Chapter 4

Threatened and Endangered Species

The protection and restoration of biota to a point where their existence is not jeopardized is a principal goal of federal and state environmental programs. Numerous private organizations and other groups have formed at local and national levels to complement governmental protection of those plants and animals collectively referred to as "species of concern." This volume discusses the status of species of concern at SRS, emphasizing the biota that: (1) are listed or proposed as endangered or threatened by the U.S. Department of the Interior, U.S. Department of Commerce, or the State of South Carolina; (2) currently exist onsite either as a permanent or temporary resident; and (3) have habitual preferences or affinities for ecosystems present on SRS. Species that are not currently classified as endangered or threatened by federal or state agencies or whose status is under review are not addressed.

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Federal Endangered Species Act

The Endangered Species Act of 1973, as amended (DOI 1973), is intended to prevent the further decline of endangered and threatened species and to bring about the restoration of these species and their habitat. The U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) jointly administer this act. As of June 30, 1996, the act protected 860 species of native flora and fauna (mammals, birds, reptiles, amphibians, crustaceans, plants, and other life forms) (Famighette 1996). Of these, 751 species are listed as endangered, and 209 species are listed as threatened. A species can be listed federally as either endangered or threatened, depending on its status and the degree of the threat. "Endangered" refers to a species or subspecies that is in danger of extinction throughout all or a significant portion of its range. "Threatened" characterizes any species or subspecies that is likely to become endangered in the foreseeable future throughout all or a significant portion of its range. In addition, species may also be classified as "threatened due to similarity of appearance." This classification is afforded to various species to ensure against excessive taking and to continue necessary protection of similar-appearing species that are still classified as threatened. When a species is proposed for either endangered or threatened status, areas essential to its survival or conservation may be proposed as "critical habitats." The process of determining a critical habitat is similar to the one for listing a species, and the two procedures often parallel. SRS contains no areas that have been designated a critical habitat for any species.

Compliance with the Endangered Species Act requires federal agencies to consult with the USFWS or the NMFS regarding the implementation of a proposed action. If the USFWS or NMFS indicates that an endangered or threatened species (or one proposed as such) or critical habitat could be present in the area of a proposed action, a biological assessment must be prepared. This assessment is used as a basis for evaluating the effects on federally protected species through the formal consultation process.

State of South Carolina Acts and Programs

The State of South Carolina's program for plants of concern recognizes and protects federally listed species and maintains an unofficial state list (Knox and Sharitz 1990) which identifies its potentially threatened and endangered plant species. An early survey of South Carolina by Jones and Dunn (1983) identified 31 species of plants that they considered endangered or threatened. These species all were found in forested community types, which were the only communities examined. Rayner et al. (1986) compiled the first government-sponsored list of threatened and endangered species in South Carolina.

The South Carolina Department of Natural Resources' Heritage Trust Progam currently lists threatened and endangered species in the state. It collects data, maintains occurrence records, and revises the list of rare plants (Knox and Sharitz 1990). The South Carolina Nature Conservancy also is active in the listing of species. The state list has no legislative

basis an therefore does not afford legal protection to flora. The Heritage Trust Program and the South Carolina Nature Conservancy use the list to determine habitat protection priorities.

The State of South Carolina has a Nongame and Endangered Species Conservation Act (Section 50-15, 1976, S.C. Code of Laws). Rules established to implement the act protect federally listed endangered and threatened wildlife that occur in South Carolina (Code of Laws of South Carolina, Chapter 123, Revision 150 [1988]), sea turtles (Code of Laws of South Carolina, Chapter 123, Revision 150 [1988]; 150.1), and predatory birds of the orders falconiformes (hawks and eagles) and strigiformes (owls) (Code of Laws of South Carolina, Chapter 123, Revision 150-160 [1976]). Additions to the state protection listings can be made by the South Carolina Department of Natural Resources.

Threatened and Endangered Plants on SRS

SRS has a diverse flora with 1322 species and varieties of 558 genera (Batson et al. 1985). Within this flora exist several unusual and rare species, one of which, smooth purple coneflower (*Echinacea laevigata*), is federally endangered (Table 4-1).

A map (Figure 4-1) illustrates the locations of rare or threatened plant populations on the SRS (Knox and Sharitz 1987a and b, 1988a and b).

In addition to the smooth purple cone flower, five plants are expected to be added as species of special concern in South Carolina when the list is next updated: blue wild indigo (*Baptisia australis*), Chapman's sedge (*Carex chapmanii*), Collin's sedge (*Carex collinsii*), long sedge (*Carex folliculata*) and Candy bulrush (*Scirpus etuberculatus*).

Table 4-1. Federal or South Carolina Endangered or Threatened Plants and Animals Known to Occur on the SRS

Species	Status[a]
Plant	
Echinacea laevigata (smooth purple coneflower)	FE/ 2 colonies on SRS
Animals	
Haliaeetus leucocephalus (bald eagle)	FT/ 2 nesting sites on SRS
Picoides borealis (red-cockaded woodpecker)	FE/ numerous colonies on SRS
Mycteria americana (wood stork)	FE/ feed in SRS swamps and reservoirs
Acipenser brevirostrum (shortnose sturgeon)	FE/ eggs and larvae collected from Savannah River adjacent to SRS
Elanoides forficatus (American swallow-tailed kite)	SE/ 1 sighting reported
Gopherus polyphemus (gopher tortoise)	SE/ 1 reported; habitat on site
Myotis austroriparius (southeastern myotis)	ST/
Condylura cristata (star-nosed mole)	SE/
Corynorhinus rafinesquii (southeastern big-eared bat)	SE/

[a] FE = Federally endangered.
FT = Federally threatened.
SE = State endangered.
ST = State threatened.

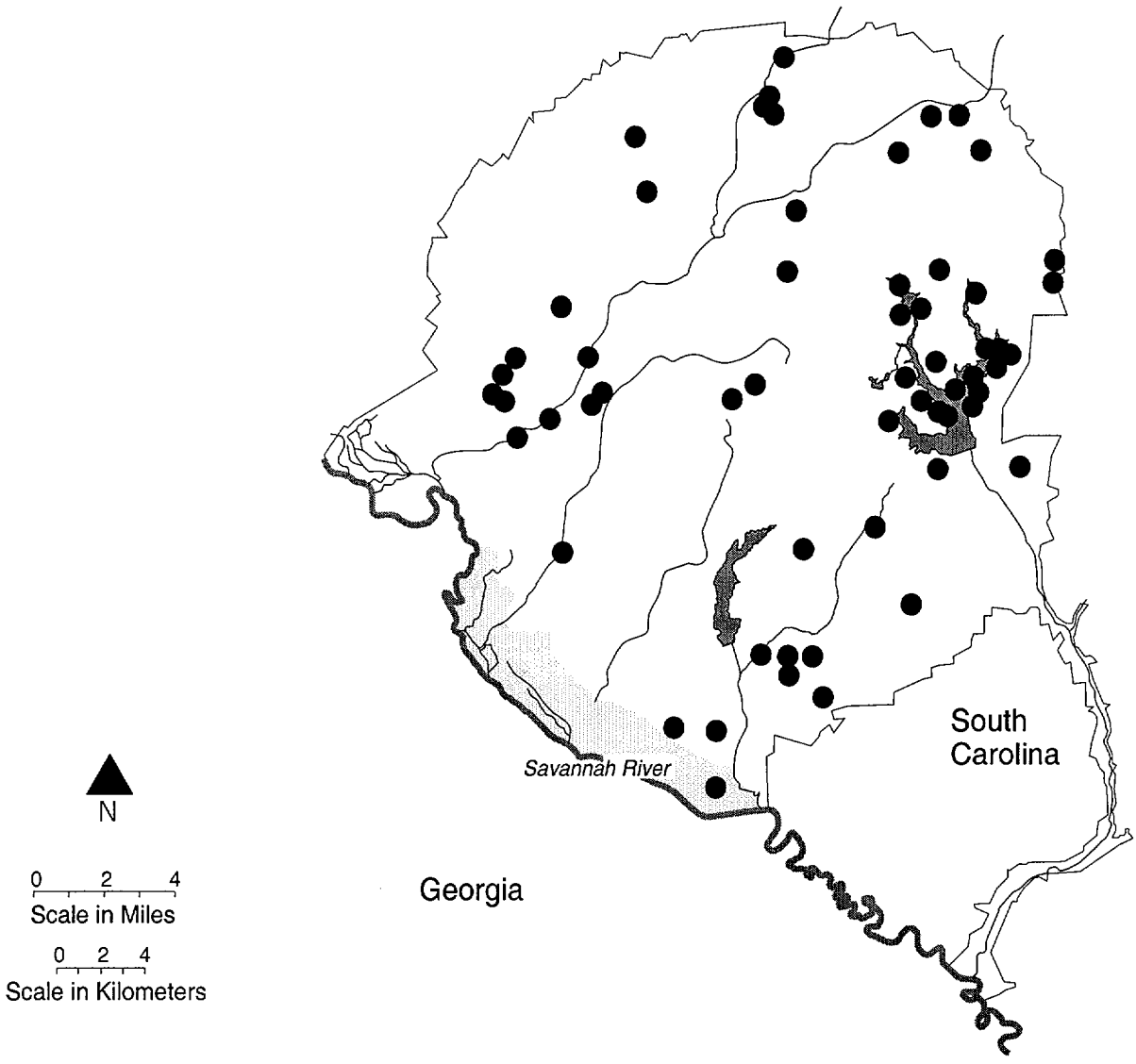

Figure 4-1. Location of Rare and Threatened Plant Species on the Savannah River Site

Threatened and Endangered Invertebrates on SRS

Introduction

Historically, the interest in endangered species has centered around the larger vertebrate species. In recent times, interest has grown rapidly in flora and is slowly gaining momentum among the invertebrate taxa. There are now more than 40 species of mollusks listed as endangered within the SRS region, but only 6 arthropods. Scientists have realized that aquatic mollusks, especially the filter-feeding bivalves, are sensitive indicators of water quality. Because of this and their inherently cryptic nature, evaluation of their populations can be difficult. Among the aquatic arthropods, the Insecta are under-recognized within the endangered species program for their ecological importance and sensitivity. Upper Three Runs, a high-quality blackwater stream on SRS, is home to more than 550 species of aquatic insects, some of which are rarely collected in the southeastern United States (Morse et al. 1980, 1983).

Brother Spike Mussel

The brother spike mussel (*Elliptio fraterna*), listed as endangered by the State of South Carolina, has been identified only in the Chattahoochee and Savannah Rivers. Aspects of the natural history and distribution of this organism are poorly known. The 1972 collection of a single *Elliptio fraterna* from the Savannah River near SRS was the first such collection of a living individual since the species was described in 1852 (Britton and Fuller 1980).

Mill Creek Ellipto

The Mill Creek elliptio (*Elliptio hepatica*), now considered a distinct mussel species, has been collected from Upper Three Runs, Mill Creek, and Tinker Creek on SRS. It is considered localized and rare. Currently, the species is not listed by either the federal government or the State of South Carolina (Hyatt 1994).

American Sandburrowing Mayfly

The American sandburrowing mayfly (*Dolania americana*), a relatively common organism in Upper Three Runs on SRS, is listed by the federal government as a candidate species for federal protection. This mayfly's habitat is clean, shifting sand substrate (Peters and Peters 1977). Based on its distribution, it appears to prefer soft, slightly acidic, clear waters containing very small amounts of organic and inorganic pollution. This species would be sensitive to any impacts or disturbances involving increased siltation, organic loading, or toxic releases.

Threatened and Endangered Fishes on the SRS

Shortnose Sturgeon

The shortnose sturgeon is the only endangered species of fish that occurs on or near SRS.

Two species of sturgeon, the Atlantic (*Acipenser oxyrhynchus*) and the shortnose (*A. brevirostrum*), occur in the Savannah River (Paller et al. 1986). The shortnose sturgeon, first documented in the Savannah River near SRS in 1982 (Muska and Matthews 1983), is rare and is listed as an endangered species in the United States by the NMFS (50 Code of Federal Regulations [CFR] 17.11 and 17.12).

Muska and Matthews (1983) and Specht (1987) have reviewed the biology of the shortnose sturgeon which is restricted to the east coast of North America. Breeding populations normally are associated with estuary-river complexes having a strong flow of freshwater. The shortnose sturgeon's endangered species status has stimulated recent investigations that have shown it to be more abundant in some drainage systems than had been known previously (Brundage and Meadows 1982). Reproducing populations have recently been studied from Canada to Georgia (Marchette and Smiley 1982; Heidt and Gilbert 1978, Brundage and Meadows 1982; Dadswell 1979a and b; Dovel 1978; McCleave et al. 1977; Squiers and Smith 1978; Taubert 1980a and b; Taubert and Reed 1978).

The species is primarily anadromous, but access to the sea is apparently not a requirement for reproductive success. Landlocked populations have been reported in the Holyoke Pool section of the Connecticut River (Taubert 1980a and b) and in the Lake Marion-Moultrie system in South Carolina (Marchette and Smiley 1982).

Spawning occurs between February and May, depending on the latitude. Ripe and spent females have been collected from January to April in the Savannah River (Marchette and Smiley 1982).

The major factor governing spawning appears to be temperature, although other factors include the occurrence of freshets and substrate character (Dadswell et al. 1982). Several investigators have reported shortnose sturgeon spawning occurring between 9 to 12°C (48.2 to 53.6°F) (Heidt and Gilbert 1978; Dadswell 1979a and b; Taubert 1980a and b; Buckley and Kynard 1981).

In northern rivers, the spawning grounds are in regions of fast flow (40 to 60 cm/sec[1.3 to 2 ft/sec]) with gravel or rubble bottoms (Taubert 1980a and b; Buckley 1982; Pekovitch 1979). This apparently has been confirmed for the Savannah River population (Hall et al. 1991). Collins et al. (1992) identified three areas of potential spawning habitat in the Savannah River at River Km 179-190, 220-230, and 275-278 (River Miles 111-118, 137-143, and 171-173). These areas have moderate to strong current (50-100 cm/sec[1.6 to 3.2 ft/sec]) and a substrate of gravel or submerged logs. The spawning location between River Km 220-230 is adjacent to SRS.

