Chapter 7

Additional Information to Support Research on the Ecology of SRS

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Introduction

The preceding chapters of this document have dealt primarily with the direct effects of man's activities on Savannah River Site (SRS) natural resources.

Since its creation in 1950, SRS has served as a unique resource for scientists studying the ecology of the Southeast, beginning with Dr. E. P. Odum's early work on theories of plant community succession that he tested in the old agricultural fields of SRS.

This chapter identifies additional sources of data on the SRS natural environment and summarizes an ecological investigation of the Burial Ground Complex. Scientists at the Savannah River Technology Center (SRTC), the Savannah River Ecology Laboratory (SREL), and the Savannah River Forest Station (SRFS) have published more than 2000 technical papers detailing research done at SRS under the auspices of the U.S. Department of Energy (DOE). Information on this research is available through the various organizations, all of which are at the SRS.

Remote Sensing Data

Remote sensing data have been used to evaluate SRS's natural resources and to monitor the environmental effects of operations since the early 1950s. From the beginning, the U.S. Forest Service used vertical aerial photography to support SRS timber resource management. Numerous other overflights have been conducted, such as those by the National High Altitude Program and the DOE Remote Sensing Laboratory. Programs documented facilities and operations with low altitude oblique and video photography. Low altitude gamma overflights have been flown every 5 to 10 years since 1974, providing data on areas of radioactive contamination on SRS. More recently, specialized airborne remote sensing scanners (multispectral scanners [MSS]) have provided special interest coverage, such as documenting the effects of thermal releases to SRS wetlands. Satellite data (SPOT and Thematic Mapper Landsat) provide large-scale synoptic views of the site. Much of the remote sensing data is now available in digital format for Geographic Information Systems (Mackey and Riley 1996). Table 7-1 summarizes available aerial data.

Aerial Oblique Video Coverage

Aerial oblique video imagery of the SRS and surrounding areas was recorded by the Remote Sensing Laboratory (RSL), DOE/NV, (formerly operated by EG&G Energy Measurements, Inc.; currently by Bechtel Nevada) during September 1982, April and June 1983, March and October 1984, August 1986, March and April 1988, September 1991; and February 1992. Altitudes between 200 and 1500 feet were common (Mackey and Riley 1996).

The purpose of the video coverage was to provide SRS personnel with a catalogue of aerial video scenes of areas of interest. These included the major SRS operating areas such as

Table 7-1. Aerial Coverage Available for the SRS

Type	Dates Available	Purpose	Specifications
Aerial oblique video	1982 - Sept 1993 - Apr, Jun 1984 - Mar, Nov 1988 - Mar, Apr 1991 - Sept 1992 - Feb	Document major operating and construction activities; areas of interest, including waste units and natural areas	altitude: 200-1,500 ft quality: good
Aerial oblique photography	1971 - Jan 1974 - June 1975 - Dec 1979 - June 1981 - Mar, Sept, Oct 1982 - Aug, Sept 1983 - Mar, Aug 1984 - Mar, May - Nov 1985 - Feb - Jun, Aug 1986 - Mar, Apr, Jun, Aug 1987 - Feb, Mar, Jun 1988 - Mar 1990 - Apr 1991 - May, Jun 1994 - Apr	Document major operating and construction activities; areas of interest, including waste units and natural areas	altitude: 30-2,300 ft size: 4x5 Original proof boxes are in vaults at the Remote Sensing Laboratory.
Vertical aerial photography	1938, 1943, 1951, 1955, 1956, 1966, 1973, 1974, 1979, 1981, 1982, 1986, 1989, 1992, 1994, and 1996; partial coverage in other years		b&w prior to 1974; color after (normal or False Color Infrared) altitude: 10,000 ft. quality: fair to good
SPOT satellite data	almost annually since 1987	Land use / cover	single band, panchromatic (10x10), and 3-band multispectral (20x20)
Thematic Mapping (TM) Landsat satellite data		Land use/cover	
Multispectrual Scanner (MSS) data	1981-1985 after 1985 almost annually	Document thermal impacts	Daedalus 1260 Daedalus 1268 kept at Remote Sensing Laboratory
Gamma surveys	1958-1991	Map natural and manmade gamma fields	available in digital format

Source: Mackey and Riley 1996.

reactors and chemical processing facilities, construction projects such as the Defense Waste Processing Facility (DWPF) and L Lake and other areas of interest such as waste units, creeks and deltas, cooling reservoirs, forestry test plots, offsite mitigation sites such as Kathwood Lake, or downriver water treatment plants. Primary use has been in public relations and site training films.

In addition, SRTC personnel obtained ground-based, hand-held video coverage of the L-Lake shoreline, Par Pond shoreline and Lost Lake at various times from 1990 to 1995 (Mackey and Riley 1996).

Aerial Oblique Photographic Coverage

The Remote Sensing Laboratory recorded aerial oblique photographs of the SRS and surrounding areas in 1971, 1974, 1975, 1979, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1990, 1991 and 1994. The purpose of the oblique photographic coverage was to provide SRS personnel with a catalogue of aerial oblique scenes of the major operating areas, construction projects (e.g., DWPF and L Lake), and other areas of interest (Mackey and Riley 1996).

Vertical Aerial Photography

A very extensive collection of vertical aerial photographs exists for the SRS. Most of the photographs prior to 1974 are black and white, while those after 1974 are color, either normal color or false color infrared (FCIR). The most common altitude is 10,000 feet above ground level and the most common scale is 1:20,000. The U.S. Forest Service photographed the site in 1955, 1956, 1966, 1973, 1974, 1979, 1982, 1986, 1989, 1992, and 1996, to assist with timber management. The site also was flown under the National High Altitude Photographic program in 1981, 1989, and 1994. Since 1981, part or all of the site has been flown almost annually by RSL. Nearly site wide coverage is available for almost every year since 1973, thus a photographic history can be created for any SRS location (Mackey and Riley 1996).

Two sets of site-wide vertical photographs taken in 1938 and 1943 predate the establishment of the SRS in the early 1950's. These provide a record of the landuse patterns on SRS area prior to establishment of the site (Mackey and Riley 1996).

Several sets of photographs were taken in the 1950s. Two sets were taken in 1951 at 2,000 and 10,000 foot altitudes, during early construction of the SRS, documenting the land cover of the site at that time in good detail. Photographs of the northern half of the site are available as a digital orthographic file. The 1955 and 1956 black and white coverage are of fair quality, but only prints have been located. Much of the photography in the 1950's and 1960's has the areas surrounding the operating areas removed from the prints and/or negatives as part of the security practices at that time, thus their utility to review history of selected locations on the SRS is reduced. The construction activities of Par Pond are covered in low and high altitude sets of photography from 1958.

The coverage flown by EG&G (currently Bechtel Nevada) started in 1974 and was extensive, especially after 1981. It supported a variety of SRS projects, most often related to reactor operations, National Environmental Policy Act (NEPA) activities, and evaluation of thermal impacts to wetlands.

In addition to supporting the development of site-wide GIS databases, representative historical photography of the SRS has been incorporated into a series of image browse files to allow for quick viewing of any SRS location over time.

SPOT Satellite Data

Acquisition of SPOT satellite data coverage of the SRS began in 1987. Coverage was repeated almost annually between 1987 and 1995. SPOT satellite data are especially useful for habitat and landuse mapping of the general landscape at a reasonable cost (Mackey and Riley 1996).

TM Landsat Satellite Data

Thematic Mapper (TM) Landsat satellite coverage exists for the SRS and surrounding region. As with SPOT data, Landsat data are particularly good for repeated coverage of a given area at reasonable cost and for habitat and land use mapping of the general landscape (Mackey and Riley 1996).

Airborne Multispectral Scanner Data

Airborne multispectral scanner (MSS) data are similar to TM satellite data with the major exception that the scanner(s) is flown at relatively low altitudes, resulting in a much higher spatial resolution than can be obtained with the current commercial satellite systems. Also, the overflights can be timed, for example, to take advantage of experimental manipulations such as thermal plume or thermal dispersion dye studies (Mackey and Riley 1996).

The vast majority of the overflights at SRS were flown after 1980, primarily to document thermal impacts of site operations on the creeks and reservoirs of the SRS and to evaluate the dispersion of thermal plumes in the Savannah River (Mackey and Riley 1996).

Aerial Gamma Survey Data

Aerial gamma surveys of the SRS and surrounding areas were conducted between 1958 and 1991. These surveys resulted in relatively good maps of natural and manmade gamma fields. In addition to site-wide surveys, special gamma overflights were conducted from time to time to provide baseline information for selected locations or for potential project evaluations or changes in site operations (Mackey and Riley 1986).

Ecological Investigations at the Mixed Waste Management Facility

Summary

The Mixed Waste Management Facility (MWMF) occupies approximately 79 ha (194 acres) in the central portion of SRS. It contains active and former disposal sites for wastes generated by SRS operations, including solid metallic waste, radioactive waste, and solvents. Three separate investigations were done in 1994 that support remedial investigation activities required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): remote sensing to develop a land-use cover map; aquatic toxicity testing to determine if surface waters were toxic to aquatic biota; and qualitative surveys of small mammals, reptiles, and amphibians to identify the species that inhabited the area (Friday et al. 1994).

The land use and cover of the MWMF is primarily grassy (46%) or industrial (45%). It includes upland pine plantations, and several small creeks bordered by mixed hardwood or bottomland hardwood forest. Grassy habitat is relatively uncommon on SRS.

Aquatic toxicity tests indicate that although some of the surface water leaving the MWMF is toxic (Table 7-2), it does not appear to be causing toxicity in either Upper Three Runs or Fourmile Branch. Toxicity of three of four seeps tested in 1993 and 1994 declined over the year, and the fourth seep had a fairly constant toxicity between the two years (Table 7-3). See the following section for a detailed discussion of the results of the toxicity tests.

Eight areas and five habitats were surveyed for small mammals and reptiles and amphibians. The habitats were old field, early successional, mixed hardwood and pine, upland pines, and bottomland hardwoods. The southern short-tailed shrew (*Blarina carolinensis*) was the most frequently captured mammal (Table 7-4), followed by the cotton rat (*Sigmodon hispidis*). The early successional habitat had more than 35% of the total catch, and 7 species. The old field and bottomland hardwood habitats had high catch rates, but low species diversity (four species in the old field and two in the hardwood forest). Animals other than those trapped use the MWMF (Table 7-5).

Table 7-6 names reptiles and amphibians observed, collected, or heard during the study. The greatest number of species were observed in the early successional and hardwood areas, which are adjacent to each other.

Chronic Aquatic Toxicity

Chronic toxicity tests using EPA protocol were performed on surface water samples collected from 11 seepline locations and 5 locations in Fourmile Branch between May 1990 and July 1994 (Figure 7-1 through Figure 7-3). In addition, surface waters from five uncontaminated background locations were also tested. Locations denoted as FSP and HSP represent F- and H-Area seepline sites, respectively. Sampling locations in Fourmile Branch are designated as FMB. The four background seepline locations include Upper Three Runs and Mixed Waste Management Facility sites. A background stream location, Upper Three Runs at the railroad bridge, was also sampled.

