the Tillery Development at Leak Island on July 5, 1971 (personal communications with Mr. John Fridell, USFWS, and Dr. Art Bogan, NCMNS). Recent surveys conducted by the NCWRC and NCDOT in the river reach at this site and downstream areas have failed to find any evidence of this species (USFWS 2002a; Table F-39). No Carolina heelsplitters were observed during the Progress Energy benthic surveys conducted from 1999 to 2001 (Table F-38).
Roanoke slabshell (*Elliptio roanokensis*) - The Roanoke slabshell is listed as a state Threatened species in North Carolina (LeGrand et al. 2001). Individuals of this species were collected by Progress Energy from four locations from 1999 to 2001: (1) the Pee Dee River, North Carolina, below the Tillery Development at North Carolina Highway 109 Bridge (Transect 12), (2) the Pee Dee River, North Carolina below the Blewett Development at U.S. Highway 74 Bridge, (3) the Pee Dee River, South Carolina below the Blewett Development near U.S. Highway 76 Bridge, and (4) Blewett Falls Lake at Transect F (Table F-38). This species was common to abundant at these locations based on qualitative observations. Occupied habitat by the species included both riverine and reservoir environments. Specimens ranged in length (diameter) from to 43 to 145 mm. Excluding the one small individual of 45 mm, the mean size of collected specimens was 138 mm. The NCWRC, NCDOT, and NCDWQ studies located this species at U.S. Highway 74 Bridge and below the Mill Creek confluence near Old Sneadsboro, North Carolina.

Eastern pondmussel (*Ligumia nasuta*) - The Eastern pondmussel is listed as a state Threatened species in North Carolina. The species was found by Progress Energy at Transects 1 and 5 located in the Pee Dee River below the Blewett Development during 1999 and 2001. Visual observations indicated this species was rare in these areas, although the noted occurrences indicate a rather wide habitat range spanning the Fall Line zone in North Carolina to the lower Coastal Plain zone in South Carolina. This species has no state-listed status in South Carolina waters of the river. The NCWRC studies also located specimens at the U.S. Highway 74 Bridge.

Eastern lampmussel (*Lampsilis radiata radiata*) - The eastern lampmussel is listed as a state Threatened species in North Carolina. Three individuals were located in the Pee Dee River at U.S. Highway 74 Bridge from January through June 2002 (Table F-39). Two specimens were also documented below the Mill Creek confluence during January 2001 by the NCWRC.

Creeper (*Strophitus undulatus*) - The creeper is listed as a state Threatened species in North Carolina. One specimen was located at Transect 12 in the Pee Dee River reach below
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the Tillery Development during May 2000 (Table F-38). Visual surveys and additional searches indicated this species was rare at this location.

- **Alewife floater** (*Anodonta implicata*) - The alewife floater is listed as a state Threatened species in North Carolina. The NCWRC, NCDOT, and NCDWQ studies documented this species at the U.S. Highway 74 Bridge during February 2001 (Table F-39). The estimate of abundance of this species was not given for this location. LeGrand et al. (2001) reported the inhabitation range for this species was the Chowan, Meherrin, and lower Roanoke Rivers in northeastern North Carolina. Collection of this specimen represents a new record and range extension of the species based on this information.

- **Yellow lampmussel** (*Lampsilis cariosa*) - This species is listed as a state Endangered species in North Carolina. Three specimens were collected below the Mill Creek confluence during January and May 2001 by the NCWRC. Progress Energy also collected this species from the Pee Dee River in the Coastal Plain region of South Carolina during August 2001. The species has no state-listed status in South Carolina.

### 4.5 Botanical Resources

This section presents a characterization of the botanical resources within the Project area. This includes discussions on terrestrial as well as wetland communities and identifies significant natural communities as well as rare, threatened, or endangered species found or with the potential to be found in the Project area.

Progress Energy has performed surveys and reviewed records at the North Carolina Natural Heritage Program (NCNHP) to characterize these resources associated with the Project. Methodology for the surveys are included in Appendix D. Progress Energy is proposing to establish an RWG for terrestrial resources with stakeholders in the spring of 2003 to review these data together. The RWG will discuss and as appropriate, identify areas where additional surveys by Progress Energy may be required to address specific Project operational effects on botanical resources provided there is reasonable evidence of a Project impact.