Threatened and Endangered Herpetofauna on the SRS

Introduction

Herpetofauna are members of the classes Amphibia and Reptila. Government agencies seem to be somewhat slow in protecting reptiles and amphibians. The sea turtles, known to frequent the South Carolina coast, have enjoyed protected status for some time. However, there is encouraging news with recent developments in protecting other turtle species and several frog, salamander, snake, and lizard species.

Amphibians

The Carolina crawfish frog, also known as the Carolina gopher frog, is a subspecies of *Rana aerolata*. This is the only one of five amphibian species listed as candidate species for federal protection that has been reported from SRS. The Carolina crawfish frog is a member of the group of stubby-appearing frogs whose habits of nocturnal activity and daytime retreat to crawfish and gopher tortoise holes or other hiding places conceal them from casual observation. The species is infrequently collected on SRS. The Carolina subspecies is distinguished by its small, closely packed warts and heavy ventral marking that gives a marbled appearance (Conant and Collins 1991). Gibbons and Semlitch (1991) reported hearing the Carolina crawfish frog calling on the SRS.

Reptiles

Introduction

The only reptile found at SRS listed as threatened or endangered is the gopher tortoise (*Gopherus polyphemus*), which is a state endangered species. The American alligator is listed as "Threatened Due to Similarity of Appearance." This classification means that the species itself is not threatened, but is given special consideration because it closely resembles a listed taxa (in this case, the very rare American crocodile), and its protection and regulation will benefit the endangered species it resembles.

Snakes

Other reptile species found on SRS that are not currently listed as threatened or endangered, but are candidate species for listing, include the pine or bull snake (*Pituophis melanoleucus*) and the Southern hognose snake (*Heterodon simus*). Neither of these species is considered rare at SRS; however, they are not common and are collected infrequently (Gibbons and Semlitch 1991).

Gopher Tortoise

It is not known whether the gopher tortoise (*Gopherus polyphemus*) is currently a resident species of the SRS. Although tortoises were believed to be gone from Aiken County by the early part of the century, their historic range extends as far north on the Coastal Plain as the North Carolina-South Carolina border. In 1992, a reproducing population of tortoises was

discovered on private property near Aiken State Park, suggesting that there may be other small relict populations that have not yet been discovered.

In 1986, an employee of the Savannah River Forest Station (SRFS) observed a live tortoise and three or four burrows near Par Pond. However, these burrows were in a lowland hardwood forest with fairly dense canopy closure, suggesting that this tortoise may have been released on site. In 1992, an employee of Savannah River Ecology Laboratory (SREL) found a gopher tortoise shell at Flamingo Bay, but its origins are also unknown. Gopher tortoise sightings also have been reported offsite near the Snelling barricade in 1996.

The most conclusive evidence for gopher tortoises as a resident species of the SRS was the discovery of a tortoise and its burrow near Deer Kill Road on May 25, 1996, by researchers from SREL. The burrow was near a powerline right-of-way in a young longleaf pine (*Pinus palustris*) stand with lots of herbaceous vegetation available for forage material. This pine stand is on a fairly large sand ridge near the northern perimeter of the SRS. Although no other tortoises were found in this longleaf pine stand, isolated individuals may have been able to persist on the Savannah River Site in small numbers, and suitable habitat exists to support a colony on the SRS.

Alligator

Introduction

The American alligator (*Alligator mississippiensis*) (Figure 4-2), has been studied extensively at SRS (Murphy 1977, 1981; Smith et al. 1981, 1982a and b; Seigel et al. 1986). These earlier studies are summarized in Volume VI of the Comprehensive Cooling Water Study Final Report (CCWS) (Mackey 1987). Seigel (1989) and Brandt (1989) more recently documented work with SRS alligators.

Protection History

The American alligator is the largest reptile on SRS, reaching a length in excess of 3.7 m (12 ft) and a weight of 150 kg (325 lb) (Murphy 1981). Although abundant as late as 1890,

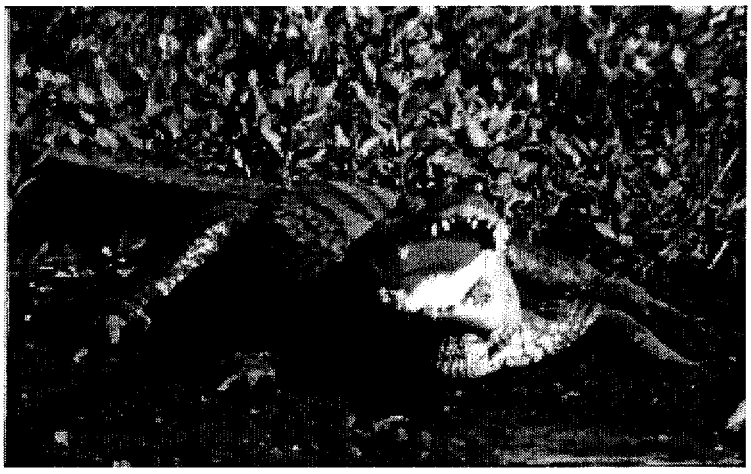

Figure 4-2. American Alligator (*Alligator mississippiensis*)

alligators in the United States dwindled by the mid-20th century to fewer than 100,000, primarily from intense hunting and habitat destruction (King 1972). State game laws restricting the harvest of alligators were moderately useful in stabilizing populations, but it was not until federal protection was enacted in the 1960s and 1970s that populations began to recover. Recovery of this species has proceeded so well that the USFWS has reclassified it from endangered/threatened to threatened due to similarity of appearance (USFWS 1992a).

General Life History

The general life history of the American alligator is well known. Courtship occurs in the late spring, and females lay about 20 to 50 eggs in late June and July. Hatching occurs in late summer, and females have been reported to guard both the nest and the newly hatched young. Hatchlings remain together for up to two years, then gradually disperse into the surrounding environment. Growth rates and ages at maturity are not fully known, but estimates from Florida and Louisiana suggest it may take as long as 10-12 years for alligators to reach sexual maturity. Maturation may occur more slowly in the northern portion of the range, such as in South Carolina (Murphy 1981). Alligators will feed on most aquatic and semi-aquatic vertebrates and some terrestrial animals. American alligators have relatively broad temperature tolerances; the critical thermal maximum is estimated at 38°C (100.4°F) and animals have survived exposure to temperatures as low as 2-4°C (35.6-39.2°F) (Colbert et al. 1946; Smith et al. 1982b; Hagan et al. 1983).

Aquatic Habitats on SRS

Introduction

The two major types of aquatic habitats of importance to alligators on SRS include riverine (flowing water) and lacustrine (lake) systems (Figure 4-3). The riverine systems includes Upper Three Runs, Beaver Dam Creek, Fourmile Branch, Pen Branch, Steel Creek, Lower Three Runs (below Par Pond), and the Savannah River adjacent to the SRS and its associated swamp. The lacustrine systems include Par Pond, Pond B, Pond C, L Lake, numerous Carolina bays, abandoned farm ponds, and beaver ponds.

Alligator Populations in the Par Pond System

Studies on the ecology of alligators on SRS focused primarily on the Par Pond system (including Ponds B and C and the precooler ponds; Figure 4-4), which harbors the largest population of American alligators onsite. (Murphy and Brisbin 1974; Murphy 1981).

Murphy (1981) suggested that many of the unusual characteristics of the Par Pond population (low reproductive rate, low density, adult-biased population structure) was the result of "reproductive asynchrony," i.e., males come into breeding condition earlier than females, resulting in a low frequency of mating, and, therefore, fewer nests. Distributions of alligators in Par Pond changed seasonally, with adult males using thermally affected areas during the winter. The use of these thermally altered sites may have permitted a longer yearly activity period for adult males, with subsequent alternation of the timing of reproduction. However, two alternative explanations might also apply. First, as Murphy (1981) noted, SRS is near the northwestern edge of the range of the American alligator. Data from other reptiles suggest that northern populations frequently have lower reproductive and growth rates than southern populations (Tinkle 1961; Fitch 1985), probably as a result of shorter growing seasons. Growth rates of juvenile alligators from Par Pond were found to be slower than those

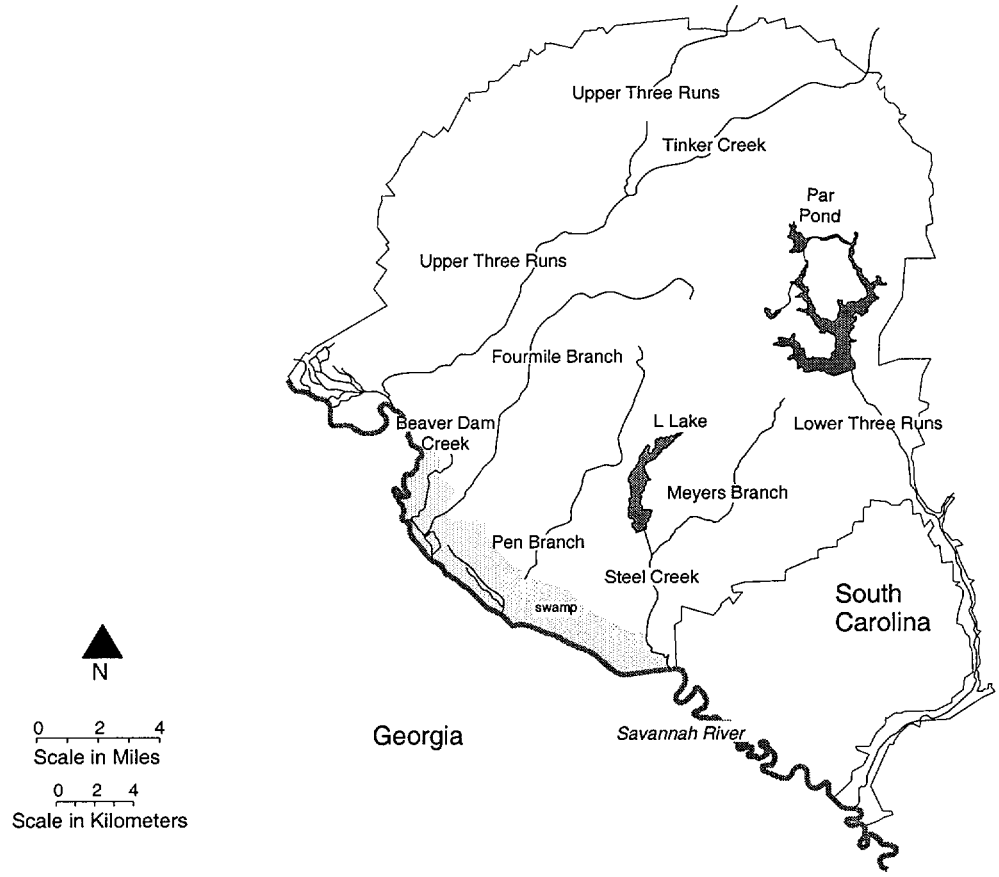

Figure 4-3. Major Aquatic Habitats at SRS

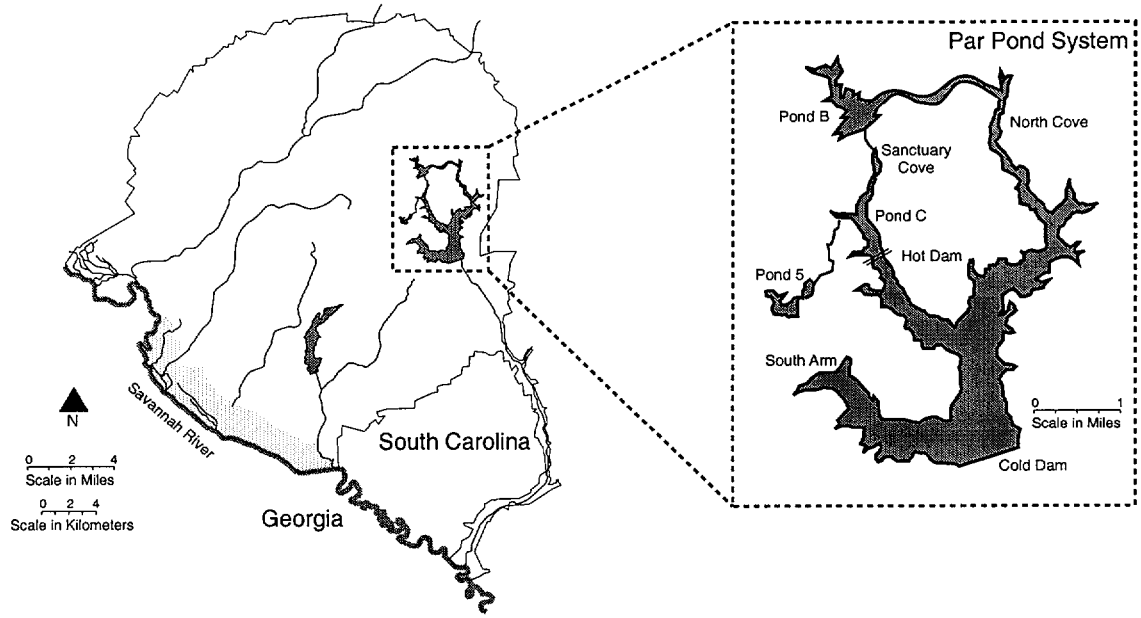

Figure 4-4. Par Pond System

of juveniles from Louisiana. Second, most previous studies of alligators have been conducted in marsh habitats, which are a better quality habitat for alligators than the open waters of Par Pond.