Table 7-2. Results of Toxicity Tests at the MWMF Study Area, 1994

Location[a]	No Observable Effects Concentration	Lowest Observable Effects Concentration
UTR-022	50%	100%
UTR-029	50%	100%
UTR-116	50%	100%
FSP-012	>100%	>100%
FSP-204	25%	50%
HSP-008	>100%	>100%
HSP-103	12.5%	25%
FMC-001F	>100%	>100%
BGW-045	>100%	>100%
UTR-RR Bridge	>100%	>100%

Source: Friday et al. 1994.
[a]UTR = Upper Three Runs.
FSP = F-Area Seepline.
HSP = H-Area Seepline.
FMC = Fourmile Branch.
BGW = Burial Ground.

Table 7-3. Results of Toxicity Tests Conducted at Four F-/H-Area Seeps in 1993 and 1994

	No Observable Effects Concentration	
Location[a]	1993	1994
FSP-012	10%	>100%
FSP-204	30%	25%
HSP-008	100%	>100%
HSP-103	3%	12.5%

Source: Friday et al. 1994.
[a]FSP = F-Area Seepline.
HSP = H-Area Seepline.

Table 7-4. Species, Total Captures, and Frequency of Captures for Small Mammals at the MWMF Study Area, 1994

Species	Total Captures	Frequency
short-tailed shrew	52	0.351
least shrew	19	0.128
golden mouse	1	0.007
cotton mouse	13	0.088
old-field mouse	12	0.081
mouse	1	0.007
Eastern harvest mouse	4	0.027
cotton rat	44	0.297
house mouse	1	0.007
Southern flying squirrel	1	0.007

Source: Friday et al. 1994.

Table 7-5. Scientific and Common Names of Mammals Observed at the MWMF Study Area, 1994

Scientific name	Common Name	Observation
Didelphis virginiana	opossum	Live trap
Blarina carolinensis	short-tailed shrew	Trapping
Cryptotis parva	least shrew	Trapping
Scalopus aquaticus	eastern mole	Active tunnels
Sylvilagus floridanus	eastern cottontail	Sighting, scat
Ochrotomys nuttalli	golden mouse	Trapping
Peromyscus gosspinus	cotton mouse	Trapping
Peromyscus polionotus	old-field mouse	Trapping
Peromyscus sp.	mouse	Trapping
Reithrodontomys humulis	eastern harvest mouse	Trapping
Sigmodon hispidus	cotton rat	Trapping
Mus musculus	house mouse	Trapping
Glaucomys volans	southern flying squirrel	Trapping
Sciurus carolinensis	gray squirrel	Observed
Felis rufus	bobcat	Tracks
Mephitis mephitis	striped skunk	Carcass
Procyon lotor	raccoon	Trapping, scat
Odocoileus virginianus	white-tailed deer	Tracks
Sus scrofa	feral swine	Scat

Source: Friday et al. 1994.

Table 7-6. Scientific and Common Names of Reptiles and Amphibians Identified During the MWMF Characterization, 1994

Scientific Name	Common Name	Observation[a]
Plethodon glutinosus	slimy salamander	HDWD, RR
Scaphiopus holbrookii	eastern spadefoot toad	ZUP
Bufo quercicus	oak toad	RR
B. terrestris	southern toad	QM, SROW, ZUP
Hyla chrysoscelis	gray tree frog	FOF, SROW, ZBOT, ZUP
H. cinerea	green tree frog	ESC/HDWD
H. gratiosa	barking tree frog	ESC/HDWD, QM, SROW, ZBOT, ZUP
H. squirella	squirrel tree frog	RR, SROW, ZBOT
Gastrophryne carolinensis	eastern narrowmouth toad	ESC/HDWD
Rana catesbeiana	bullfrog	ESC/HDWD, ZUP
R. clamitans	bronze frog	ESC/HDWD, ZUP
R. grylio	pig frog	ESC/HDWD
R. sphenocephala	southern leopard frog	QM, ZUP
Terrapene carolina	box turtle	SROW, ZBOT
Anolis carolinensis	green anole	RR, ZUP
Cnemidophorus sexlineatus	six-lined racerunner	ZBOT
Eumeces inexpectatus	southeastern five-linked skink	QM, RR, SROW, ZBOT
Scincella lateralis	ground skink	HDWD, RR, SROW, ZBOT
Elaphe obsoleta	rat snake	ESC

Source: Friday et al. 1994.
[a]HDWD = Upland Hardwood/Pine.
RR = Railroad Pine Forest.
ZUP = Z-Area Upland Pine.
QM = H-Area Seepline.
SROW = Streamline Right-of-way.
FOF = Old Field.
ZBOT = Z-Area Bottomland.
ESC = Early Successional.

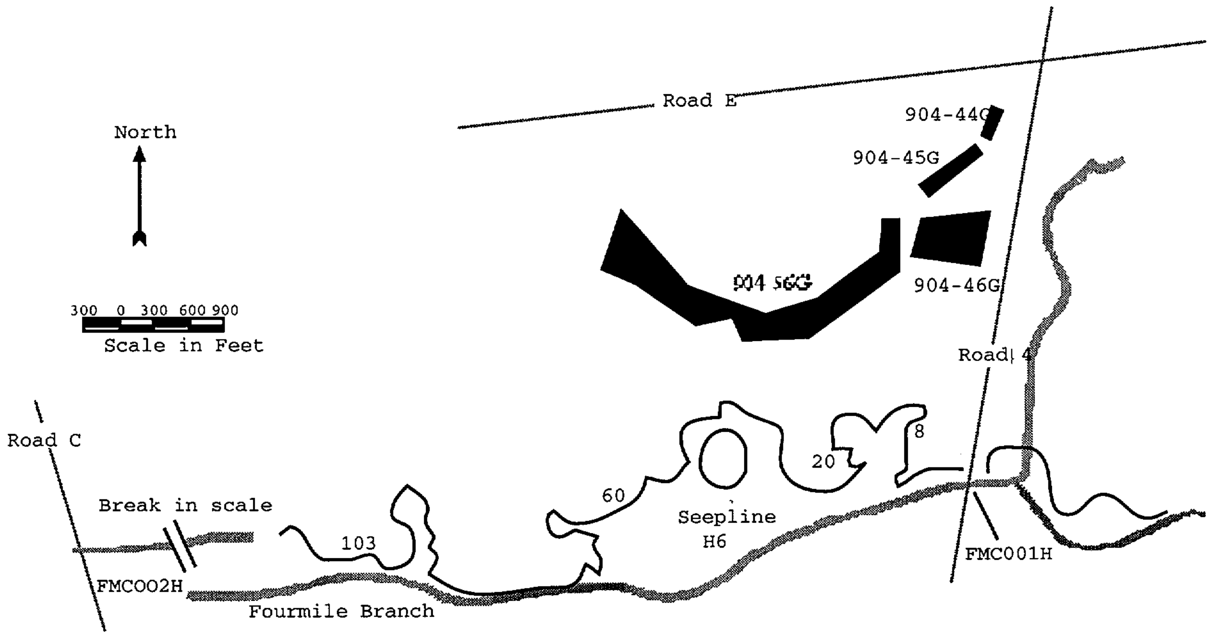

Figure 7-1. Sampling Locations for Toxicity Testing along the H-Area Seepline (Source: Friday 1997)

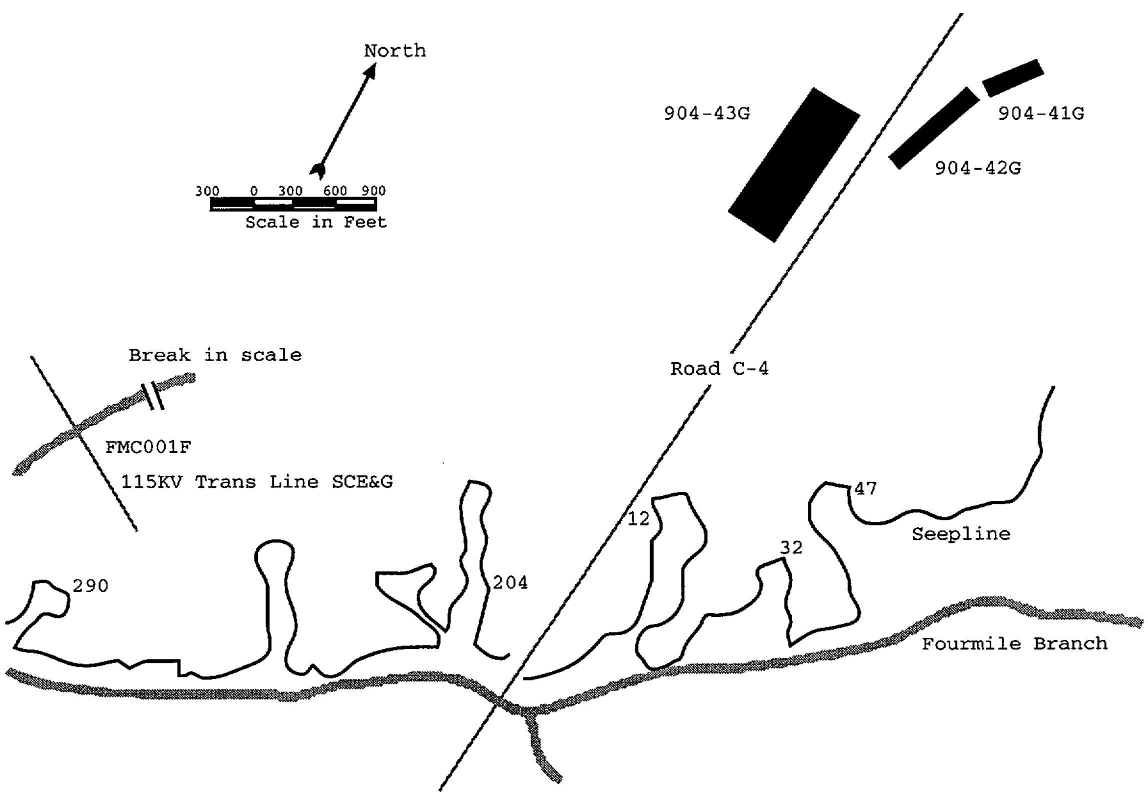

Figure 7-2. Sampling Locations for Toxicity Testing along the F-Area Seepline (Source: Friday 1997)