More recent work comparing previous study results with current population estimates has shown an increase and change in distribution by size class. The estimated population size went from 110 adults and juveniles in 1974 to 197 in 1988 (Table 4-2). Although the sex ratio changed from 3.2:1 (male:female) to 2.6:1 between 1977 and 1988 (Table 4-2, Figure 4-5), this is not considered a statistically significant change. Size distribution changed from a population dominated by large individuals to one of smaller animals (Figure 4-6). Reproductive success in the Par Pond alligator population almost doubled the population between 1974 and 1988. Brandt (1989) calculated an average annual population exponential rate of increase of 0.06 (Figure 4-7), which projects a population of more than 320 individuals by the year 2000.

Beginning in June 1991, the Par Pond water level was lowered approximately 6 m (20 ft), reducing the reservoir surface area by almost 50%. The water level remained down until August 1994, when the lake began to passively refill by retaining rainfall and runoff that had previously been siphoned over the dam. In February 1995, water was pumped from the Savannah River to the reservoir to complete the refill. Full pool was reached in March 1995. Throughout the drawdown, SREL monitored the effects on the alligator population. Chapter 5, Section 5.8—Par Pond has a complete discussion of the drawdown of Par Pond.

Although it was documented that several adult alligators left the reservoir soon after the initial reduction in the water level, most of the resident animals did not leave the reservoir during the four years the water level was reduced. Alligator clutch size and hatchling weight was monitored during the summer of 1994. Both were significantly lower in 1994 than in previous years, when the lake was at full pool (Table 4-3). However, nests were less frequently depredated and hatch rates were higher, so smaller clutch sizes and hatchling weights may have been offset by the increased rate of hatching. At the time of this writing, there were no data on the survival rates of the smaller hatchlings (Brisbin et al. 1997).

Concentrations of total mercury and cesium-137 in alligator tissues were analyzed. The source of mercury in Par Pond is not known, but it is believed to have come from industries on the Savannah River, which served as the major source of water for Par Pond. Cesium-137 was released into the reservoir system in the early 1960s and has been decaying ever since, but there are measurable concentrations in the sediments. The concentrations of mercury in alligator tissues before and after refill were not statistically different (Table 4-4). The concentrations of cesium-137 in alligator tissues were not significantly different between predrawdown and postrefill (Brisbin et al. 1997).

Alligator Populations in Beaver Dam Creek

Beaver Dam Creek has a high frequency of alligator sightings. The high density of alligators may be due to the availability of a relatively undisturbed, high-quality habitat and the moderate thermal effluent discharged into the creek. This thermal regime is not extreme enough to exceed the critical thermal maximum of the species and may contribute to alligator success by enhancing growth and survival through year-round foraging and decreased mortality from freezing temperatures. Size distribution of the Beaver Dam Creek population (Figure 4-8) shows a high representation of juveniles and subadults, suggesting successful recruitment into the population (Seigel 1989).

Table 4-2. Estimated Population Size and Sex Ratios for Alligators Inhabiting Par Pond, 1972-1974, 1976, and 1986-1988

Year	Category	Size Ratio adult: juvenile	Population Estimate and Confidence Interval (method)		Sex Ratio male: female	Nests/ Year
1972-1974[a]	Adults		70	29-143 (Lincoln)	3.7:1	
	Juveniles		40	19-72 (Lincoln)	1.8:1	
	Total		110	48-215 (Lincoln)	3.2:1	2.3
1976		1.43: 1[b]			3.6: 1	
1986-1988[c]	Adults		108	97-120 (Lincoln)	2.5:1	
	Juveniles		83	45-121 (Jolly)	3.1:1	
	Total		197[c]		2.6:1	

Source: Brandt 1989.

[a]1972-1974 data from Murphy 1977.

[b] Ratio for coastal South Carolina populations in 1976 was 0.4:1.

[c] 1988 total population includes 6 animals 1.25-1.5 m that were captured but not represented in earlier estimate.

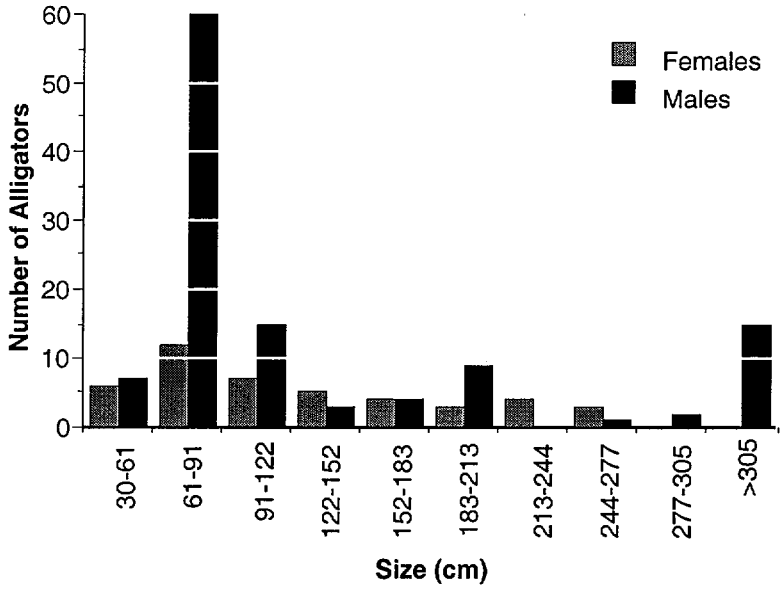

Figure 4-5. Size and Sex Structure of Alligators Captured in Par Pond, 1986-1988 (Source: Brandt 1989)

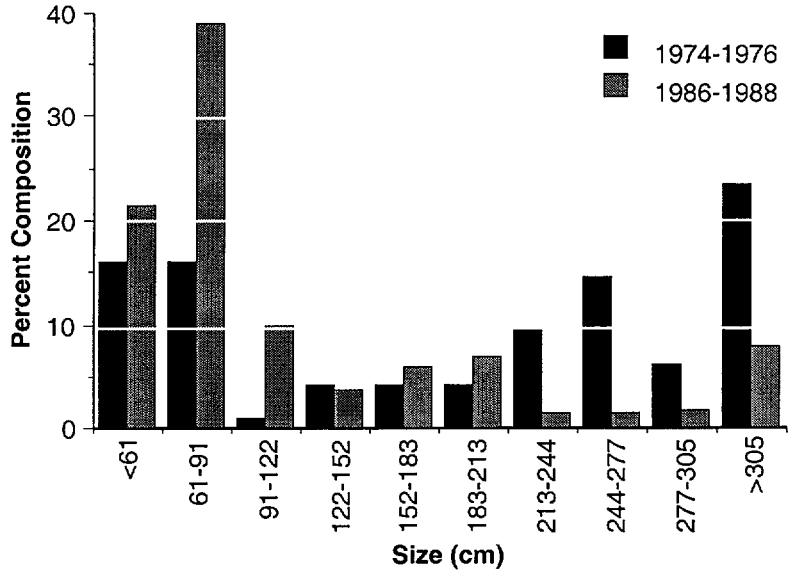

Figure 4-6. Size Distribution of Alligators in Par Pond, 1974-1976 and 1986-1988 (Source: Brandt 1989)

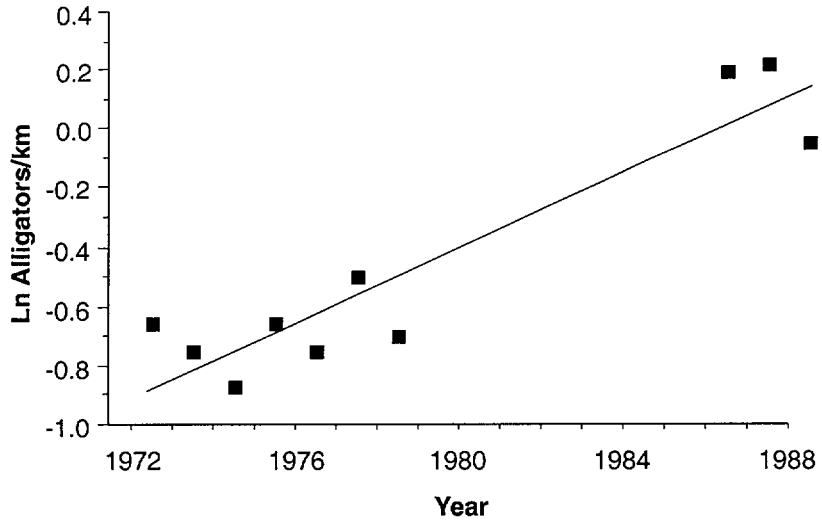

Figure 4-7. Alligator Population Growth in Par Pond 1972-1988 (Source: Brandt 1989)

Table 4-3. Mean Clutch Size, Mean Hatchling Weight, Hatching Rate, and Number of Depredated Nests in 1994 Versus 1981-1988.

	Clutch Size X (N)[a]	Hatchling Weight (g) X (N)	Hatching Rate (range)	Percent of Depredated Nests
1994[b]	43.5±2.9 (6)	43.7±0.4 (95)	49.9% (65.9-41.7%)	0%
1981–1988[c]	48.8±1.3 (8)	50.7±0.4 not known	48.3%+9.1 (76-22%)	25%

[a]Data are presented as means ± standard error, with N for each given in parentheses.
[b]Source: Brisbin et al. 1997.
[c]Source: Brandt 1989.

Table 4-4. Tissue Mercury Concentrations (µg/g dry mass) in American Alligators from the Par Pond Reservoir Before and After the Reservoir was Refilled.[a]

	Liver	Muscle	Scute
Before Refill	15.30±2.65(11)	3.87±0.44(13)	5.84±0.90(18)
After Refill	12.09±7.77(2)	8.05±4.43(3)	3.97±0.98(17)

Source: Brisbin et al. 1997.
[a]Data are presented as means ± standard errors, with N for each given in parentheses.

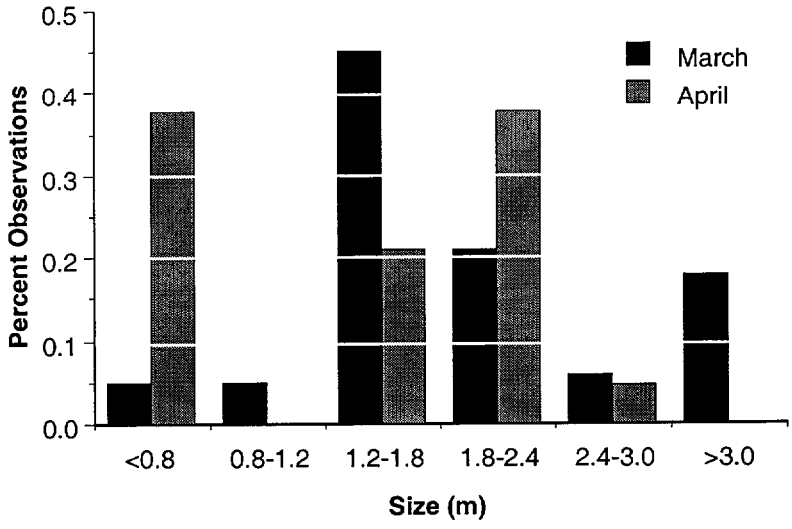

Figure 4-8. Size Structure of the Beaver Dam Creek Alligator Population as Assessed by Aerial Surveys in 1984 (Source: Seigel 1989)

Alligator Populations in Steel Creek Below L Lake

Steel Creek below L Lake supports a small population of alligators in all areas of the drainage, with most animals concentrated in the delta. Seigel (1989) found evidence of nesting activity. Although alligators are known to exist in L Lake and have been collected there, no quantitative data on population size are currently available (Gladden et al. 1988).

Alligator Populations in Fourmile Branch

During the operation of C Reactor, Fourmile Branch was not a suitable alligator habitat and supported no population. Although the Fourmile Branch delta did contain some suitable habitat, no alligators were observed there prior to 1980 (Murphy 1981). However, more recently, there has been a relatively high frequency of alligator sightings in Fourmile Branch. Although the population is small, it uses the delta and lower stream channel. No reproduction has been documented. The source of individuals in Fourmile Branch is most likely Beaver Dam Creek because of its close proximity and large alligator population. The shutdown of C Reactor may have lead to sufficient habitat recovery to support an alligator population (Seigel 1989).

Alligator Populations in Pen Branch

Pen Branch received thermal effluent from K Reactor until 1988, and high flows and temperatures during reactor operation almost certainly precluded use of the drainage by alligators. Even though individuals were reported moving upstream during reactor outages, and alligators are sighted occasionally in Pen Branch, no large or self-sustaining population exists there. Cessation of reactor operations may have provided suitable habitat, but the distance of Pen Branch from a pool of immigrants (Seigel 1989) may have slowed the rate at which the Pen Branch population would have developed.

Alligator Populations in Other SRS Areas

Other areas on SRS provide potential alligator habitat, but there is little information on these populations. Although Lower Three Runs, dammed in 1958 to form Par Pond, supports a self-sustaining population directly below the dam, the remainder of the creek has not been surveyed for alligator use (Murphy 1981). Upper Three Runs provides a minimum of suitable habitat (Murphy 1981), and few alligators have been sighted there (Seigel 1989). Except for Steeds Pond, which supported a moderate population of alligators until it was drained in 1984, there is no evidence that any of the ponds and Carolina bays on SRS support alligator populations (Seigel 1989). The Savannah River swamp system appears to contain suitable habitat for alligators (Murphy 1981), and although alligators are seen there regularly, difficulty in sampling makes it impossible to estimate the size of the population (Seigel 1989).

Threatened and Endangered Avifauna on SRS

Introduction

Current and past observations and SRS records indicate that 13 species of birds listed as threatened or endangered by the federal or state government occur or have been sighted on SRS. This group includes the federally endangered red-cockaded woodpecker (*Picoides borealis*), bald eagle (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus*), Kirtland's warbler (*Dendroica kirtlandii*), and wood stork (*Mycteria americana*); the federal candidate species Bewick's wren (*Thyromanes bewickii*), loggerhead shrike (*Lanius ludovicianus*), and Bachman's sparrow (*Aimophila aestivalis*); and the State of South Carolina listed golden eagle (*Aquila chrysaetos*), American osprey (*Pandion haliaetus*), Cooper's hawk (*Accipiter cooperii*), swallow-tailed kite (*Elanoides forficatus*), and the Savannah sparrow (*Passerculus sandwhichensis princeps*).