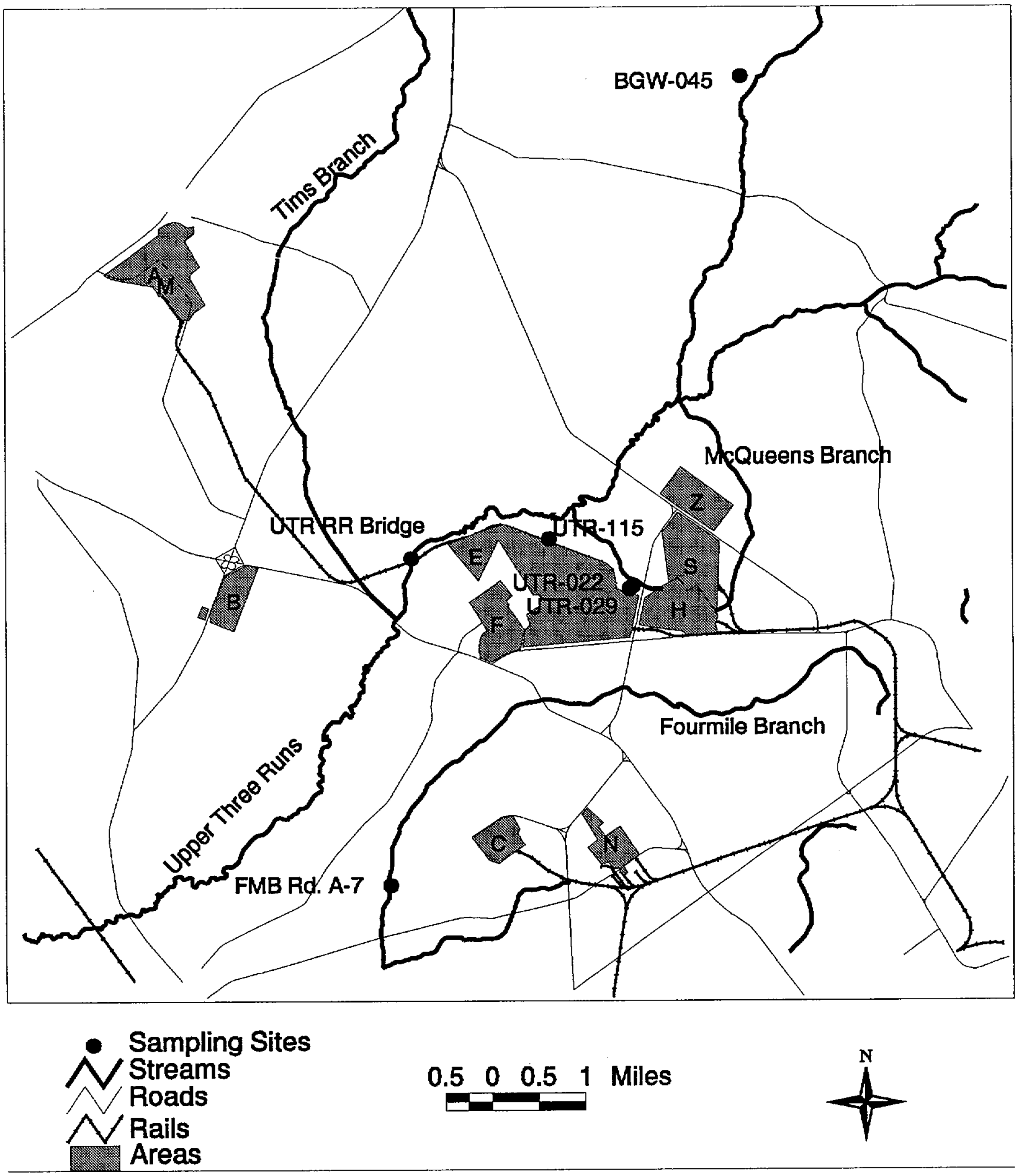

Figure 7-3. Sampling Locations for Toxicity Testing in Fourmile Branch, Upper Three Runs, and Reference Seeps (Source: Friday 1997)

Toxicity tests were initially conducted in May and June, 1990. Six representative sampling locations were selected based on water chemistry analyses conducted by Haselow et al. (1990): (a) two at the F-Area seepline, (b) two at the H-Area seepline, and (c) two locations in Fourmile Branch (Table 7-7). Fourmile Branch at Road C was selected because it occurs downstream from the H-Area seepline, yet upstream from the F-Area seepline. Fourmile Branch at Road C-4 was selected because it lies downstream of both seeplines. In November and December 1990, samples were collected at the same locations except for Fourmile Branch which was sampled at Road A-7 rather than at Road C-4 (Korthals 1991). The location at Road A-7 lies downstream from both the F- and H-Area seepage areas (Figure 7-3). The results of the 1990 testing indicated the presence of toxicity at both seeplines and also in Fourmile Branch at Road A-7 (Table 7-7).

In July 1991, a second toxicity test was conducted on surface water collected from Fourmile Branch at Road A-7. These results, however, showed no evidence of toxicity in the stream (Table 7-7). Toxicity testing was not conducted for the F- and H-Area seeplines in 1991 nor was any toxicity testing performed in 1992.

In September 1993, toxicity tests were conducted at five F-Area seepline locations, four H-Area seepline locations, and four locations in Fourmile Branch (Table 7-7). The seepline locations were selected based on water chemistry results of Dixon and Rogers (1993), and included several locations that were tested in 1990. The creek locations were selected to be upstream of the F- and H-Area seeps (Road 4), between the F- and H-Area seeps (Road C), immediately downstream of most of the seeps (Road C-4), and downstream of all seeps (Road A-7). Except for a single location in H Area, all seepline locations were toxic in 1993 (Table 7-7). No toxicity was detected in Fourmile Branch.

Toxicity testing continued in 1994 at 10 locations: (1) two seepline sites in F Area, (2) two seepline sites in H Area, (3) Fourmile Branch at the SCE&G powerline, (4) four background seepline sites, and (5) one background location in Upper Three Runs. The results of these analyses indicated that seepline waters at F and H Area were toxic, background seepline locations were slightly toxic, and Fourmile Branch and reference streams were not toxic. Compared to earlier observations, toxicity at some seepline locations appeared to decline.

Aquatic toxicity varied by location and year (Table 7-7). Toxicity results for background, seepline, and Fourmile Branch locations are summarized below.

Background Locations

Three of the four background seepline locations that were sampled in 1994 were toxic (No Observable Effects Concentration [NOEC] values of 50%). One seepline location and the single stream location in Upper Three Runs at the railroad bridge were not toxic. These results indicate that some seepline locations on the SRS, even though they are not influenced by the F- and H-Area seepage basins, can be toxic to *Ceriodaphnia dubia*.

Seepline Locations

Toxicity tests conducted on seepline locations downgradient from the F- and H-Area seepage basins had NOECs ranging from 3% to 100% (Table 7-7). Of the 11 seepline locations that were sampled in 1993 and 1994, only 2 showed no evidence of toxicity (HSP-008 and H-6). The remaining locations were toxic on at least one occasion. The degree of toxicity at the seepline seeps appears to vary temporally. The variation is probably related to the

Table 7-7. No Observed Effect Concentrations (NOECs) for Toxicity Testing Locations, 1990-1994

Location	May-June 1990	Nov-Dec 1990	July 1991	September 1993	April-June 1994
FSP-012	60%	60%	-	10%	100%
FSP-032	100%	-	-	30%	-
FSP-047	-	-	-	30%	-
FSP-204	-	-	-	30%	25%
FSP-256	-	-	-	30%	-
HSP-008	-	-	-	100%	100%
HSP-020	-	-	-	3%	-
HSP-043	60%	60%	-	-	-
HSP-060	-	-	-	10%	-
HSP-103	-	-	-	3%	13%
H-6	100%	100%	-	-	-
FMB Road 4	-	-	-	100%	-
FMB Road C	100%	100%	-	100%	-
FMB Road C-4	100%	-	-	100%	-
FMB SCE&G	-	-	-	-	100%
FMB Road A-7	-	60%	100%	100%	-
UTR-022	-	-	-	-	50%
UTR-029	-	-	-	-	50%
UTR-116	-	-	-	-	50%
BGW-045	-	-	-	-	100%
UTR RR Bridge	-	-	-	-	100%

Source: Friday 1997.
FSP = F-Area seepline.
HSP = H-Area seepline.
FMB = Fourmile Branch.
UTR = Upper Three Runs.
BGW = Mixed Waste Management Facility.

amount of rainfall in the week or two prior to sample collection. Rainfall can dilute the seepline surface water directly and can also infiltrate the shallow groundwater, causing further dilution.

Fourmile Branch

Between 1990 and 1994, surface waters from five locations in Fourmile Branch were tested (Table 7-7). Of the 10 toxicity tests that were performed, only Fourmile Branch at Road A-7 in winter 1990 showed evidence of toxicity (NOEC = 60%). It could not be determined if this toxicity was due to naturally occurring conditions or to contamination associated with the F-Area seepline. However, no toxicity has been observed in Fourmile Branch below the F- or H-Area seeplines since 1990. This suggests that the seeplines were not toxic to Fourmile Branch.

Toxicity Identification Evaluations

In order to determine the cause of observed toxicity, Toxicity Identification Evaluations (TIEs) were performed on three representative seepline locations: (1) FSP-204, which is downgradient from the F-Area seepage basins, (2) HSP-103, which is downgradient from the H-Area seepage basins, and (3) UTR-029, which is not influenced by F or H Areas. In addition, as part of another study, a TIE was performed on water collected from Fourmile Branch at Road F, which is upstream from all SRS discharges.

The results of the TIE's indicated that the toxicity in Fourmile Branch and Upper Three Runs was due to naturally occurring iron, and the toxicity of the F-Area seep was due to aluminum and cadmium. The toxicity of the H-Area seep appeared to be due to a volatile toxicant, but the toxicity of the seep declined before the toxicant could be identified. It is possible that the toxicity was due to ammonia, which was chemically reduced from nitrate in the ground-water.

Aquatic Toxicity Tests

South Carolina Department of Health and Environmental Control (SCDHEC) requires effluent toxicity testing at selected SRS National Pollutant Discharge Elimination System (NPDES) outfalls. The U.S. Environmental Protection Agency (EPA) and SCDHEC have recommended the cladoceran *Ceriodaphnia dubia* as the species of choice for effluent toxicity testing. Although other species of daphnids, such as *Ceriodaphnia reticulata* and *Daphnia ambigua*, are common in SRS ponds and reservoirs, *C. dubia* is not found on the SRS. The following discussion on the suitability of using SRS stream waters as diluents in toxicity tests is taken from Specht (1994a).

The chemical composition of surface waters in the United States varies widely with respect to water hardness and trace mineral content. In order to provide a consistent source of culture water for performing toxicity tests, the EPA and SCDHEC recommend that *C. dubia* be cultured in 20% dilute mineral water (DMW), which is a mixture of 80% deionized water and 20% Perrier mineral water. DMW has sufficient calcium and trace minerals to maintain long-term cultures of *C. dubia*. DMW has a hardness of approximately 200 mg/l as $CaCO_3$ and is considered to be moderately hard water. In contrast, SRS stream water is extremely soft, with hardnesses ranging from approximately 2 to 30 mg/l. If mineral water is diluted to the hardness values that are typical of SRS waters, it does not contain sufficient calcium and trace minerals to support *C. dubia*. Because *C. dubia* does not occur on the SRS and the natural water chemistry of SRS surface waters differs greatly from that of DMW, *C. dubia* may not thrive when exposed to unimpacted SRS surface water. SCDHEC has specified that SRS surface waters may be used as the diluent for effluent toxicity tests. However, if *C. dubia* will not thrive in SRS surface waters, the use of SRS water as diluent may result in less than optimal conditions for the test species and produce inconclusive or erroneous test results.

In order to determine if *C. dubia* can thrive in water from SRS streams, water was collected from three unimpacted reaches of streams (Upper Three Runs at Road 8-1, Fourmile Branch at Road F, and Pen Branch at Road B). Collectively, these three streams and their tributaries are the receiving streams for approximately 70% of SRS's NPDES discharges. The three main objectives of this study were to determine if: 1) *C. dubia* is adversely affected by SRS stream waters that do not receive NPDES discharges; 2) *C. dubia* can be cultured for extended periods of time in SRS stream waters; and 3) *C. dubia* that are cultured in stream waters differ in sensitivity to a reference toxicant when compared to organisms that are cultured in 20% DMW. Increased sensitivity to a toxicant is generally an indication of stress.

Water was collected monthly from the three locations and cultures of *C. dubia* were established in all three waters in December 1993 (Specht 1994a). Once each month the percent survival and mean number of young produced during a seven-day period was determined for each water source and for 20% DMW. In addition, a reference toxicity test using sodium chloride was performed on each water source and DMW each month.

The water chemistry data confirm that SRS streams are soft, with total hardness averaging 4.4 mg/l in Upper Three Runs, 12.9 mg/l in Fourmile Branch, and 19.6 mg/l in Pen Branch (Table 7-8). The pH of the streams averaged 5.3 in Fourmile Branch, 5.7 in Upper Three Runs, and 6.7 in Pen Branch.

Table 7-8. Water Quality Data For Pen Branch, Upper Three Runs, and Fourmile Branch, 1994

	Pen Branch		Upper Three Runs		Fourmile Branch	
Parameter	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**
Dissolved oxygen (mg/l)	9.1	6.6 - 11.8	9.0	6.4 - 12.0	4.3	1.2 - 7.1
Hardness (mg/l)	19.6	12.0 - 30.9	4.4	1.96 - 8.0	12.9	8.0 - 23.3
Alkalinity (mg/l)	16.6	6.0 - 26.9	2.4	1.0 - 6.7	4.0	2.0 - 11.0
Dissolved organic carbon (mg/l)	5.6	2.9 - 16.9	3.7	1.1 - 11.0	12.1	5.1 - 18.0
Conductivity (μS/cm)	51.7	37.7 - 66.0	17.4	13.4 - 34.3	36.9	28.5 - 49.0
pH	6.72	6.1 - 7.42	5.7	5.23 - 7.45	5.3	4.55 - 5.93

Source: Specht 1994a.

C. dubia did best in water from Pen Branch and poorest in water from Fourmile Branch (Table 7-9 through Table 7-11). However, even in water from Pen Branch, reproduction was significantly lower than for organisms cultured in DMW in 5 of 11 tests. Overall, the number of young produced in Pen Branch water averaged 21.1 young/female as compared to 24.4 young/female in DMW. Water from Pen Branch never induced acute toxicity (mortality >10%).

C. dubia cultured in water from Upper Three Runs exhibited some degree of acute toxicity in 6 of 11 tests. In the chronic tests, organisms cultured in water from Upper Three Runs had significantly lower rates of reproduction in all 11 tests. Overall, the number of young produced in Upper Three Runs water averaged 13.8 young/female as compared to 24.6 young/female in DMW.

Cultures of *C. dubia* that were established in water from Fourmile Branch in December 1993 declined in vigor so they were not sustainable by February. No further culturing was attempted with Fourmile Branch water until August. Based on results for the five months that cultures were maintained in water from Fourmile Branch, the water was

Table 7-9. Reproductive Rates And Mortality In Pen Branch Water, 1994

	Reproductive Rate (young/female)			Percent Survival		
	Control	**Creek**	**Chronic Toxicity**	**Control**	**Creek**	**Acute Toxicity**
January	23.3	25.3	No	100	95	No
February	21.1	25.1	No	100	90	No
March	20.4	19.7	No	90	95	No
April	21.9	20.1	No	100	95	No
May	25.8	15.7	Yes	100	95	No
June	28.8	18.7	Yes	100	100	No
July	25.8	25.0	No	100	100	No
August	27.2	18.6	Yes	100	95	No
September	29.1	21.0	Yes	95	100	No
October	24.6	16.6	Yes	95	95	No
November	20.8	26.3	No	100	100	No

Source: Specht 1994a.

Table 7-10. Reproductive Rates And Mortality In Upper Three Runs Water, 1994

	Reproductive Rate (young/female)			Percent Survival		
	Control	**Creek**	**Chronic Toxicity**	**Control**	**Creek**	**Acute Toxicity**
January	24.1	8.5	Yes	100	90	No
February[a]				100	85	Yes
March	20.4	6.7	Yes	90	65	Yes
April	21.9	12.1	Yes	100	85	Yes
May	25.8	15.3	Yes	100	95	No
June	28.8	16.4	Yes	100	90	No
July	23.0	12.5	Yes	100	80	Yes
August	27.2	12.4	Yes	100	45	Yes
September	29.0	17.6	Yes	100	90	No
October	24.6	15.4	Yes	95	100	No
November	20.8	5.2	Yes	100	15	Yes

Source: Specht 1994a.
[a]No chronic test was performed.

Table 7-11. Reproductive Rates And Mortality In Fourmile Branch Water, 1994

	Reproductive Rate (young/female)			Percent Survival		
	Control	**Creek**	**Chronic Toxicity**	**Control**	**Creek**	**Acute Toxicity**
January	24.1	6.6	Yes	100	80	Yes
February[a]						
March[a]						
April[a]						
May[a]						
June[a]						
July[a]						
August	27.2	22.1	Yes	100	90	No
September	28.1	20.4	Yes	100	95	No
October	18.6	6.5	Yes	95	10	Yes
November	20.8	0.0	Yes	100	0	Yes

Source: Specht 1994a.
[a]Cultures could not be maintained long-term (>1 month) in water from Fourmile Branch.

acutely toxic in three of the five months; percent survival ranged from 0 to 95% and averaged 55% (Table 7-11). In the chronic tests, organisms cultured in water from Fourmile Branch had significantly lower rates of reproduction in all five months. Overall, the number of young produced in Fourmile Branch water averaged 11.1 young/female as compared to 23.8 young/female in DMW. Reproductive rates showed a continuous decline between August (22.1 young/female) and November, when no young were produced. These data indicate that Fourmile Branch is not capable of sustaining *C. dubia* long-term.

The reference toxicity tests with sodium chloride produced results similar to those of the chronic tests. In all instances, organisms cultured in SRS stream waters were more sensitive to the reference toxicant (sodium chloride) than were organisms cultured in DMW (Table 7-12). Organisms in water from Fourmile Branch were most sensitive and those from Pen Branch were least sensitive. These results suggest that *C. dubia* cultured in unimpacted SRS stream water are stressed to various degrees, and therefore, more sensitive to the added stress of a toxicant.

The results of both the reproduction tests and the reference toxicity tests indicate that none of the three SRS water sources that was tested do as well as DMW in supporting long-term cultures of *C. dubia*. Of the three water sources, Pen Branch came closest to matching the results obtained in DMW, and Fourmile Branch was the worst. These results indicate that it may not be possible to distinguish between toxicity resulting from effluent discharges and naturally occurring toxicity, except by performing toxicity tests on samples collected upstream and downstream from outfalls and comparing the results. In many instances, the

Table 7-12. Results of Reference Toxicant Toxicity Tests Conducted With Sodium Chloride, 1994

	LC_{50}[a] (g NaCl/l)				Survival NOEC[b] (g NaCl/l)				Reproductive NOEC (g NaCl/l)			
	Control	Pen Branch	Upper Three Runs	Fourmile Branch	Control	Pen Branch	Upper Three Runs	Fourmile Branch	Control	Pen Branch	Upper Three Runs	Fourmile Branch
January	2.08	1.22	<0.2	<0.2	1.5	0.8		<0.2	0.4	0.4	<0.2	<0.2
February[c]	2.08	1.13			1.5	0.8			0.4	0.8		
March[c]	2.08	1.22			1.5	0.4			0.4	0.4		
April[c]	2.08	1.19	<0.0625		1.5	0.8	<0.0625		0.4	0.8	<0.0625	
May[c]	2.08	2.07	0.128		1.5	1.5	0.13		0.4	0.8	0.03	
June[c]	2.08	1.92	0.18		1.5	1.5	0.032		0.4	0.8	0.032	
July[c]	2.08	1.55	<0.03		1.5	1.5	0.06		0.4	0.8	0.06	
August	2.08	1.43	<0.03	<1.0	1.5	1.5		<0.02	0.4	0.8		<1
September	2.11	1.43	>0.25	0.26	1.5	1.5	0.25	<0.06	0.4	0.4	0.0125	0.26
October	2.2	1.41	0.11	0.62	1.5	0.8	>0.02		0.8	0.8	>0.02	0.62
November[c]	2.2	1.11	0.16		1.5	0.8	0.01		0.4	0.8	<0.005	

Source: Specht 1994a.

[a] Lethal concentration 50 = the concentration that kills 50% of the test organisms in a given time period.

[b] No Observable Effects Concentration.

[c] Some fields contain no data because a toxicity test could not be performed due to high mortality.

use of upstream and downstream locations for toxicity testing is not feasible, because the effluent may discharge into the headwaters of a stream so that there is no upstream location for comparison. Because at least two of the three streams (Upper Three Runs and Pen Branch) support diverse macroinvertebrate communities, these results also suggest that *C. dubia* may not be an appropriate species to use for toxicity testing at the SRS.

As a follow-up to this study, a Toxicity Identification Evaluation (TIE) was performed on a sample of water collected from Fourmile Branch at Road F to determine if the poor performance of *C. dubia* in Fourmile Branch water was due to a naturally occurring toxicant or to unsuitable water chemistry (e.g. low pH, low hardness, or low levels of essential trace minerals). The results of the TIE indicate that naturally occurring iron was responsible for the observed toxicity (Specht 1996). The EPA aquatic life water quality criterion for iron is 1 mg/l. In contrast, the iron concentration in Fourmile Branch at the time of sampling was 6.2 mg/l. The source of the iron is probably the iron-rich clays in the soil. When these clays are exposed to the naturally low pH conditions that exist in blackwater streams and their watersheds, iron is leached from the clay particles.

Rapid Bioassessments of SRS Streams

Because of time and budget constraints, it is often necessary to determine quickly the relative health of an aquatic system. Scientists have worked to develop methods of rapid bioassessment that can be used to accurately but quickly evaluate aquatic systems. Two such bioassessments have been developed for Coastal Plain streams such as those found on SRS, one based on macroinvertebrate populations and the other based on fish populations.

Rapid Bioassessment Methods for Assessing Stream Macroinvertebrate Communities

As part of a program to assess the use of rapid bioassessment methods identifying impacts to macroinvertebrate communities in streams, Specht and Paller (1995) developed an index for use with Hester-Dendy multiplate data. The index was developed using Hester-Dendy multiplate data collected from 16 locations in SRS streams in 1994 (Table 7-13) and 24 locations in 1993 (Specht 1994b). Sampling stations that were unperturbed, as well as stations that were downstream from industrial, sanitary and thermal or post-thermal discharges were included. More than one type of perturbation impacted several of the sites.