Bald Eagle

Introduction

With a wingspan of 1.8-2.3 m (6-7.5 ft), the bald eagle (*Haliaeetus leucocephalus*) is the largest raptor commonly observed on SRS. The coloration of an adult bald eagle is unmistakable, being uniformly dark brown with a white head, neck, and tail (Figure 4-9). This species exhibits a variety of plumage coloration patterns associated with the age of the bird. Bald eagles begin to molt into the characteristic adult plumage during their fourth or early fifth year of age. Adult bald eagles typically weigh between 3 and 5 kg (6.6-11 pounds) (Sprunt and Chamberlain 1970).

Figure 4-9. Bald Eagle (*Haliaeetus leucocephalus*)

The bald eagle is a permanent South Carolina resident and is most abundant in the coastal region (Sprunt and Chamberlain 1970). As many as 200 nesting pairs of bald eagles may have been in the state historically. By the late 1950s, these numbers had dropped to about 100 pairs. This decline in South Carolina and other locations in the eastern United States has been attributed to the negative effect on bald eagle reproduction of persistent pesticides and other environmental contaminants (Murphy and Coker 1978). In 1978, only 15 nesting pairs of eagles could be found in South Carolina (Murphy and Coker 1978). Primarily as a result of restrictions on pesticide use, the number of bald eagle nesting pairs in the state have been increasing since 1981 (Mayer et al. 1986) with 105 nesting pairs being found in South Carolina in 1996.

As the number of nesting pairs and mating success of bald eagles along the South Carolina coast increased during the early 1980s, a greater number of fledged young have dispersed into inland areas. The successful colonization of more inland portions of the state has largely been the result of the man-made impoundments on the Santee-Cooper and Savannah River drainages. These impoundments provide both extensive forage habitat and aquatic prey base for bald eagles immigrating inland from coastal territories (Mayer et al. 1986).

Bald Eagle Use of SRS

Records of bald eagle sightings in the central Savannah River area date back to 1904 (Murphey 1937). The presence of this species on SRS was documented as early as May 1959, when an adult bald eagle was observed on the newly filled Par Pond (Norris 1963). At least two more sightings were recorded for Par Pond during that year. One of these birds, seen in September, was an immature bald eagle (Norris 1963). Par Pond has been and continues to be the location of most of the eagle sightings on SRS. Jenkins and Provost (1964) reported that two bald eagles had been recorded on SRS, neither being permanent residents, nor breeders. Langley and Marter (1973) also noted that three bald eagles were observed as transients near Par Pond. Bald eagles were sighted on Par Pond "once or twice a week" in the winter of 1971-72 (Mayer et al. 1986). Between 1971 and 1975, bald eagles were seen regularly on Par Pond from late September or early October to mid-March. In the late 1970s and early 1980s, both adult and immature bald eagles were observed on Par Pond during the annual SRS Christmas Bird Count in December (Mayer et al. 1986). Dukes (1984) stated that a few bald eagles had been observed on Par Pond, but that no resident population of this species existed onsite. This species has apparently increased on SRS as a result of the inland colonization. Sightings of bald eagles on site have continued to increase (Table 4-5). Between 1986 and 1992, the estimated numbers of bald eagles wintering on SRS increased from two to six birds (SRFS 1992).

SRS Bald Eagle Study

A one-year study of bald eagle use of SRS was conducted between September 1984 and August 1985 (Mayer et al. 1985). Ground or aerial surveys were conducted on the Par Pond system at least twice per month. The location, date, time of day, number of adult and immature birds, and behavior were recorded. Thirty-six bald eagles were sighted in 31 instances. Most (91.7%) of these sightings were reported in the vicinity of Par Pond (Figure 4-10) with 66.7% of sightings specifically on Par Pond (Mayer et al. 1985). Fewer eagles were seen on Pond C (24.2%), Pond B (6.1%), and Pond 2 (3.0%). On Par Pond, the Big Lake section adjacent to the Cold Dam had the most use (22.7%), followed by Loyals Lair (18.2%), and then the Hot Arm, North Arm, and Pump House Cove in the South Arm

Table 4-5. Number of Bald Eagles Observed During Four Annual Surveys at SRS.

Year	Audubon Christmas Bird Count	SRS Waterfowl Aerial Surveys	SRS Wood Stork Aerial Surveys	Par Pond/L-Lake Boat Surveys
1978	2	-	-	-
1979	1	-	-	-
1980	0	-	-	-
1981	0	1	-	-
1982	1	1	-	-
1983	0	2	-	-
1984	1	0	-	-
1985	2	0	-	-
1986	0	0	-	-
1987	0	3	-	3
1988	4	0	-	8
1989	2	9	-	5
1990	5	7	-	0
1991	8	3	2	3
1992	3	14	11	23
1993	4	16	13	23
1994	4	9	5	17
1995	3	5	4	-
1996	2	9	9	16

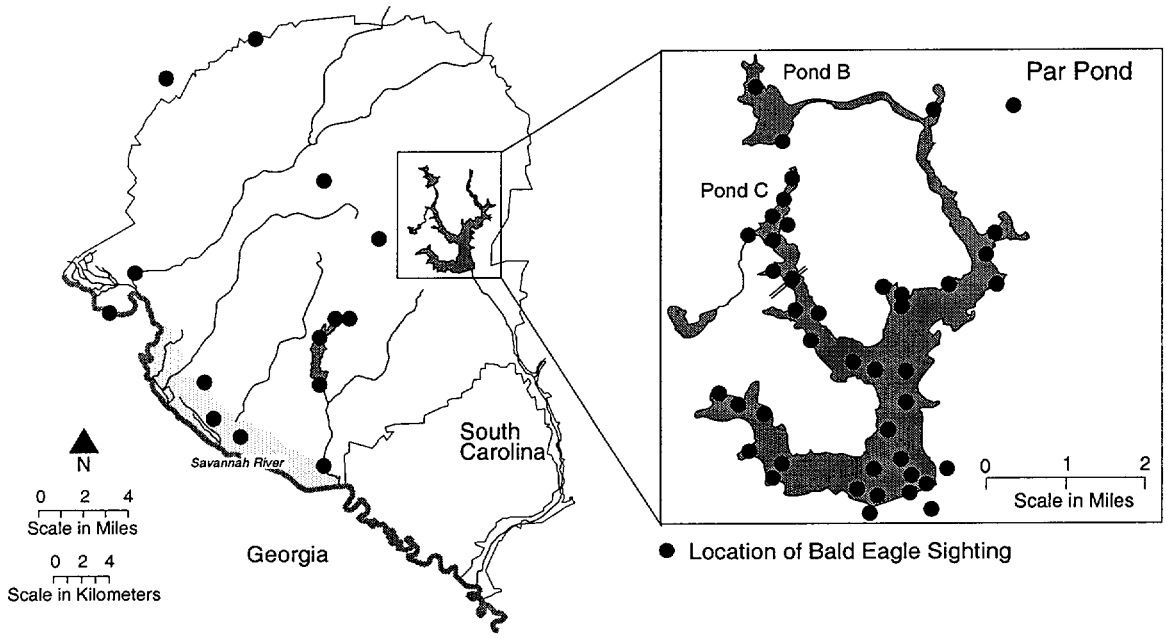

Figure 4-10. Location of Bald Eagle Sightings on SRS (Source: Mayer et al. 1986)

(each at 13.6%). On Pond C, most of the sightings were between the main lake and Sanctuary Cove. In part, the thermal fish kills on Pond C attracted bald eagles to that impoundment (Gladden et al. 1985). Sightings on Pond C were of birds feeding on dead fish in the littoral zone (Mayer et al. 1985). Of all the bald eagles sighted during the study, 72% were adults and 13% (10) were paired birds. Of these five pairs, two pairs were composed of two adults, two were composed of two immatures, and one was an adult/immature pair. Bald eagles were seen during every month of the one-year study. Most of the birds (63.9%) were seen during the winter and spring (November through May). This was also the period when most of the immature birds (90.0%) were observed. Only one immature bald eagle was seen in the fall during the study, and none was observed during the summer (Mayer et al. 1985). The conclusion of the study was that bald eagle use of SRS was more common than previously had been known. The apparent increase was postulated to be the result of either poor earlier documentation or a recent increase in the use of the site by this species.

Supplemental SRS Observations

Data collection subsequent to Mayer et al. (1985) continued until January 1986 (Mayer et al. 1986). Twenty-two bald eagles were observed between September 1985 and January 1986. Seven of the sighting localities were new records for SRS. Bald eagle use of L Lake was reported within one month of its completion of filling. An immature bird was seen feeding on dead fish in the outflow of L Lake Dam, and three adult bald eagles were observed soaring above the lake (Mayer et al. 1986).

Adult to Immature Ratio

Based on a total of 197 bald eagle sightings recorded for the site between 1959 and 1992, the overall observed age class ratio was 1.6 adults to 1.0 immature (Figure 4-11). This is similar to the regional age class composition of two adults for every immature (Mayer et al. 1986).

Season	Percentage of Total Number of Birds Observed	
	Adults	Immatures
Winter	24	11
Spring	9	8
Summer	5	5
Fall	24	14

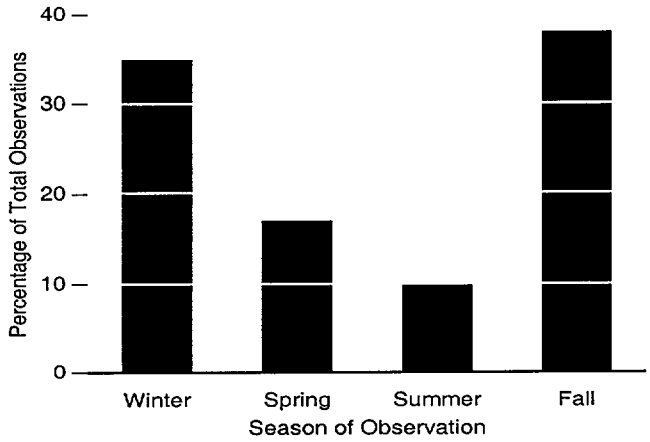

Figure 4-11. Percentage of Adult and Immature Bald Eagles Observed Seasonally on SRS, Based on a Total of 197 Birds Observed Between 1959 and 1992

Social Organization

Most sightings (95%) of bald eagles on SRS were of solitary birds; however, social groupings of between two and five bald eagles have been observed. Pairs of birds are the most common social grouping observed. One social grouping of five immature bald eagles was observed soaring over the main lake section of Par Pond in 1992.

Seasonal Use

Banding studies have documented mid-summer migration to the northern states and Canada of bald eagles that have nested in the southeast (Sprunt and Chamberlain 1970). These birds return south in the fall or early winter to nest and rear their young and remain there until late spring (Sprunt and Chamberlain 1970). Most of the bald eagles are observed on SRS during the fall and winter when this species is nesting and wintering in South Carolina (Figure 4-11). Birds seen during the summer are most likely transients migrating either north or south.

Diet and Forage Behavior

In South Carolina, the diet of bald eagles consists almost exclusively of fish. However, these raptors are also known to prey on ducks, American coots (*Fulica americana*), herons, and small mammals. Bald eagles will opportunistically feed on carrion, usually in the form of dead fish. This species often reportedly steals food from ospreys rather than foraging for prey themselves (Sprunt and Chamberlain 1970). Observations of foraging activities of bald eagles on SRS indicate a varied diet composed of fish (largemouth bass [*Micropterus salmoides*]), waterfowl (coots [*Fulica americana*] and buffleheads [*Bucephala albeola*]), small mammals (gray squirrel, [*Sciurus carolinensis*]), and carrion (thermally killed fish and road-killed small mammals) (Mayer et al. 1986, 1988).

Records of Marked/Tagged Birds

Less than 2% of the 197 recorded observations of bald eagles using SRS consisted of birds that were marked or tagged. Two of the birds observed during the one-year study were marked. One of these birds had been tagged as a fledgling along the South Carolina coast north of Charleston. The second bird was of unknown origin because the tagging method and color were neither registered with nor known to either the USFWS or the Raptor Information Center (Mayer et al. 1985). The adult female bald eagle of the original nesting pair at Eagle Bay was marked with an orange wing tag that indicated it was a fledgling on either the Cooper River or near Georgetown during the 1978-1981 nesting seasons (Mayer et al. 1988). Based on this small sample, the bald eagle nesting population along the South Carolina coast now is documented as being one of the contributing sources of birds that use SRS.

Reproductive Biology

The nesting season for bald eagles in South Carolina is midwinter. The nest, usually built in a tall pine, is a huge mass of sticks, bark, grass, moss, and other debris. Bald eagles typically return and add materials to the same nest year after year. After many seasons' use, bald eagle nests can attain very large proportions. The typical clutch consists of two eggs, but can range in size from one to four. Incubation requires approximately 35 days. Both adults in the nesting pair participate in incubating the eggs and feeding the young (Sprunt and Chamberlain 1970).

Bald Eagle Nesting on SRS

Two confirmed bald eagle nesting territories have been documented on SRS (Figure 4-12). The first (the Eagle Bay nesting territory) was discovered on May 21, 1986. By June 6, 1986, the nest and the presence of two juvenile bald eagles was confirmed (Mayer et al. 1988). Seven bald eagle chicks were hatched and fledged from that nest between 1986 and 1988 (Table 4-6). In 1989, both the nest and the single hatchling produced that season were presumed lost when extreme winds (87 mph) knocked the nest out of the tree in April. The South Carolina Department of Natural Resources installed a braced wooden and wire platform in the area of the original nest and constructed an artificial nest of pine limbs and twigs. The pair initiated nesting in 1990, but abandoned the nest by February of that year. A pair of great blue herons (*Ardea herodias*) took over the nest later that same month.