The index proved more useful than the EPA Rapid Bioassessment Protocol (Plafkin et al. 1989) in assessing impacts in SRS Coastal Plain streams. The index included community structure variables (taxa richness; Ephemeroptera, Plecoptera, Trichoptera [EPT] richness), community balance variables (percent Tanytarsini, percent Trichoptera, percent Ephemeroptera, and community similarity, using the Pearson-Pinkham community similarity index; Pinkham and Pearson [1976]), and community function variables (density and Pearson-Pinkham similarity index with respect to functional feeding groups). Table 7-14 summarizes the index metrics and the scoring criteria for each metric. The rationale used in developing the index can be found in Specht and Paller (1995).

Table 7-13. Sampling Locations and Impact Status for Macroinvertebrate Rapid Bioassessment, September 1994

Location	Stream Order	Impact Status
Unimpacted		
Pen Branch at Road C	2	Unperturbed
Pen Branch at Road B	2	Unperturbed
Mill Creek at Road E-2	2	Unperturbed
Meyers Branch at Road 9	3	Unperturbed
Tinker Creek at Kennedy Pond Road	3	Unperturbed
Upper Three Runs at Road C	4	Relatively unperturbed
Industrial/Sanitary Discharges		
Crouch Branch at Road 4	1	Scouring; industrial discharges
Beaver Dam Creek at steel walkway	1	Mildly thermal; industrial discharges; sanitary waste
Tims Branch at Road 2	2	Industrial discharges; sanitary waste
Fourmile Branch at Road C	2	Industrial discharges
Rosemary Creek near Folk Pond	2	Sanitary waste
Rosemary Creek near Rosemary Church	3	Sanitary waste
Post-thermal		
Indian Grave Branch at Road B	1	Post-thermal; 1988
Pen Branch at Road A	2	Post-thermal; 1988
Fourmile Branch at Road A-13.2	3	Post-thermal; 1985
Lower Three Runs at Road B	3	Post-thermal; 1958; reservoir impacts

Source: Specht and Paller 1995.

Table 7-14. Metrics And Scoring Criteria Used In The Macroinvertebrate Biotic Index, September 1994

	Scoring Criteria		
	1	**3**	**5**
Number of taxa	<35	35-45	>45
Standardized density[a]	>2.5	>1.5-2.5	<1.5
Number EPT[b] taxa	<10	10-14	>15
%Tanytarsini	<10	10-25	>25
%Trichoptera	0 or >10		>0-10
%Ephemeroptera	<2	2-7	>7
Taxonomic similarity[c]	<0.25	0.25-0.45	>0.45
Functional group similarity[d]	<0.45	0.45-0.55	>0.55

Source: Specht and Paller 1995.

Note: Individual metrics are assigned scores of 1, 3, or 5. The biotic index is calculated by summing the scores for the individual metrics.

[a]Standardized density = (X-M)/SD where X = density, M = average density for the unimpacted stations, and SD = standard deviation of the mean for the unimpacted stations.

[b]Ephemeroptera, Plecoptera, and Trichoptera.

[c]Similarity to the average taxonomic composition at the unimpacted stations (calculated with Pinkham and Pearson Index).

[d]Similarity to the average functional group composition at the unimpacted stations (calculated with Pinkham and Pearson Index).

Also presented for each 1994 sampling location, for comparison, are the more standardly reported macroinvertebrate metrics (Table 7-15 and Table 7-16).

Index of Biotic Integrity

Paller et al. (1996) developed an index of biotic integrity (IBI) using fish community data and a biotic index based on fish species richness (FSBI) to assess quickly the health of streams in the Sand Hills regions of the southeastern Coastal Plain. The northern half of SRS is located in the Sand Hill region of South Carolina. The IBI uses species richness, abundance, and percent composition variables that reflect important aspects of community structure and function. The FSBI uses species number information alone to discriminate between disturbed and undisturbed streams. The metrics are measured at the assessment sites and compared to undisturbed benchmark streams; results are summarized in a single number that reflects the extent to which the measured stream exhibits benchmark conditions.

IBI metrics are developed for each of six categories: species richness, species composition, trophic composition, fish abundance, fish condition, and local indicator species. The IBI originally was developed for the midwest, therefore, the metrics were modified to accurately characterize streams in the Sand Hills. In this region, 10 fish community variables differed significantly between disturbed and undisturbed streams: four species richness variables (total number of species, number of cyprinid species, number of darter [*Etheostoma*] species, and number of madtom [*Noturus*] species), two species composition variables (percent sunfish, primarily *Lepomis*, and percent Cyprinidae), three trophic composition variables (percent omnivores, percent specialized insectivores, and percent generalized insectivores), and a percent tolerance variable.

When assessing streams, sample unit size and level of effort must be matched to the needs of the study. Paller et al. (1996) found that sampling a stream reach of 150 m (492 ft) gave results with good precision, even if the reach was sampled with only one electrofishing pass. In contrast, a 50-m (164-ft) reach yielded results with poor precision, even with multiple passes. Sample lengths of 50 m (164-ft) provide only a general indication of biotic integrity in Sand Hill streams while sample lengths of 150 m (492 ft) often will yield a sample that is representative and accurate enough for most purposes.

The FSBI also produced accurate results, despite containing only species occurrence information.

Table 7-15. Summary For Hester-Dendy Data, September 1994

	Tinker Creek at Kennedy Pond	Mill Creek at Road E-2	Upper Three Runs at Road C	Pen Branch at Road C	Meyers Branch at Road 9	Pen Branch at Road B	Rosemary Creek (upstream)	Rosemary Creek (downstream)	Crouch Branch at Road 4	Tims Branch at Road 2	Beaver Dam Creek	Fourmile Branch at Road C	Lower Three Runs at Road B	Indian Grave Branch at Road B	Pen Branch at Road A	Fourmile Branch at Road A-13.2
	Station 2	**Station 3**	**Station 6**	**Station 8**	**Station 9**	**Station 11**	**Station 1**	**Station 16**	**Station 4**	**Station 5**	**Station 14**	**Station 7**	**Station 10**	**Station 12**	**Station 13**	**Station 15**
Impact Status[a]	U	U	U	U	U	U	SAN	SAN	IND	IND	IND	IND	PT	PT	PT	PT
Total organisms	1604	1547	548	1218	1388	855	2590	916	223	1535	450	1754	1943	2256	2001	1726
Total taxa	55	56	36	37	48	40	56	46	25	39	27	55	23	38	51	48
Mean #/m^2	1792.2	1728.5	765.4	1360.9	1550.8	1194.1	2893.9	1023.46	249.2	1715.1	502.8	1959.8	2171.0	2520.7	2235.8	1928.5
Number of samplers	5	5	4	5	5	4	5	5	5	5	5	5	5	5	5	5
Mean taxa/ sampler	29.6	26.2	20.8	20.2	27.0	26.0	30.0	20.6	11.8	22.4	14.4	27.6	14.2	18.0	35.0	30.6
EPT[b]	16	18	13	6	17	11	13	12	3	6	9	11	4	9	15	17
SC/CF[c]	0.32	0.53	0.27	6.79	0.53	1.90	4.62	1.04	2.00	0.01	2.53	0.12	0.14	0.67	0.16	1.11
Biotic Index	6.00	6.50	5.72	6.01	5.87	6.18	6.25	6.18	8.46	6.64	4.86	6.92	7.60	7.73	6.50	5.63
Biomass (g/m^2)	0.0956	0.0986	0.3090	0.0336	0.1071	0.2828	0.2145	0.8382	0.0409	0.0327	0.4422	0.0904	0.1012	0.3462	0.5365	0.3176
Taxa (% Composition)																
Hydra	0.00	0.06	0.00	0.00	0.00	0.00	0.12	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
Hirudinea	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.99	0.04	0.00	0.00
Nemertea	0.06	0.00	0.00	0.90	0.00	0.70	0.00	0.11	0.00	0.13	0.00	2.79	0.46	2.26	2.45	0.81
Nematoda	0.00	0.00	0.18	0.00	0.00	0.00	0.08	0.00	0.90	0.00	0.00	0.00	0.00	0.00	0.35	0.12
Oligochaeta	0.94	3.88	0.18	3.37	2.31	11.23	6.02	2.51	17.94	3.65	3.56	13.00	0.00	71.81	25.04	4.69
Turbellaria	3.12	0.06	0.00	0.16	0.00	0.12	0.46	0.00	1.79	0.00	0.00	8.95	1.03	0.00	0.20	0.23
Bivalvia	0.06	0.00	0.00	0.00	0.00	0.47	0.00	0.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gastropoda	0.19	0.00	0.00	0.16	1.15	1.40	1.08	0.11	1.35	0.07	1.11	0.11	0.05	0.53	0.55	0.00
Amphipoda	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.87	0.00	0.00	0.22	0.40	0.00	0.00	0.00	0.00
Decapoda	0.06	0.06	0.00	0.00	0.00	0.00	0.08	0.11	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydracarina	0.19	0.06	0.00	0.00	0.07	0.58	0.35	0.00	0.00	0.98	0.00	0.11	0.00	0.13	0.40	0.52
Ephemeroptera	19.95	9.95	9.31	19.38	24.57	16.49	19.46	10.04	2.24	0.39	73.33	1.37	0.41	1.06	14.29	44.67
Plecoptera	0.00	0.00	4.01	0.00	1.08	1.05	0.12	5.46	0.00	0.33	0.22	0.00	0.00	0.00	0.00	0.17
Trichoptera	2.99	2.20	4.01	0.66	1.51	1.17	2.51	1.64	0.00	0.07	11.78	0.91	0.93	0.80	24.09	12.63
Odonata	0.31	0.13	0.00	1.07	0.14	0.47	0.12	0.00	3.59	0.13	0.00	0.46	0.05	0.09	0.40	0.29
Coleoptera	1.00	0.52	1.09	0.66	1.15	6.43	0.85	0.22	0.00	2.08	1.56	0.91	0.05	0.04	4.60	1.97
Megaloptera	0.06	0.13	0.55	0.00	0.00	0.82	0.00	0.33	0.00	0.00	1.56	0.00	0.31	0.04	1.10	0.06
Lepidoptera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00
Chironomini	11.97	23.79	31.39	4.11	8.72	12.51	4.44	5.68	56.05	11.92	2.22	11.29	40.40	10.06	1.10	3.88
Diamesinae	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orthocladiinae	4.74	7.24	22.99	0.90	5.69	11.93	7.26	58.41	0.45	17.72	2.00	3.19	7.36	1.24	12.94	4.00
Pseudochirono-mini	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00
Tanypodinae	2.00	4.85	2.37	4.27	1.30	3.27	1.47	0.98	9.87	3.65	0.67	14.42	7.31	4.65	3.30	5.45
Tanytarsini	51.81	46.86	8.39	64.29	50.94	30.88	55.33	10.37	4.48	57.20	1.78	41.28	0.51	5.54	8.75	19.93
Other Diptera	0.50	0.19	15.51	0.08	1.37	0.23	0.15	2.07	0.90	1.69	0.00	0.74	1.13	1.68	0.30	0.52
Functional Group (% Composition)																
Collector-gatherer	43.20	78.54	62.77	80.79	62.82	75.79	79.73	77.84	78.48	62.93	54.67	66.19	88.68	88.70	56.62	55.97
Collector-filterer	37.66	9.31	22.26	1.56	21.83	0.00	2.93	6.22	1.35	25.54	11.78	4.85	1.90	1.33	27.39	14.25
Predator	6.17	5.43	7.48	6.81	3.17	7.37	2.70	6.88	16.59	6.71	2.44	27.82	9.16	7.45	8.60	8.69
Scraper	11.91	4.91	6.02	10.59	11.60	10.88	13.55	6.44	2.69	0.33	29.78	0.57	0.26	0.89	4.25	15.76
Shredder	0.81	1.36	1.46	0.25	0.58	5.73	1.04	2.51	0.00	4.50	1.11	0.40	0.00	1.24	0.50	0.98