In June of 1990, the second bald eagle nesting location (on Pen Branch) was discovered. Although initially believed to be the displaced pair from Eagle Bay, neither of the nesting bald eagles at Pen Branch was marked. Two chicks were observed at that nest during the first year. The Eagle Bay nest site was completely inactive in 1991, while the Pen Branch nest again produced two nestlings (Table 4-6). In 1992, a pair of bald eagles initiated and then abandoned nesting at Eagle Bay. During that same year, the pair at the Pen Branch nest produced two nestlings. In 1993, a pair of eagles initiated a nest at Eagle Bay, and two newly hatched bald eagle chicks were observed in the nest in March of that year. Two chicks again were observed at the Pen Branch nest in the 1993 nesting season. In 1994, the Eagle Bay nest fell and was replaced a second time. It produced no chicks that year. In 1995 a pair nested and laid one egg that was not successfully incubated. One nestling was hatched in 1996. In 1994, 1995, and 1996, two chicks were fledged successfully from the Pen Branch nest (Hart et al. 1996).

A third nest was discovered east of Par Pond after the 1995-1996 nesting season. The status of this nest is unknown as of this writing.

Bald Eagle Management on SRS

The U.S. Forest Service Savannah River Forest Station began an active management program in 1986 for the Eagle Bay nesting territory and in 1990 for the Pen Branch nesting territory. These management plans encompass primary and secondary management zones for protecting the nesting territories and key areas along the shores of both Par Pond and L Lake for perching and roosting activity. Through the use of management zones and because of the distances between the two nests and existing SRS facilities, it is expected that activities at SRS will have no adverse effect on the bald eagle.

Golden Eagle

History in South Carolina

The golden eagle (*Aquila chrysaetos*) is a rare resident in the mountains of northwestern South Carolina, but is found during the winter in other areas of the state (Sprunt and Chamberlain 1970). Records of this species in the central Savannah River area date back to at least 1933 (Murphey 1937). Even then, the golden eagle was considered locally to be

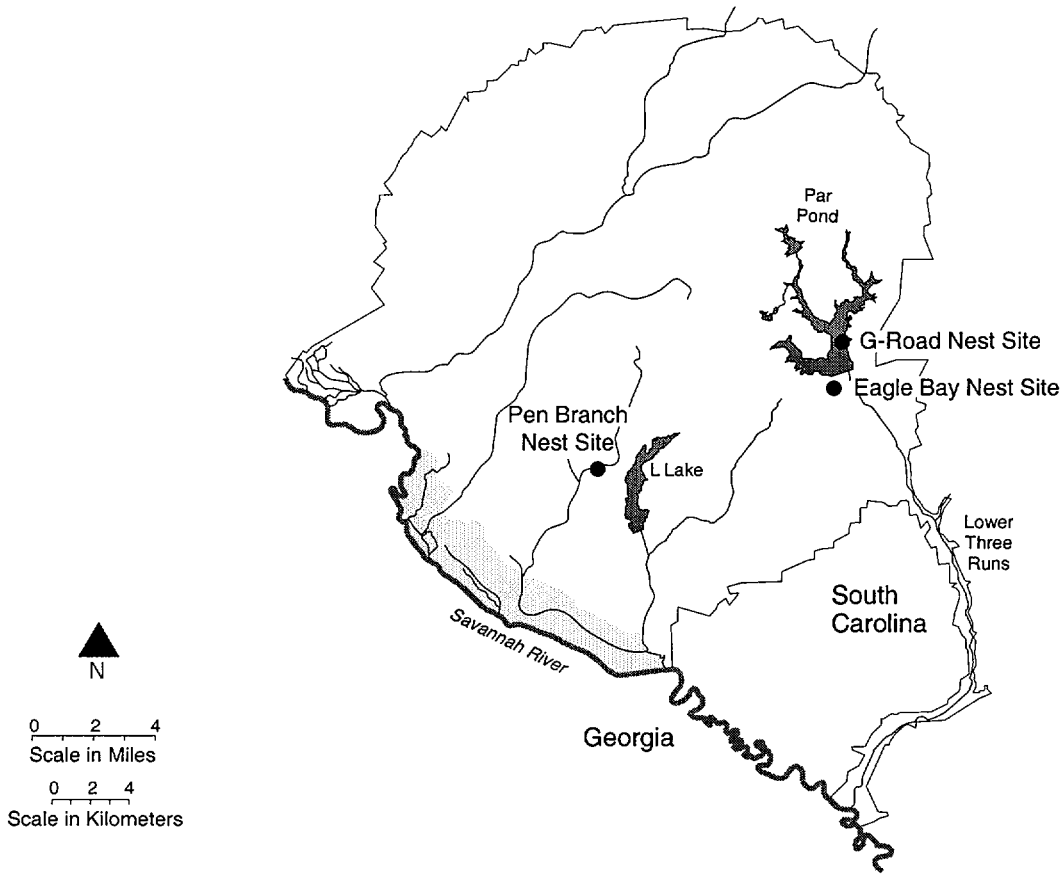

Figure 4-12. Locations of the Three Bald Eagle Nests on SRS

Table 4-6. Number of Nestlings Produced Annually by the Bald Eagle Nesting Pairs on SRS

	Annual Number of Nestlings Produced	
Year	**Eagle Bay Nest Site**	**Pen Branch Nest Site**
1986	2[a]	-
1987	2	-
1988	3	-
1989	1[b]	-
1990	-	2[a]
1991	-	2
1992	-	2
1993	2	2
1994	-	2
1995	-	2
1996	1	2
Total	11	14

Source: Hart et al. 1996.
[a]First year for nest.
[b]Single nestling present, presumed lost when nest was dislodged during a wind storm.

rare (Murphey 1937). There have been no documented nesting records for this species in South Carolina (Mayer et al. 1985, 1986).

Golden Eagle Use of SRS

Sightings of golden eagles on SRS are rare (Mayer et al. 1985, 1986). Although SRS is not ideal golden eagle habitat, it does provide potential wintering habitat for this species (Mayer et al. 1985, 1986). Only three golden eagles have been recorded as being sited on SRS (Table 4-7). All of the sightings have been on Par Pond. The first was an immature bird that spent several weeks on Par Pond during December 1972-January 1973. The second observation was of an adult golden eagle during the 1978 SRS Christmas Bird Count survey on Par Pond. The last series of observations, in December 1991 on Par Pond, were assumed to have been multiple sightings of the same adult bird. Since recent numbers of this species have not substantially increased in this region of the southeastern United States, the level of use of SRS also is not expected to increase.

Red-Cockaded Woodpecker

Introduction

The red-cockaded woodpecker (*Picoides borealis*) (Figure 4-13) was included in the federal list of endangered species in 1970 due to the declines in local populations, its perceived rarity, and the apparent reduction in available nesting habitat (Lennartz and Henry 1984). Although the red-cockaded woodpecker was once common, its current status largely can be attributed to its unique life history requirements and how they are affected by the reduction of mature pine forests. The red-cockaded woodpecker is a native of the southern pine forests of the United States with the largest populations found in the Coastal Plain forests of the Carolinas, Florida, Alabama, Mississippi, Louisiana, and eastern Texas. Populations are also found in the Sandhills forests of the Carolinas. An endangered species recovery plan (Lennartz and Henry 1984) prepared for the USFWS describes the life history, ecology, and historic and current status of the species.

Breeding

The red-cockaded woodpecker is a cooperative breeder; auxiliary or helper birds aid the mated pair with incubation, feeding, and brooding. Groups with helpers generally have higher reproductive success. These groups are nonmigratory and maintain year-round territories around their nesting and roost trees. Groups can range in size from only the mated pair to nine birds, including helpers and fledglings. The normal group size is two to four birds prior to nesting and four to six birds after fledging. Nesting season is usually April

Table 4-7. Golden Eagle Sightings on SRS

Year	Age Classification	Location	Source
1972-1973[a]	Immature	Par Pond	Mayer et al. 1985, 1986
1978	Adult	Par Pond	Mayer et al. 1985, 1986
1991[a]	Adult	Par Pond	1991 SRS Christmas Bird Count and SREL aerial surveys

[a] Based on a number of observations made of what was assumed to be the same individual.

Figure 4-13. Red-Cockaded Woodpecker (*Picoides borealis*)

and May, with clutch initiation in late April or early May. Clutch size is generally between two and five eggs. Incubation takes approximately 10 days, and fledging occurs between 26 and 29 days after hatching. Juveniles remain in their natal territory through summer into fall. Juvenile females disperse during late fall, winter, and early spring, while some juvenile males may remain with their clan and become helpers (Lennartz and Henry 1984).

Habitat

Cavity Excavation

The red-cockaded woodpecker is the only North American species that uses exclusively living pines for cavity excavation. The birds use many species of pines, prefer trees over 70 years old, and may actively select trees suffering from heart rot. They are often associated with longleaf pines (*Pinus palustris*) because of the high incidence of heart rot in older trees. The same cavity trees may be used for many years, possibly decades, and the trees used by a group tend to be located in what are referred to as clusters. Trees in most clusters are within a 460-m (1500-ft) diameter area in open stands of pine with sparse midstories. Dense hardwood midstories may cause red-cockaded woodpeckers to abandon the area. This may be due to more intense interspecific competition from other woodpecker species (Lennartz and Henry 1984) or other cavity-dwelling competing species, particularly the flying squirrel.

Foraging

Red-cockaded woodpeckers also prefer to forage on living pines. Other tree species, such as cypress, also are used, but primarily when pine foraging areas are low quality. The preferred habitat is more than 50% basal area in pine, more than 24 pine stems per acre larger than 10 in. in diameter at breast height, and at least 30 years old. Based on the relationship of home range, available foraging area, and reproductive success, a group of red-cockaded woodpeckers requires for survival and productivity at least 125 acres of well-stocked pine or pine-hardwood stands more than 30 years old (Lennartz and Henry 1984).

Relationship Between Population Numbers and Suitable Habitat

Since its listing as an endangered species, the red-cockaded woodpecker has been the focus of extensive research and population studies. Active clusters on federal lands may exceed 3000; however, there are documented losses of active clusters in recent literature. Red-cockaded woodpecker population trends will most likely parallel the trends in availability of suitable habitat. On federal lands, there is a significant positive correlation between old-growth longleaf-slash pine (*Pinus palustris - P. elliotti*) communities and active red-cockaded colonies. Stands of old-growth pines are a scarce and declining resource throughout the South. Total acreage declined by 13% over the last 30 years. There are 129,900 acres of pine on SRS (SRFS 1993); of this, less than 1% consists of age classes greater than 80 years.

Savannah River Forest Station (SRFS) Management Program

Creating Nesting Habitats

Since 1985, the SRFS wildlife management program at SRS has been working to improve red-cockaded woodpecker habitat. In 1980, a program was initiated to increase the availability of nesting and foraging habitat. Arboreal midstories were reduced using mechanical and chemical means and prescribed burns. Artificial nesting cavities also were placed in appropriate areas to enhance reproduction. Since 1980, 62,255 acres have been altered to enhance populations of the red-cockaded woodpecker (Table 4-8).

Monitored Colonies at SRS

SRFS monitors 65 active or potential breeding areas: 21 active clusters that contain productive groups, 7 inactive sites that supported active colonies within the last 10-15 years, abandoned sites that supported active colonies more than 15 years ago (Figure 4-14), and recruitment sites containing appropriate habitat (LeMaster, E. T. Savannah River Forest Station, U.S. Forest Service. Personal Communication with K. K. Patterson, Dunaway & Fletcher, Inc. 1997).

Table 4-8. Acres Altered by SRFS to Create Nesting Habitats for the Red-Cockaded Woodpecker

Year	Midstory	Prescribed Burns	Artificial Nest Cavities
1980-1989	130	68	2
1990	234	204	28
1991	726	1,106	20
1992	634	6,232	52
1993	417	4,503	50
1994	206	3,873	50
1995	136	14,019	59
1996	321	10,875	60
1997	461	18,110	20

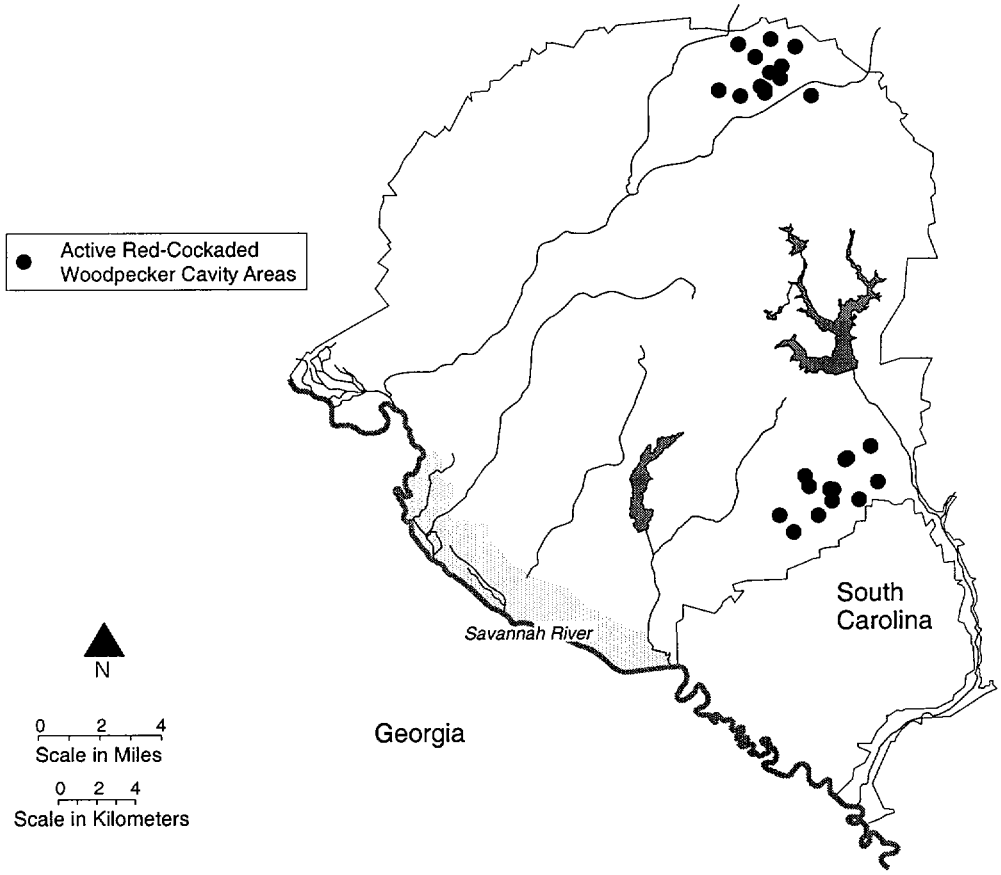

Figure 4-14. Location of Red-Cockaded Woodpecker Colonies on SRS, June 1997

SRS Population

The 1997 red-cockaded woodpecker population inhabiting SRS consisted of 109 individuals, making up 21 breeding pairs (Table 4-9). The number of fledglings has increased consistently since 1985, indicating positive reproductive success. Since 1988, sex ratios of the total population and fledglings have not changed significantly.

Ten groups of red-cockaded woodpeckers were active prior to the 1992 breeding season. Eight of these consisted of at least one male and one female; two groups contained solitary males. In 1992, 5 groups successfully fledged at least 1 young, producing a total of 13 young (6 males, 7 females); the mean reproductive rate was 1.6 young fledged per breeding pair. Four of the five groups that successfully produced young in 1992 did so on their first attempt. The other group was successful on its second attempt. The remaining three groups were unsuccessful in producing young. Status of the colonies as of June 15, 1997, is in Table 4-10.

Wood Stork

Introduction

During the last 50 years, the North American breeding population of the wood stork (*Mycteria americana*) (Figure 4-15) has decreased from an estimated 20,000 breeding pairs in the early 1930s to 4800 pairs in 1980 and 3650 pairs in 1983 (Ogden and Nesbitt 1979; Ogden and Patty 1981). This population decline prompted the U.S. Department of Interior (DOI) to list the wood stork as an endangered species (DOI 1993). The number of breeding pairs in the early to mid-1980s remained relatively stable at approximately 4000-5000 pairs (Coulter 1986a). More recently (1993-1996) more than 6000 breeding pairs have been estimated for this species (USFWS 1996).

Birdsville Colony

The DOI identified 23 colonies of wood storks in Florida and Georgia in the proposed listing (DOI 1993). The Birdsville Colony, the most northern and inland colony, is located at Big Dukes Pond, a 567-ha (1400-acre) cypress swamp, 12.6 km (7.8 mi) northwest of Millen, Jenkins County, Georgia (32°52'N, 82°03'W). This wood stork colony (Figure 4-16) was believed to be the source of storks observed at the Steel Creek delta in

Table 4-9. Numbers of Documented Red-Cockaded Woodpeckers on SRS

Year	Individuals	Breeding Pairs
1985	4	1
1990	24	6
1991	30	6
1992	38	8
1993	53	11
1994	76	13
1995	89	16
1996	99	19
1997	109	21

Table 4-10. Number of Red-Cockaded Woodpeckers on SRS as of July 18, 1997

Group/Cluster	Number of Adults	Number of Fledglings
1	4	2
2	3	2
3	3	3
5	4	2
15	4	2
16	5	2
18	2	0
19	4	1
24.01	2	0
24.04	3	2
24.05	2	3
24.33	4	0
25.18	3	1
25.21	2	2
28.00	2	2
39.00	3	2
40.00	4	3
43.00	5	3
79.06	2	0
80.28	4	1
82.42	2	2
82.44	2	0
84.17	2	0

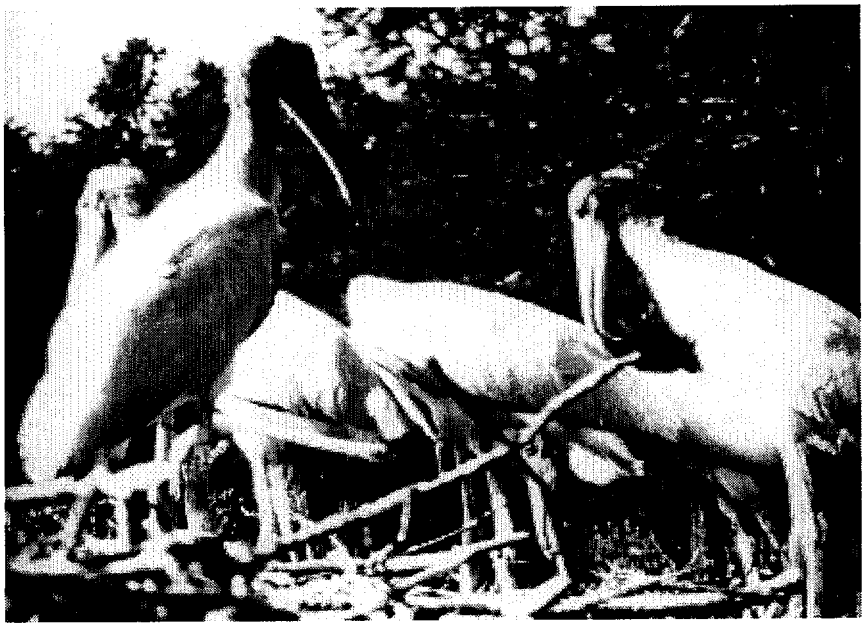

Figure 4-15. Wood Stork (*Mycteria americana*)

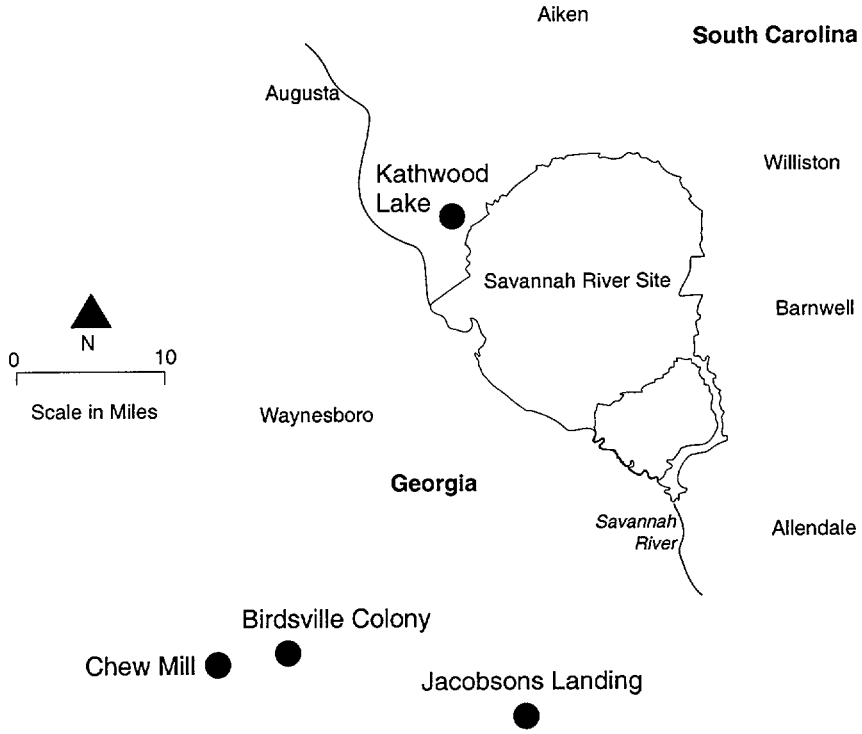

Figure 4-16. Location of Kathwood Lake and Nearby Wood Stork Colonies

the SRS Savannah River swamp during 1980-1982 (Smith et al. 1982a and b). The SRS Savannah River swamp is 45 km (28 miles) from the Birdsville Colony, a distance within the 60-70 km (37-43 mi) maximum radius that wood storks can travel during daily feeding flights (Bryan and Coulter 1987; Coulter 1993).

Chew Mill Pond Colony

Wood storks first nested in Chew Mill Pond, approximately 6 km (3.7 mi) southwest of the Birdsville Colony, in 1993. Chew Mill Pond had a history of being a wood stork foraging site and a wading bird rookery. Researchers consider it to be an overflow or satellite colony of the Birdsville Colony. It has a more stable hydrology than the Big Dukes Pond.

Jacobsons Landing Colony

The Jacobsons Landing rookery, with 36 stork nests, was discovered in 1995. It is approximately 38 km (23.6 mi) southeast of the SRS in Screven County, Ga. In 1996, it contained an estimated 40 wood stork nests.

Effect of Reactor Operations

In 1983, studies were initiated to assess the potential effects of the operation of SRS on the wood stork (Meyers 1984). The study objectives included

- determining the foraging locations of storks from the Birdsville Colony
- characterizing the habitat, water quality, and fish density and biomass at foraging sites
- determining food resources used by wood storks from the Birdsville Colony
- assessing the importance of the SRS Savannah River swamp to wood storks

Much of the data and information presented here are summarized from the studies and reports by the Savannah River Ecology Laboratory (SREL) (Meyers 1984; Coulter 1986a, b, and c, 1987, 1988, 1989, 1991, 1993; Bryan 1992a and b, 1994, 1995, 1996; Bryan et al. 1997).

Savannah River Swamp

The SRS Savannah River swamp comprises about 3800 ha (9400 acres) bordering the Savannah River on the southwestern edge of SRS (Jensen et al. 1984). The swamp area, including the deltas of Beaver Dam Creek, Fourmile Branch, Pen Branch, and Steel Creek, contains nonpersistent and persistent emergent wetlands, deciduous forest wetlands (including cypress-tupelo forest), and scrub-shrub wetlands. Earlier studies placed particular emphasis on wood stork use of the Steel Creek delta (Meyers 1984; Coulter 1986b and c) because the forage potential of this area would be reduced due to increased water depths associated with L Reactor restart in October 1985. Although the cooling water used by L Reactor was cooled in L Lake, the water volume below L Lake increased the water depth in areas of the Steel Creek delta where storks have been observed foraging. Because it was anticipated that the Steel Creek delta could be lost as a foraging site for wood storks following L Reactor restart, alternate foraging ponds were built at the site of Kathwood Lake on the National Audubon Society's Silver Bluff Plantation Sanctuary (Figure 4-16) (Mackey 1985).

Birdsville Colony Survey

SREL wood stork studies began in 1983 (Meyers 1984). During the first year, there were only a few observations made at the colony. From 1984 through 1989, the study of the breeding biology of the storks expanded. Since 1980, the maximum number of active nests in the colony has been determined to document colony growth and overall colony reproductive success (Table 4-11). In 1984 and 1985, unsuccessful nests also were included in measuring breeding success (Coulter 1986a). Storks begin to arrive at the Birdsville Colony in early March. Breeding and chick rearing are variable from year to year and usually extend from March through May with fledglings dispersing from the colony from late May through mid-summer. Reproductive success, which is estimated as the number of chicks fledged per nest (Table 4-12), has varied yearly, as affected by predation (primarily racoons), intraspecific aggression, violent storms, and the availability of prey (Coulter and Bryan 1995).

Foraging Surveys 1983-1989

Introduction

Storks have been followed by an airplane from the colony to foraging sites in all years of the surveys. The majority of foraging sites (75%) were in Jenkins, Burke, and Emanuel Counties, Georgia (Hodgson et al. 1987, 1988). Storks and other wading birds were counted at each foraging site, and the water depth and the minimum distance to the shore were measured. In 1983, Meyers (1984) recorded five original foraging habitat types, including a shrub swamp that was incorporated into different swamp types of later surveys. Drainage ditches, hardwood swamps, and natural ponds were additional types of foraging sites used in 1984 (Coulter 1986b). In 1985, Carolina bays were added (Coulter 1986b). In 1984 and 1985, there were a few forage sites that did not fit into the general classification, including logging roads and powerline rights-of-way. These were listed as

Table 4-11. Number of Active Nests in the Birdsville, Chew Mill Pond, and Jacobsons Landing Colonies

	Number of Active Nests				
Year	Birdsville	Chew Mill Pond	Jacobsons Landing	Data Maximum Number of Nests were Counted	Source
1980	About 100[a]			-	Meyers 1984
1981	Failed			-	Meyers 1984
1982	About 60[a]			-	Meyers 1984
1983	113[b]			-	Meyers 1984
1984	About 100			-	Coulter 1986b
1985	About 108			-	Coulter 1986c
1986	160			May 14	Coulter 1987
1987	193			May 26	Coulter 1988
1988	101			May 31	Coulter 1989
1989	126			June 13	Coulter 1991
1990	259			June 1	Coulter 1991
1991	270			May 22	Bryan 1992a
1992	243			May 19	Bryan 1992b
1993	330	44			Bryan 1994
1994	230	65			Bryan 1995
1995	245	45			Bryan 1996
1996	189	95	40		Bryan et al. 1997

[a]Estimated from ground and aerial surveys.
[b]Actual counts from 26 trees.

Table 4-12. Reproductive Success of Wood Storks at the Birdsville Colony

Year	Mean Number of Young per Nest[a]	Source
1980	About 2[b]	Meyers 1984
1981	0[c]	Meyers 1984
1982	No data	Meyers 1984
1983	2.19	Meyers 1984
1984	2.39[d], 2.04[e]	Coulter 1986b
1985	2.50[d], 0.33[e]	Coulter 1986c
1986	2.86[d], 2.68[e], 2.16[f]	Coulter 1987
1987	2.33[d], 2.0[e], 1.96[g]	Coulter 1988
1988	1.80[d], 0.35[e]	Coulter 1989
1989	1.88[d], 0.63[e]	Coulter 1991
1990	2.67[d], 0.63[e]	Coulter 1991
1991	1.95[e]	Bryan 1992a
1992	1.40[d], 2.10[e, h]	Bryan 1992b
1993	2.5[i]	Bryan 1994
1994	0.9[i]	Bryan 1995
1995	1.9[i]	Bryan 1996
1996	1.9[i]	Bryan et al. 1997

[a]Young at least five weeks old.
[b]Estimated from ground or aerial surveys.
[c]Colony failed in 1981.
[d]Chicks at least 50 days old; this does not include whole nests that were lost.
[e]Chicks at least 50 days old; this includes whole nests that were lost.
[f]Includes the 25% decline in numbers of nests recorded during the ground censuses.
[g]Includes the 20% decline in numbers of nests recorded during the ground censuses.
[h]Previously unpublished data.
[i]Fledged young/nest.