Table 7-15. (cont)

	Tinker Creek at Kennedy Pond	Mill Creek at Road E-2	Upper Three Runs at Road C	Pen Branch at Road C	Meyers Branch at Road 9	Pen Branch at Road B	Rosemary Creek (upstream)	Rosemary Creek (downstream)	Crouch Branch at Road 4	Tims Branch at Road 2	Beaver Dam Creek	Fourmile Branch at Road C	Lower Three Runs at Road B	Indian Grave Branch at Road B	Pen Branch at Road A	Fourmile Branch at Road A-13.2
	Station 2	**Station 3**	**Station 6**	**Station 8**	**Station 9**	**Station 11**	**Station 1**	**Station 16**	**Station 4**	**Station 5**	**Station 14**	**Station 7**	**Station 10**	**Station 12**	**Station 13**	**Station 15**
Herbivore	0.25	0.45	0.00	0.00	0.00	0.23	0.04	0.11	0.90	0.00	0.22	0.17	0.00	0.40	2.65	4.35
Functional Group Biomass																
Collector-gatherer	17.28	44.44	2.35	40.53	20.65	19.95	29.22	19.07	49.18	47.44	13.95	47.71	21.08	18.55	21.01	26.35
Collector-filterer	5.72	8.16	2.31	8.64	17.94	1.53	11.93	2.59	4.10	20.14	20.06	4.33	9.05	4.45	14.47	20.72
Predator	9.35	9.45	89.33	8.64	15.85	62.58	2.08	30.37	13.66	15.02	20.59	35.35	68.87	5.65	43.82	5.80
Scraper	56.54	27.10	4.29	33.55	43.38	14.02	41.61	6.60	7.38	2.73	26.12	6.43	0.99	4.26	10.29	29.41
Shredder	1.05	6.24	1.72	8.64	2.19	1.98	14.53	6.04	0.00	11.26	16.17	3.46	0.00	66.34	5.91	7.11
Herbivore	10.05	5.33	0.00	0.00	0.00	0.00	0.63	35.34	25.68	3.41	3.11	2.72	0.00	0.74	4.50	10.62

Source: Specht and Paller 1995.

[a]U = Unimpacted; SAN = Sanitary outfall; IND = Industrial outfall; PT = Post-thermal.

[b]EPT = total number of Ephemeroptera, Plecoptera, and Trichoptera taxa collected.

[c]SC/CF = scraper/collector-filterer.

Table 7-16. Dominant Taxa on Hester-Dendy Multiplate Samplers, September 1994

	Tinker Creek at Kennedy Pond Road	Mill Creek at Road E-2	Upper Three Runs at Road C	Pen Branch at Road C	Meyers Branch at Road 9	Pen Branch at Road B	Crouch Branch at Road 4	Tims Branch at Road 2	Beaver Dam Creek	Fourmile Branch at Road C	Lower Three Runs at Road B	Indian Grave Branch at Road B	Pen Branch at Road A	Fourmile Branch at Road A-13.2	Rosemary Creek (upstream)	Rosemary Creek (downstream)
Stations	**2**	**3**	**6**	**8**	**9**	**11**	**4**	**5**	**14**	**7**	**10**	**12**	**13**	**15**	**16**	**1**
Impact Status[a]	U	U	U	U	U	U	IND	IND	IND	IND	PT	PT	PT	PT	SAN	SAN
Taxon																
Tanytarsus	15.5	36.5		61.4	32.3	26.5		31.0		36.5		5.2	6.7	17.4	5.6	53.5
Rheotanytarsus	36.0	7.6			18.4			25.3								
Polypedilum	9.1		30.5		7.0	11.8	6.3	5.6		6.2	37.7	9.7				
Microtendipes		8.5														
Dicrotendipes		7.8														
Kiefferulus dux							26.9									
Labrundinia							6.7									
Chironomus							5.8									
Rheocricotopus			7.8			6.4		10.0							7.3	
Thienemanniella			10.9													
Cricotopus													7.8			
Corynoneura															43.8	
Ablabesmyia										8.6						
Conchapelopia											7.2					
Simulium			14.6													
Stenonema	10.2		5.5	10.3	10.4	8.7			28.7					15.7	6.2	11.1
Baetis									40.9					18.5		
Acerpenna	6.2															
Eurylophella				6.2												
Tricorythodes					5.5											
Oligochaeta						11.2	17.9			13.0	40.0	71.8	25.0			6.0
Turbellaria										9.0						
Macronychus						5.4										
Cheumatopsyche													12.1	5.5		
Hydropsyche									9.6				8.0			

Source: Specht and Paller 1994b.
[a]U = unimpacted.
IND = industrial.
PT = Post thermal.
SAN = sanitary.

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List of Abbreviations and Acronyms, Units of Weights and Measures, and Glossary

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List of Abbreviations and Acronyms

ADH	-	alcohol hydrogenase
AFDW	-	ash-free dry weight
ANSP	-	Academy of Natural Sciences of Philadelphia
BGC	-	Burial Ground Complex
CCWS	-	Comprehensive Cooling Water Study
CERCLA	-	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	-	Code of Federal Regulations
cfs	-	cubic feet per second
COE	-	U.S. Army Corps of Engineers
cms	-	cubic meter(s) per second
CSRA	-	Central Savannah River Area
DOE	-	U.S. Department of Energy
DOI	-	U.S. Department of the Interior
DWPF	-	Defense Waste Processing Facility
EAS	-	Environmental Analytical Section
EMS	-	Environmental Monitoring Section
gdm	-	grams dry mass (grams dry weight)
RKm	-	River Kilometer
msl	-	mean sea level
MSS	-	multispectral scanner
MWMF	-	Mixed Waste Management Facility
NEPA	-	National Environmental Policy Act
NPDES	-	National Pollutant Discharge Elimination System
NTS	-	Nonproliferation Technology Section
NTU	-	Nephelometric Turbidity Units
RCRA	-	Resource Conservation and Recovery Act
RM	-	River Mile
SCDHEC	-	South Carolina Department of Health and Environmental Control
SCDNR	-	South Carolina Department of Natural Resources
SCWMRD	-	South Carolina Wildlife and Marine Resources Department
SREL	-	Savannah River Ecology Laboratory
SRS	-	Savannah River Site
SRFS	-	Savannah River Forest Station
SRTC	-	Savannah River Technology Center
SWDF	-	Solid Waste Disposal Facility
UFWS	-	U.S. Fish and Wildlife Service
USGS	-	U.S. Geological Survey
WSRC	-	Westinghouse Savannah River Company

Units of Weights and Measures

Ci	-	curie
cm	-	centimeter
ft	-	feet
ft^2		square feet
ft^3	-	cubic feet
fCi	-	femtoCurie (10^{-15} curie)
g	-	gram
ha	-	hectare
ha^2	-	square hectare
in	-	inch
kg	-	kilogram
km	-	kilometer
km^2	-	square kilometer
l	-	liter
m	-	meter
m^2	-	meter square
m^3	-	cubic meters
meq	-	milliequivalent; 1/1000 of a compounds' or an element's equivalent weight
mg	-	milligram
mi	-	mile
ml	-	milliliter
mm	-	millimeter
mV	-	millivolt; a unit of potential difference equal to 1/1000 of a volt
ppb	-	parts per billion
ppm	-	parts per million
pCi	-	picoCurie (10^{-12} Curie)
µg	-	microgram (10^{-6} gram)
µS/cm	-	micro Seimens per centimeter; a measure of conductivity or the ratio of electric current density to the electric field in the medium

Glossary

7Q10 - the expected lowest flow averaged over seven consecutive days in a 10 year period

abiotic - referring to the nonliving components of an ecosystem

aestivate - to become dormant or torpid

aestivation - the condition of dormancy or torpidity

alcohol dehydrogenase - a plant enzyme

anadromous - said of fish, such as shad or sturgeon, that ascend freshwater rivers from the ocean to spawn

anoxia - a lack of oxygen to or in living tissue

anoxic - oxygen-depleted

anuran - refers to animals in the order Anura in the Class Amphibian; specifically frogs and toads

apices - the growing tip of a stem or root

argillic horizon - argillic refers to clay and horizon is a layer of soil; ergo, a layer of clay in the soil

benthic - pertaining to, or living in or on the substrate at the bottom of a body of water

biomass - the weight of living matter

biotic index - a measure of the living community; there can be many kinds of indices composed of many different variables

bivalve - the common name for a number of bilaterally symmetrical organisms having a soft body enclosed in a calcareous two-part shell (clams and oysters for example)

braided stream - a stream with many small channels and no single main channel

canonical discriminant analysis - a way to mathematically express the similarity of independent units

canopy - the collective name for the crowns of the tallest trees in a forest

clutch - a nest of eggs or a brood of young

commensal - describing an interspecific, symbiotic relationship in which two different species are associated; one is benefited and neither is harmed

conductivity - the ratio of electric current density to the electric field in a material

cove rotenone - a method of sampling fish in a small area

curie (Ci) - a unit of radioactivity; that quantity of nuclear material that has 3.700×10^{10} disintegrations per second

deltaic - referring to an alluvial deposit, usually triangular in shape at the mouth of a river or stream

depauperate - inferiority of natural development or size; in this context, a depauperate community has few species

diel - refers to a 24-hour cycle

diurnal - active during daylight hours

dystrophic - pertaining to an environment that does not supply adequate nutrition

ectotherm - an animal that gets most of its heat from the environment (aka “cold-blooded”)

electrofishing - a sampling technique where an electric current is introduced into the water that stuns aquatic organisms, primarily fish

emergent - refers to plants such as cattails, that are rooted in an aquatic substrate, but grow above the water

endemic - peculiar to a particular region; the opposite of ubiquitous

endlap - in aerial photography refers to the amount of image repeated from one frame to the next

entrainment - the process whereby planktonic organisms or weak swimmers such as young fish are caught in a powerful current from which they cannot escape, and hence are swept into turbines

ephemeral - temporary; carrying or holding water only during or immediately after precipitation events

epilimnetic - refers to the epilimnion of a waterbody

epilimnion - a freshwater zone of relatively warm water in which mixing occurs as a result of wind action and convection currents; the epilimnion is the shallowest water in a lake and remains oxygenated (see hypolimnion)

eurythermal - tolerant of a wide range of temperatures

eutrophic - pertaining to a lake containing a high concentration of dissolved nutrients; often shallow, with periods of oxygen deficiency

eutrophication - the process by which a body of water becomes, either by natural means or through pollution, excessively rich in dissolved nutrients, resulting in increased primary productivity that often leads to a seasonal deficiency in oxygen