"other" in the survey reports (Coulter 1986a and b). The average straight-line distance between the colony and the foraging sites is in Table 4-13.

Foraging Habitats

The foraging habitats described in this section include (in parentheses) the comparable category of the USFWS system for classifying wetland habitats (Cowardin et al. 1979). Blackgum (*Nyssa sylvatica*) and cypress (*Taxodium distichum*) swamps (palustrine forested) were the predominant species at the swamp foraging sites. Hardwood swamps (palustrine forested) had a mix of hardwood tree species including red maple (*Acer rubrum*) and sweetgum (*Liquidambar styraciflua*). Shrub swamps (palustrine scrub-shrub) contained predominantly buttonbush (*Cephalanthus occidentalis*). Natural ponds (palustrine unconsolidated shore/lacustrine littoral unconsolidated shore) contained open water with little or no vegetation. Carolina bays (forested wetland/palustrine scrub-shrub/persistent emergent) are common in east-central Georgia. Man-made ponds (palustrine unconsolidated shore/lacustrine littoral unconsolidated shore) included agricultural and fish ponds. Drainage and agricultural ditches are also common. Open marshes (palustrine emergent) were usually seasonally flooded pastures. Table 4-14 summarizes the types and frequency of foraging habitats commonly used by wood storks from the Birdsville Colony. Water quality parameters (including temperature, pH, dissolved oxygen concentration, turbidity, and conductivity) were measured at each foraging site (Coulter 1986a).

The wood storks foraged in various wetland habitat types (Table 4-14). Storks were followed most frequently to swamps; the most common were blackgum and cypress swamps (Hodgson et al. 1988; Coulter 1993; Coulter and Bryan 1993). The extent of the canopy cover ranged from completely open (marsh or pond) to completely closed (swamp). Most sites had little understory or woody vegetation. At all sites, the water was either still or very slowly moving.

Table 4-13. Mean Distances of Wood Stork Foraging Sites from the Birdsville Colony, 1983-1989

Year	Number of Storks	Mean Distance (km)[a]	Standard Deviation	Source
1983	30	17.39	15.60	Coulter 1986a
1984	55	13.75	13.16	Coulter 1986a
1985	39	11.94	7.87	Coulter 1986a
1986	36	11.85	8.33	Coulter 1987
1987	44	13.2	12.97	Coulter 1988
1988	40	9.1	7.35	Coulter 1989
1989	47	12.1	11.38	Coulter 1991

[a]To convert kilometers to miles multiply by 0.6214.

Table 4-14. Wood Stork Foraging Site Habitat Types in East-Central Georgia, 1983-1989

Habitat Type	Year						
	1983 Number (%)	1984 Number (%)	1985 Number (%)	1986 Number (%)	1987 Number (%)	1988 Number (%)	1989 Number (%)
Blackgum swamp	14 (31)	10 (20)	6 (29)	7 (23)	4 (18)	-	-
Hardwood swamp	-	4 (8)	-	2 (6)	2 (9)	11 (38)	8 (19)
Cypress swamp	13 (28)	7 (14)	6 (29)	9 (29)	3 (14)	3 (10)	10 (23)
Shrub swamp	8 (17)	-	-	-	-	-	-
Carolina bay	-	-	3 (14)	-	-	-	-
Open marsh	9 (20)	3 (6)	-	1 (3)	2 (9)	5 (17)	2 (5)
Natural pond	-	2 (4)	-	-	1 (4.5)	-	-
Man-made pond	2 (4)	11 (22)	2 (9)	5 (16)	3 (13.5)	4 (14)	7 (16)
Drainage ditch	-	4 (8)	-	-	-	-	-
Other	-	9 (18)	4 (19)	7 (23)	7 (32)	6 (21)	16 (37)
Total	46 (100)	50 (100)	21 (100)	31 (100)	22 (100)	29 (100)	43 (100)

Source: Coulter (1986a, 1987, 1988, 1989, 1991).

Vegetation Structure

The vegetation structure of a wetland may contribute to its suitability as a foraging site for wood storks, or a dense canopy may obscure a site from a flying stork. The birds may not be able to land if the understory is very thick. Aquatic vegetation may make it difficult for the birds to wade through the water and grope with their bills. Most sites had little aquatic vegetation, although a few sites had dense submergent or emergent vegetation. Submergent vegetation included species such as *Myriophyllum* spp. and algae; emergents included lotus (*Nuphar luteum*), water lily (*Nymphaea odorata),* bladderwort (*Utricularia inflata), Ludwigia* spp., and various species of duckweeds, sedges, and rushes.

Water Depth

The median water depth at the foraging sites was 18-26 cm (7-10 inches) during the 7 years of the survey (Coulter 1986a, 1987, 1988, 1989, 1991). The water depths ranged from 0 to 63 cm (0-25 in). Meyers (1984) suggested that the length of the legs of storks set an upper limit to water depth at about 50 cm (20 inches). Kahl (1963) stated that wood storks fed in water between 15 and 50 cm (6 and 20 inches) deep.

Major Diet Components

Regurgitation and stomach samples and recent literature indicate the major component of the diet of wood storks is sunfish (*Lepomis* spp.). Mosquito fish (*Gambusia* spp.) were common at many sites, but storks do not seem to prefer this species (Depkin et al. 1992).

SRS Savannah River Swamp Surveys

Introduction

Wood storks were reported in the vicinity of SRS before the site was established in 1952 and before the discovery of the Birdsville Colony (Murphey 1937). E. E. Murphey, describing the status of storks in the area in the early 1900s, noted that the birds probably did not breed locally, but that flocks of more than 30 birds were seen regularly in August and Sep-

tember. In June 1956 and July 1957, storks were recorded on SRS (Norris 1963). In July 1973 and 1974, flocks of 200 and more than 400 storks, respectively, were observed in the Steel Creek delta (Coulter 1986a). Storks have been followed from the Birdsville Colony to SRS (Meyers 1984; Coulter 1986a). Some of the birds observed foraging in the SRS Savannah River swamp may be storks from farther south, either nonbreeders or birds already finished breeding for the year (Coulter 1986a).

Results of the Aerial Surveys

More than 900 aerial surveys were conducted to census feeding or roosting storks in the SRS Savannah River swamp from mid-June 1983 through mid-October 1996 (Table 4-15). Wood storks are most commonly observed in the SRS Savannah River swamp during July and August (Table 4-16). In addition to the swamp and Kathwood Lake, wood storks have been observed foraging in the following locations on SRS: "RR site" (1993, 1994, 1996); Craigs Pond (1994, 1996); Sarracenia Bay (1994, 1996); Peat Bay (1994, 1996); Thunder Bay (1994); Eagle Bay (1994); Steel Creek Bay (1995); Robbins Station (1995) (Figure 4-17).

Stream Flows and Numbers of Foraging Storks

Sources of Water Flow

The water depth in the Savannah River swamp is dependent on the water flow from the Savannah River and site streams. The swamp receives overflow from the Savannah River during flooding. The river flow and the amount of water that reaches the swamp are influenced by the amount of water discharged from the Clarks Hill (Lake Thurmond) Dam, almost 160 km (99 mi) upstream. The water level in the swamp also depends on the water that flows into the swamp from Beaver Dam Creek, Fourmile Branch, Pen Branch, Steel Creek, and other smaller streams on SRS. The waterflow in these streams depends on rainfall and the outflow of water from L Lake (Steel Creek), Par Pond (Lower Three Runs), and the D-Area power plant. Meyers (1984) suggested that water depth may affect the suitability of a wetland as a wood stork foraging site on SRS.

Flow Effect on Number of Wood Storks

Both the number of observations of wood storks and the number of wood storks counted during aerial surveys of the SRS Savannah River swamp are greater in the areas of the swamp receiving lower flows, especially in the flow class of 51 to 100 ft^3/sec (1.4 to 2.8 m^3/sec)(Figure 4-18; Table 4-17 and Table 4-18). The one area that may be different is an area of sloughs between the Fourmile Branch and the Pen Branch deltas.

Foraging Use

Data from the aerial wood stork surveys of the SRS Savannah River swamp and the studies at the Birdsville Colony suggest that the SRS Savannah River swamp probably is not used extensively during the breeding or prefledging phases of the Birdsville Colony. Most of the observations of storks on SRS occur during the late-nestling or the post-fledging period. Larger numbers of wood storks have been observed foraging in the SRS Savannah River swamp following successful breeding and fledging years at Birdsville (1983, 1984, 1986, and 1987) than after less successful years (1985 and 1988).

Table 4-15. Number of Aerial Surveys Used to Monitor the Number of Wood Storks on the SRS Savannah River Swamp, 1983-1996

Year	Number of Woodstorks Counted During Aerial Surveys						
	Steel Creek Delta	Interdelta Area	Pen Branch Delta	Interdelta Area	Four Mile Creek Delta	Beaver Dam Creek	Total Number of Surveys
1983	87	0	6	0	0	170	35
1984	95	0	21	102	46	106	89
1985	9	0	9	236	346	0	120
1986	81	0	0	0	94	15	115
1987	139	0	0	0	11	0	123
1988	6	1	0	0	0	0	143
1989	9	1	5	6	6	2	99
1990	1	0	0	0	12	0	12
1991	1	16	1	17	36	7	34
1992	9	79	70	10	0	4	41
1993	22	1	16	68	55	6	40
1994	21	2	1	0	5	1	29
1995	5	7	0	1	0	0	26
1996	4	0	0	0	1	0	16
Totals	480	100	129	439	611	311	
Average Storks/ Area/Year	34.29	7.14	9.21	31.36	43.64	22.21	
Average Storks/ Area/Survey	0.55	0.11	0.15	0.50	0.69	0.35	

Source: Meyers 1984; Coulter 1986a, 1987, 1988, 1989, 1991, 1993; Bryan 1992a and b, 1994, 1995, 1996, Bryan et al. 1997.

Table 4-16. Number of Wood Storks Observed in the SRS Savannah River Swamp during Aerial Surveys, 1983-1996.

Period	Number of Storks	Percent of Total
Before June	45	2.1
June 1-15	123	5.6
June 16-30	146	6.7
July 1-15	588	26.8
July 16-31	425	19.4
Aug 1-15	207	9.4
Aug 16-31	191	8.7
Sept 1-15	171	7.8
Sept 16-30	274	12.4
After Sept	24	1.1
Total	2,194	100.0

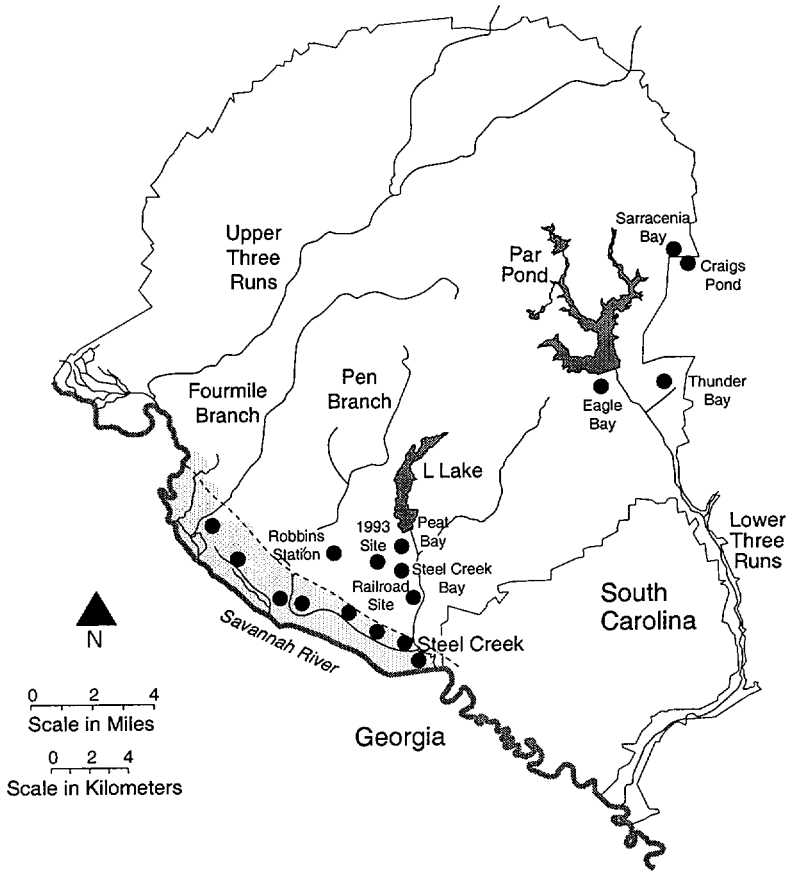

Figure 4-17. Wetlands on the Savannah River Site where storks foraged in 1993, 1994, 1995, or 1996

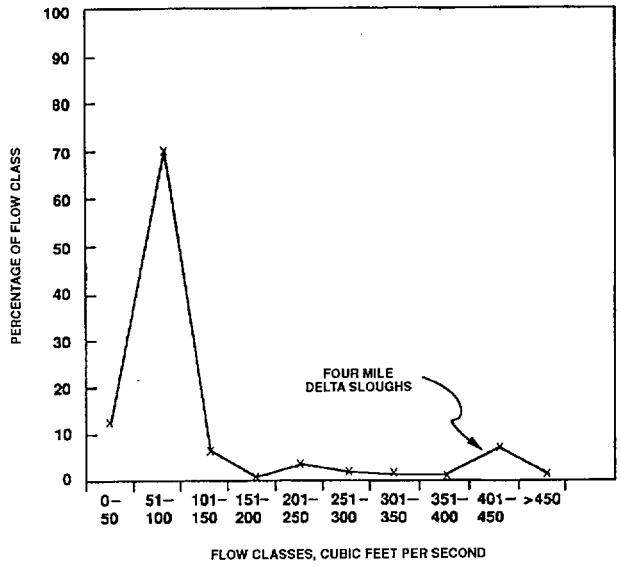

Figure 4-18. Percentage of Wood Storks Observed in the SRS Swamps from 1983 to 1988 Under Different Stream Flow Classes

Table 4-17. Number of Observations of Wood Storks in the SRS Savannah River Swamp, June-September, 1983-1988

	Number of Wood Stork Observations							
Flow Classes in the Creeks (ft^3/s)	**BDC**	**FM**	**FMS**	**PB**	**SC**	**Total**	**Percent of Total**	**Cumulative Percentage**
0 - 50	-	10	2	-	15	27	19.42	19.42
51 - 100	24	19	20	2	18	83	59.71	79.13
101 - 150	1	0	0	0	5	6	4.32	83.45
151 - 200	-	0	1	0	0	1	0.72	84.17
201 - 250	-	0	1	1	0	2	1.44	85.61
251 - 300	-	-	0	1	0	1	0.72	86.33
301 - 350	-	0	0	0	0	0	0.00	86.33
351 - 400	-	0	0	0	-	0	0.00	86.33
401 - 450	-	7	11	0	-	18	12.95	99.28
>450	-	0	0	1	-	1	0.72	100.00
Total	25	36	35	5	38	139	100.00	-

Source: Meyers 1984; Coulter 1986a, 1987, 1988, 1989.
BDC = Beaver Dam Creek delta area.
FM = Fourmile Branch delta area.
FMS = Fourmile Branch sloughs between Fourmile Branch and Pen Branch deltas.
PB = Pen Branch delta area.
SC = Steel Creek delta area.

Table 4-18. Total Numbers of Wood Storks Observed During Aerial Surveys of the SRS Savannah River Swamp, June-September, 1983-1988

	Number of Wood Storks							
Flow Classes in the Creeks (ft^3/s)	**BDC**	**FM**	**FMS**	**PB**	**SC**	**Total**	**Percent of Total**	**Cumulative Percentage**
0 - 50	0	97	3	0	92	192	12.43	12.43
51 - 100	291	291	235	27	249	1093	70.74	83.17
101 - 150	1	0	0	0	67	68	4.40	87.57
200	-	0	8	0	0	8	0.52	88.09
201 - 250	-	0	16	1	0	17	1.10	89.19
251 - 300	-	0	0	10	0	10	0.65	89.84
301 - 350	-	0	0	0	0	0	0.00	89.84
351 - 400	-	0	0	6	0	6	0.39	90.23
401 - 450	-	36	101	4	0	141	9.13	99.36
>450	-	0	0	10	-	10	0.65	100.01
Total	292	424	363	58	408	1545	100.01	-

Source: Meyers 1984; Coulter 1986a, 1987, 1988, 1989.
BDC = Beaver Dam Creek delta area.
FM = Fourmile Branch delta area.
FMS = Formula Branch sloughs between Fourmile Branch and Pen Branch deltas.
PB = Pen Branch delta area.
SC = Steel Creek delta area.

Both high (>100 ft^3/sec [>2.8 m^3/sec]) and low flows (<50 ft^3/sec [<1.4 m^3/sec]) from the SRS creeks probably limit the usefulness of the swamp as a foraging site. During periods of low flow (<50 ft^3/sec [<1.4 m^3/sec]) the streams are more confined to their channels, and habitats are not suitable for stork foraging. During periods of high flow, water depths may be limiting. Flows and flooding patterns also can affect vegetation patterns, thus influencing available foraging sites. Typical wood stork foraging sites have reduced quantities of both submerged and emergent macrophytes (Coulter 1986c). Moderate flows (>50 ft^3/sec, but < 150 ft^3/sec [> 1.4m^3/sec but < 4.2 m^3/sec]) to the SRS deltas during the summer months probably would maintain wood stork foraging sites in the SRS Savannah River swamp.

Par Pond

From late June 1991 through March 1995, the water level in the Par Pond reservoir was lowered approximately 6 m (20 ft) due to structural anomalies found in the dam impounding that system. Twenty surveys of the reservoir system monitored for possible wood stork use of the reservoir during the initial drawdown. A single stork was observed on Pond C on July 18, 1991. Stork numbers gradually increased to a maximum of 84 on September 19, 1991 and then declined through mid-October, when the storks were last seen on the reservoir (Bryan 1992a).

No storks have been observed foraging in the Par Pond system since 1991 (Bryan 1993, 1994, 1995, 1996; Bryan et al. 1997).

Wood Stork Use on Kathwood Lake

Introduction

Because preliminary data from the wood stork surveys of the Steel Creek delta indicated that the increased flow following the restart of L Reactor could result in loss of potential foraging areas, DOE, the USFWS, and the National Audubon Society agreed to construct a series of foraging ponds on the Silver Bluff Plantation Sanctuary (Mackey 1985). The site selected for the foraging ponds is referred to as "Kathwood Lake."

Physical Attributes

The Kathwood Lake site is approximately 15 ha (37 acres). It is west of SRS and about 45 km (28 mi) north of the Birdsville Colony. The lake originally was created for mill operations by diking a shallow depression and diverting water from Hollow Creek via a canal (Figure 4-19). Kathwood Lake drained in May 1977, when the wooden water control structure at the lower end of the lake failed. Wood storks (about 24) were observed foraging in pools of water in the lake bed in September 1977. A few wood storks were observed during aerial surveys at Kathwood Lake in late July and early August 1984 (Mackey 1985; Coulter 1986a).

Water control structures were added to subdivide the lake, control flow, facilitate fish rearing, and to provide the capability to sequentially lower the water level of each subdivision of the lake during the wood stork foraging season (Figure 4-20) so that some area of the lake would always be at the optimal wood stork foraging depth. Construction was completed in the early fall of 1985, and the ponds were stocked with fish beginning in late November 1985.

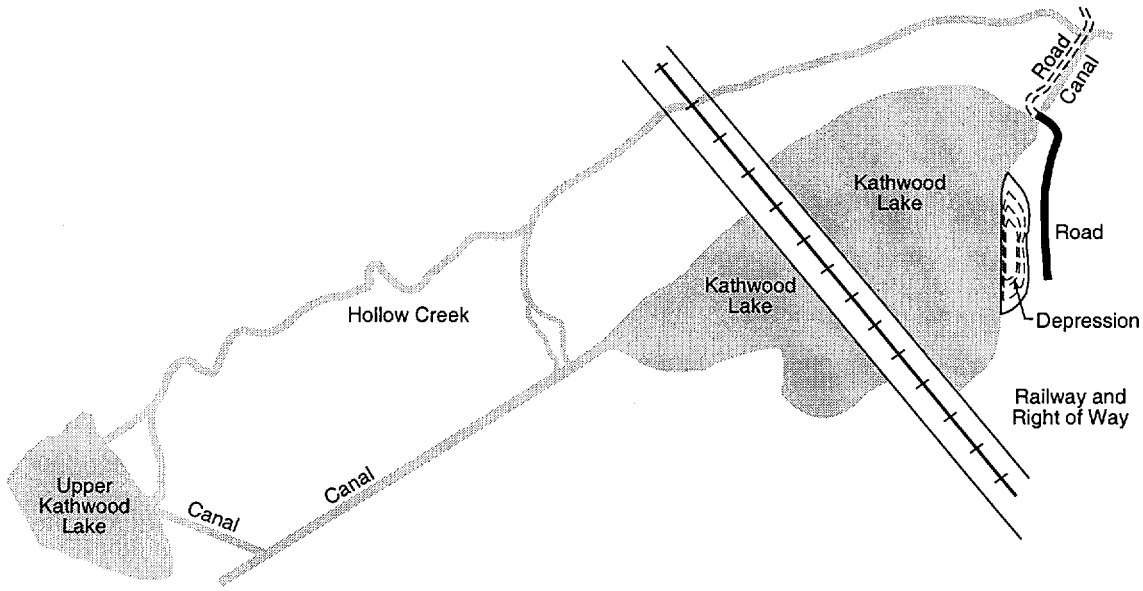

Figure 4-19. Kathwood Lake and Hollow Creek

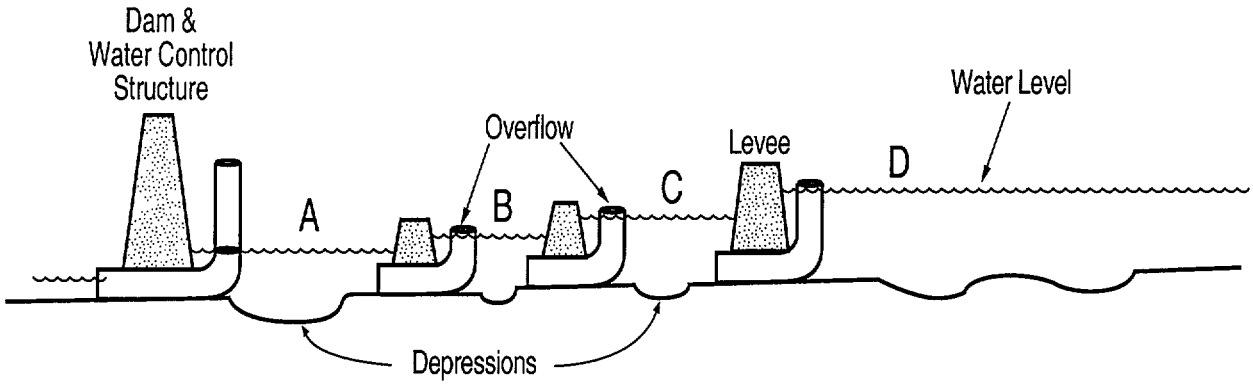

Figure 4-20. Longitudinal Section Through Kathwood Lake Showing General Features of the Subimpoundments and Water Levels

Wood Stork Use

Wood storks have used the foraging ponds at Kathwood Lake extensively during the summers of 1986 through 1992. Most of these storks have been juveniles, although banded wood storks from the Birdsville Colony have been observed there (Coulter 1987, 1988, 1989, 1991; Bryan 1992a and b). Storks banded as nestlings at the Harris Neck National Wildlife Refuge on the coast of Georgia also have been observed at Kathwood Lake (Bryan 1996; Bryan et al. 1997). Kathwood Lake more than compensates for any decline in available wood stork foraging sites on the Steel Creek delta.

Threatened and Endangered Mammals on SRS

Introduction

Either the DOI (USFWS 1992a) or the State of South Carolina (SCWMRD 1992) lists eight species of mammal that have historically resided in South Carolina as endangered or threatened; these include four bats, the black bear, two subspecies of cougar, and the red wolf (Table 4-19). With the exception of Rafinesque's big-eared bat (*Plecotus rafinesquii*), the occurrence of these mammals on SRS is unconfirmed. It is improbable that breeding populations of the other seven species exist on SRS.

Bats

The gray bat (*Myotis grisescens*) and Indiana bat (*Myotis sodalis*) have not been found on SRS, nor does the site provide caves or cave-like areas, which are the preferred habitat for these species. The small-footed bat (*Myotis leibii*) and Rafinesque's big-eared bat are not federally listed, but are recognized as threatened and endangered, respectively, by South Carolina. There is no information regarding the presence of the small-footed bat on SRS (Cothran et al. 1991), and its status is unconfirmed. Two specimens of Rafinesque's big-eared bat were collected from SRS and placed in the University of Georgia Museum of Natural History; however, field surveys of bats in 1979 were unsuccessful in confirming the presence of this species (Cothran et al. 1991). Furthermore, Golley (1966) did not report any of the four listed species of bats in his account of South Carolina mammals.

Carnivores

The black bear (*Ursus americanus*) is considered a possible rare transient traveling along the Savannah River; no permanent populations of this species are expected to occur on SRS (Cothran et al. 1991). The eastern cougar (*Felis concolor couguar*) and Florida panther (*F. c. coryi*) are federally listed as endangered; their home ranges historically included South Carolina (USFWS 1992a). Although there have been reports of cougars in the area, none has been confirmed, and it is unlikely that either of these subspecies is a permanent resident on SRS. The red wolf (*Canis rufus*) once ranged throughout South Carolina, but the present population exists primarily in captivity (USFWS 1992b). Red wolves recently have been released by USFWS on Bull's Island, SC, the Alligator River National Wildlife Refuge, NC and in the Great Smoky Mountains National Park (Mayer, J. J. Westinghouse Savannah River Company. Personal communication with K. K. Patterson, Dunaway & Fletcher, Inc. 1997).

Table 4-19. Endangered and Threatened Mammals of South Carolina

Scientific Name	Common Name	Federal Status[a]	State Status[b]	Critical Habitat[c]	Status on SRS[d]
Myotis grisescens	gray bat	endangered	none	no	unconfirmed
Myotis sodalis	Indiana bat	endangered	endangered	yes	unconfirmed
Myotis leibii	small-footed bat	none	threatened	no	unconfirmed
Plecotus rafines-quii	Rafinesque's big-eared bat	none	endangered	no	rare
Ursus americanus	black bear	none	threatened	no	rare transient
Felis concolor couguar	eastern cougar	endangered	endangered	no	unconfirmed
Felis concolor coryi	Florida oanther	endangered	none	no	unconfirmed
Canis rufus	red wolf	endangered	none	no	unconfirmed

[a]Federal Status USFWS 1992a.
[b]State Status SCWMRD 1992.
[c]Critical Habitat USFWS 1992b.
[d]Status on SRS Cothran et al. 1991; Golley 1966; USFWS 1992a, b.

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