facultative - an organism that prefers or does best in one environment but can survive in others; a facultative wetland plant grows best in wetlands but will grow in dry places

fecundity - the innate potential reproductive capacity of an organism

fledged - refers to young birds' newly acquired ability to fly

fledglings - young birds just learning to fly

forb - a broad-leaved herbaceous plant

freshet - a stream caused by heavy rains or snowmelt

fyke net - a type of net used to collect fish, consisting of several to many hoops, covered with a mesh, and wings of the mesh material that direct the fish into the opening of the net

genera - plural of genus which is a taxonomic category that includes groups of closely related species

geomorphology - the study of the origin of secondary topographic features which are carved by erosion of the primary elements and built up of erosional debris

gill net - a type of net used to collect fish where the fish swim into the net which is lowered through the water column and are trapped in the net's mesh by their gills

gonosomatic - reproductive tissue

graminoids - grasses

guilds - organisms grouped or associated due to a special mode of living (e.g., shorebirds)

hardpan - a secondary accumulation of calcareous material in layers in soil

hectare - a measure of area, 2.471 acres in size

herbivore - an animal that eats plants

herpetofauna - the term used to refer to reptiles and amphibians, collectively

Hester-Dendy multiplate sampler - a series of hardboard squares arrayed vertically along a central axis with established spacing between the squares; deployed in aquatic environments and colonized by aquatic macroinvertebrates

hoop net - yet another way to catch fish or turtles; similar in design to a fyke net but without the wings

hydric - characterized by or thriving in an abundance of moisture

hypolimnetic - referring to the hypolimnion of a lake

hypolimnion - the lower part of the water column in a stratified lake, characterized by a uniform temperature that is cooler then the epilimnion; may also have less oxygen than the epilimnion

ichthyofauna - larval fish

ichthyoplankton - larval fish

impingement - collection of debris by screens at water intakes; fish are also trapped on these screens

insectivorous - refers to animals that eat insects

invertebrate - an animal that does not have a backbone

isozymes - any of the electrophoretically distinct forms of an enzyme; having different polymeric states but performing the same functions

Jolly - a mark-multiple recapture model for estimating the size of population

lacustrine - belonging to or produced by lakes

land cover - the predominant vegetation type in an area

lentic - of or pertaining to still waters such as lakes and reservoirs

limnetic - of or pertaining to inhabiting the pelagic region of a lake

Lincoln index - a mark-recapture model for estimating the size of a population

littoral - of or pertaining to the biogeographic zone between the high and low water marks

lorica - a hard shell in certain invertebrates that functions as an exoskeleton

lotic - of or pertaining to swiftly moving waters

macrohabitat - an extensive habitat presenting considerable variation of the environment, containing a variety of ecological niches, and supporting a large number and variety of complex flora and fauna

macroinvertebrate - a large invertebrate; visible to the naked eye and collected by hand

macrophyte - an aquatic vascular plant, usually rooted in the littoral zone

macrozooplankton - the large zooplankton

malate dehydrogenase - a plant enzyme

maximum contaminant level - a drinking water regulatory standard which is the maximum level of a contaminant which is not expected to cause adverse health effects over a lifetime of exposure and includes a margin of safety

meroplankton - plankton composed of floating developmental stages (eggs and larvae) of the benthos (bottom living) and nekton (free-swimming) organisms; temporary plankton

mesic - of or pertaining to a habitat characterized by a moderate amount of water

meso-eutrophic - moderately eutrophic

metamorphose - to change markedly structurally as an animal grows from an embryo to subadult or adult

methylation - a chemical process for introducing a methyl group ($CH3$—) into an organic compound; the process by which mercury is introduced into animals

microhabitat - a small, specialized and effectively isolated habitat

microzooplankton - the smaller classes of zooplankton

midstory - in a forest, trees with crowns below the canopy

monospecific - affecting or characterized by a single species

morphometry - measuring the structure of an organism

multispectral - describing the recording of images in more than the visible spectrum

obligate - restricted to a specified condition of life; an obligate wetland plant can not survive in other than a wetland

overstory - the top layer of leaves in a forest; also known as the canopy

oxic - relating to the presence of adequate oxygen

paedogenic - reproducing as a larvae; conversely, adults that retain juvenile characteristics

palustrine - being, living or thriving in a marsh

panchromatic - of a photographic film, emulsion or plate sensitive to all wavelengths in the visible spectrum

pelagic - pertaining to the open water in a body of water; beyond the outer limits of the littoral zone

peptones - a water-soluble mixture of proteoses and amino acids

perched water table - the upper surface of a body of perched water (groundwater that is unconfined and separated from an underlying main body of groundwater by an unsaturated zone); also known as apparent water table

periphyton - algae attached to a substrate

phenological - pertaining to the local climate and seasonal changes

phenology - the science which studies periodic biological phenomena with relation to climate, especially seasonal changes

photointepretation - deciphering the images on aerial photographs

photogrammetry - the science of making accurate measurements and maps from aerial photographs

phytoplankton - planktonic algae, that is, algae that floats in the water columns

planktivorous - describing organisms that feed on plankton

ponar dredge - a device for the collection of benthic organisms; it consists of two metal jaws that are cocked open and shut on command to scoop up sediments

quadrat - a sampling plot

quiescent - inactive, latent, dormant, at rest

recruitment - when the young of a population become capable of reproduction

refugia - areas which provide conditions for relict populations to survive

revetment - a facing made on a soil or rock embankment to prevent scour by weather or water

riffle - a shallow area of stream bed over which water flows swiftly and is broken into waves by submerged obstructions

riparian - pertaining to a stream or riverbank

riverine - pertaining to a river

scalar - a single value or item; having magnitude only, no direction

sedge - a wetland plant

seed bank - the seeds that remain in the ground, and that, under the right conditions will germinate even years after the parent plant is gone

senesce - to die back

senescence - aging

Shannon-Weaver diversity - a mathematical measure of the diversity of a ecological community

sidelap - in aerial photography refers to the amount of image repeated from one flightline to the next

sp. - species singular

spp. - species plural

stoloniferous - having runners or horizontally growing adventitious roots

stump community - the plants and animals living on stumps, usually in wetland or aquatic systems

submergent - aquatic plants that do not grow on or above the water surface

synoptic - refers to the use of technical data obtained simultaneously over a wide area for the purpose of presenting a comprehensive picture of the atmosphere

taxa - the plural of taxon

taxon - a taxonomic group or entity; one of a hierarchy of levels in the biological classification scheme

thermocline - a temperature gradient in a body of water in which the temperature decrease with depth is greater than that of the overlying and underlying water; marks the transition between the epilimnion and hypolimnion

thermophilic - describing an organism that thrives at high temperatures

topographical relief - the natural features of a region, treated collectively

transect - to cut across; in this case describing a method of sampling vegetation or other biological communities by running a straight line through the community and sampling at designated points along the line or "transect"

trophic - pertaining to nutrition

unconsolidated sediments - loose or unstratified mud

understory - the trees that are naturally shorter than canopy trees

vertebrate - an animal with a backbone

xeric - of or pertaining to a habitat having a low or inadequate supply of moisture

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SAVANNAH RIVER SITE RED-COCKADED WOODPECKER MANAGEMENT PLAN

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EXECUTIVE SUMMARY

The red-cockaded woodpecker (RCW) is a federally endangered species endemic to pine forests of the southeastern United States. RCW populations have declined rangewide during the past century, suffering from habitat loss and effects of fire exclusion in older pine forests. Currently, RCW populations continue to decline and many remain at risk because of small size (<50 active groups) and habitat degradation.

RCWs are cooperative breeders that live in groups of 2 to 9 birds, each group inhabits a home range consisting of a cluster of cavity trees and foraging habitat. A cluster may contain 1 to 30 cavity trees. Group members roost in cavities year-round, each using a separate cavity, with the breeding male's cavity typically used as the site for the group's nest. Cavities are excavated only in mature, living pine trees which generally average 80-120 years in age. RCWs forage primarily on living pine stems in pine dominated habitats. Quality of foraging habitat is believed to increase in older stands (i.e., >30 years of age) and where larger (>25 cm or 10 inch) diameter stems are available. For more information on RCW life history see Appendix A.

SRS RCW Population

Recovery of the RCW population on the Savannah River Site (SRS) represents an extreme challenge because most of the pine forest is too young to be considered suitable habitat for the RCW. Prior to its purchase in 1950, the SRS population contained an unknown number of RCW groups. Of 40 known active and inactive clusters surveyed in 1975, only 16 were active in 1977. Between 1977 and 1984, the population declined to 5 active clusters. By December 1985, only 4 birds remained in 3 clusters, a breeding pair and 2 single males. A lack of suitable and potential cavity trees, interspecific competition for cavities, and midstory hardwood encroachment were putative factors leading to cluster abandonment and population decline.

As a result, the Department of Energy (DOE), in cooperation with U. S. Forest Service, made a progressive commitment to recover the RCW on the SRS. In 1986, a management and research program was initiated to establish a viable population of RCWs on the SRS. This proactive decision by DOE should be recognized and commended, for without it, the SRS RCW population would in all likelihood be extinct today. A primary objective of U. S. Forest Service, Savannah River Institute (SRI) Wildlife, Fisheries, and Botany Operations Plan is to attain viable populations of endangered species native to the SRS. Because the SRS is a federal site, DOE is mandated by the Endangered Species Act of 1973, as amended, to proactively manage for endangered species. Section (2) (c) of the Act states, "that all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of the Act." Furthermore, under Section 7 (a) (2) of the Act, each Federal agency must insure that any action authorized, funded, or carried out by them is not likely to jeopardize the continued existence of a listed species.

The Federal Red-cockaded Woodpecker Recovery Plan specifies the need for 15 viable RCW populations (>500 groups) in 5 physiographic provinces in 8 states to recover (i.e., delist) the species. Because the SRS RCW population is not recognized as a recovery population, it is relegated to one of support of the regional recovery of the species. In this support role, RCWs from the SRS are available to augment or to enhance the genetic diversity of other RCW populations, and to provide on-site research opportunities to address questions of region-wide interest. In addition, the SRS will serve as a repository for mitigated RCWs and provide suitable habitat for birds dispersing from nearby populations.

SRS RCW Management Plan

The DOE and SRI supported numerous research projects between 1986 and 1997 to address applied questions regarding RCW conservation strategies and technology. Knowledge of RCW biology and ecology was greatly enhanced by these University and Agency studies and their many scientific and technical publications. These site-specific results, coupled with new information from throughout the Southeast, presented a unique opportunity to revise the *1991 Red-cockaded Woodpecker Management Standards and Guidelines for the Savannah River Site* (Appendix B). Consequently, it was our objective in this revision to synthesize site-specific RCW research, to corroborate these findings with those from other RCW studies, and to integrate this information into an ecologically sound and mission-compatible RCW management plan.

Under the 1991 RCW Management Plan, designation of management boundaries and forest management practices were less compatible with RCW ecology, and offered limited flexibility with regards to mission-related site development. Management Area 1 (33,658 ha; 83,168 acre) was centrally located and intended to include all existing and proposed DOE production facilities; Management Area 2 (46,613 ha; 115,179 acre) encompassed Management Area 1 and provided for RCW management, and also acted as a buffer between production areas and surrounding private lands. Because few RCWs were present on the SRS at the time (1986) management areas were established, emphasis was placed on centralizing facilities development while less consideration was given to the proposed long-term expansion of the RCW population. Timber management practices in Management Area 1 discouraged natural colonization by RCWs. However, colonization was possible, and if it occurred would have required cluster protection and the provisioning of adequate forage. No options, other than formal consultation with the U. S. Fish and Wildlife Service (USFWS), were available to translocate or remove RCWs in the event that their cluster occupied a proposed development site.

The population target of 400 RCW groups permanently committed virtually all of the potential RCW habitat found in Management Area 2 for RCW management. Because Management Area 2 was habitat limited with regards to suitable RCW habitat, only minimal development could be supported in this area. Any future development within Management Area 2 would require the addition of suitable and contiguous habitat from Management Area 1. Moreover, if a proposed site included an active RCW cluster, development of the site could be delayed 1 to 3 years until a suitable cluster was provisioned and a RCW group established in Management Area 1.

Proposed SRS RCW Management Plan

The proposed RCW Management Plan emphasizes ecosystem-level RCW management that is DOE mission compatible, and provides for flexibility in future development. In an effort to more closely align facilities planning with RCW and ecosystem management, planning and ecological criteria were considered concurrently to reapportion management areas. Planning criteria included infrastructure, depth to water table, and proposed DOE facility sitings. On the basis of these criteria, the central and northwestern portions of the SRS are most suited for facilities development. These areas represent more xeric sites, in close proximity to existing facilities, and are connected by transportation corridors. Ecological criteria included current forest conditions, potential vegetative conditions, and the use of prescribed fire. On the basis of future forest conditions and the reliance on prescribed fire to produce these conditions, RCW habitat is most suited for the eastern two-thirds of the SRS. Given the location of existing facilities, the need for future facilities development, and the spatial restrictions on the use of prescribed fire to maintain forest types, the SRS was reapportioned into 3 management areas: a 34,832 ha (86,069 acre) RCW Habitat Management Area (HMA); a 19,493 ha (48,167 acre) Supplemental RCW HMA; and a 25,946 ha (64,111 acre) Other-use Area.

RCW management will occur in the RCW HMA and Supplemental RCW HMA. Differences in management activities between these areas are primarily due to forest management options (Appendix C). RCW management within the Supplemental RCW HMA will approximate that found in the RCW HMA with the primary objective in both to reach the population target. Realizing, however, that where logistical constraints and resource limitations exist, priority will be in the RCW HMA.

Incidental-take Authorization

The inclusion of incidental-take authorization from the USFWS in the Supplemental RCW HMA and Other-use Area will greatly enhance DOE's flexibility in future development of sites on the SRS. Incidental take authorization permits the removal of RCWs, their cavity trees, and habitat after written notification to the USFWS. Incidental-take authorization is only for mission-related development (i.e., new facilities). Incidental take is not an option in the RCW HMA, but limited flexibility does exist for future development and for relocation of existing groups. This flexibility is tempered, however, by a no-net-loss policy regarding habitat and number of groups within the RCW HMA. At the population objective of 315 groups, the RCW HMA will still contain some "excess" RCW habitat that will be available for alternative uses, if needed. Therefore, a proposed facility could develop a portion of this area. However, if the proposed siting impacted active clusters, not only would there have to be "excess" habitat available, but an equivalent number of new groups would also have to be established prior to the initiation of the proposed development (i.e., no net loss in the number of groups). Once this "excess" acreage is developed, no future siting can occur without formal consultation with the USFWS. One alternative to formal consultation is the annexation of RCW habitat and/or existing groups from the Supplemental RCW HMA. Because the presence of 315 clusters could conceivably "lock up" the RCW HMA to future development, the ability to provision and "bank" RCW groups in the Supplemental RCW HMA provides DOE additional management options. If circumstances warrant the immediate need for a site occupied by a RCW group(s), an active cluster could be annexed from the Supplemental RCW HMA without the delay associated with establishing a new group within the existing RCW HMA.

The proposed SRS RCW Plan includes modifications to the 1991 SRS RCW Plan that reflect research-based advancements in RCW ecology and management, and is an attempt to integrate RCW management at the ecosystem level. Conservation of the RCW is also part of a broader goal to conserve biological diversity. Biological diversity and the long-term survival of the RCW on the SRS, ultimately depend upon sustaining the longleaf pine ecosystem.

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ACKNOWLEDGMENTS

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1.0 PURPOSE OF MANAGEMENT PLAN

1.1 Background

The Savannah River Site (SRS) comprises 80,271 ha (198,347 acres) in Aiken, Allendale, and Barnwell Counties in South Carolina (Fig. 1). The site was selected by the Atomic Energy Commission (AEC) in 1950 for construction of a nuclear defense material production facility (Savannah River Forest Station History 1966). The Department of Energy's (DOE), formerly the AEC, Office of Environmental Programs is primarily responsible for policy and administration of natural resources management on SRS (Department of Energy 1991). However, through an interagency agreement with the DOE, the USDA Forest Service, Natural Resource Management and Research Institute (SRI), formerly the Savannah River Forest Station, has been charged with management of natural resources on the SRS since 1951 (Savannah River Forest Station History 1966). General strategy and responsibility for natural resource management are found in the *Natural Resource Management Plan: Strategic Guidance for the Savannah River Site Natural Resource Programs* (Department of Energy 1991). SRI's standards and guidelines are outlined in *Resource Management Operations Plans of the Savannah River Site* (Savannah River Forest Station 1993).

1.2 Mission Statements

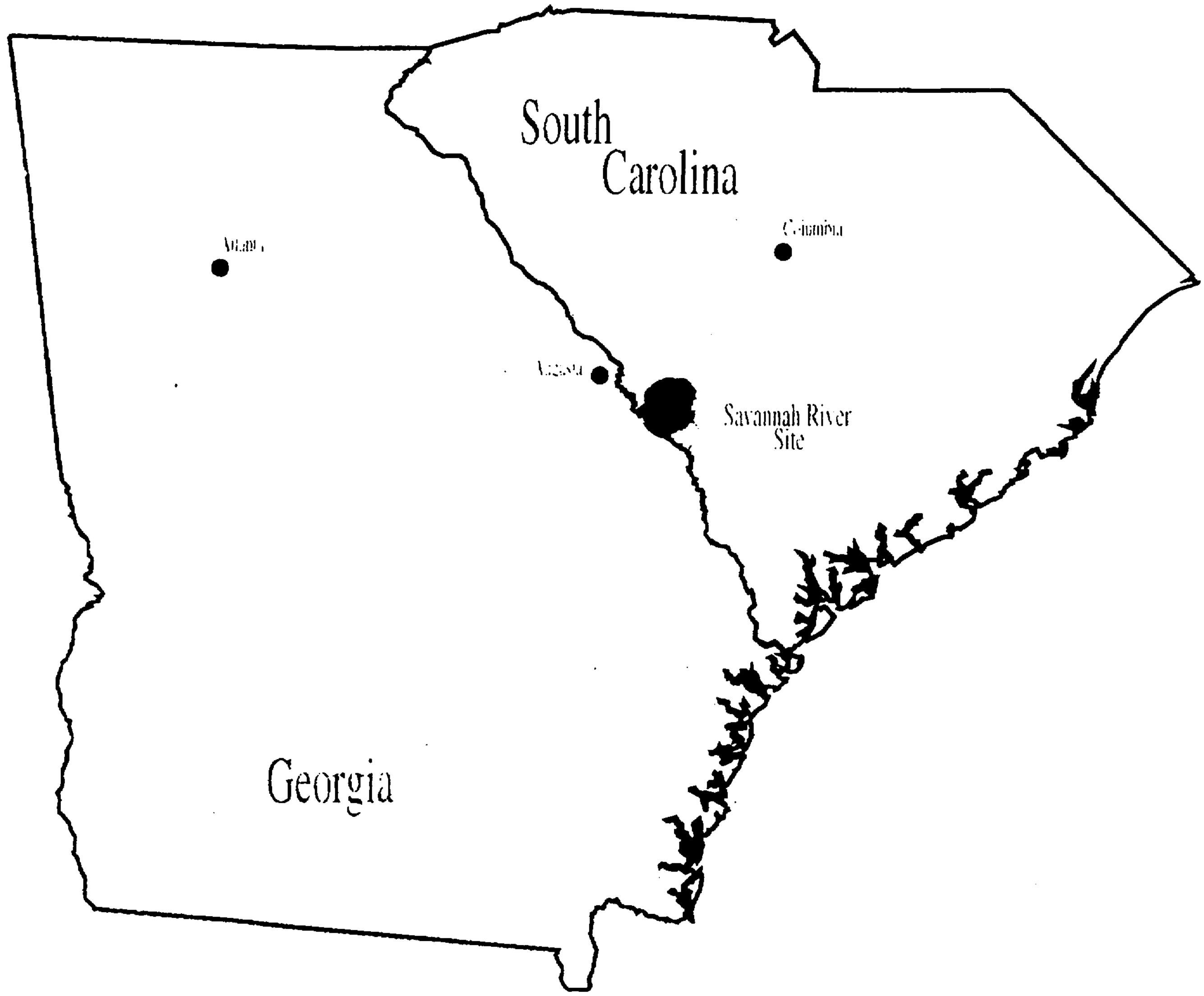
Beginning in the early 1950s, the primary DOE mission on the SRS was the production of nuclear materials for the national defense. However, since the end of the Cold War, the primary mission on the SRS has, and continues, to undergo fundamental changes to meet overall DOE missions (Department of Energy 1997). In the current Strategic Plan (Department of Energy 1997), DOE states that its mission on the SRS is to serve the national interest by ensuring that SRS programs, operations, and resources are managed in an open, safe, and cost-effective manner to:

1) Protect and restore the environment while managing waste and nuclear materials.
2) Conduct mission-supportive research and technology development.
3) Support current and future national security requirements.
4) Reduce the danger of global, nuclear proliferation.

It is further stated in the Strategic Plan that the DOE will manage in a manner that preserves natural resources and is compatible with the site's designation as a National Environmental Research Park. It is also stated that the DOE will actively restore wetlands and other habitats; manage threatened and endangered species; and conduct an effective environmental outreach program.

In concordance with DOE's primary mission, and to meet its natural resources management goals, the *Natural Resources Management Plan* (Department of Energy 1991) outlines management and research objectives that include:

1) Maintain and support a well planned and coordinated program of manipulative and non-manipulative research on environmental and natural resource systems under the charter of the SRS National Environmental Research Park.



Compiled by: SRI-GIS, New Ellenton, SC on February 22, 1999 using current GIS data.

Scale 1:3,550,000

Figure 1. The Savannah River Site is located in western South Carolina along the Savannah River, southeast of Augusta, GA.

2) Become the standard for efficiency and compatibly for joining industrial production, environmental protection, and natural resources management on the same site.
3) Attain viable populations of the endangered species native to the SRS and demonstrate techniques to maintain them.
4) Establish and demonstrate the techniques for maintaining populations of all species of plants and animals native to the region.
5) Effectively manage the fish and wildlife resources on the SRS to maintain biological productivity and diversity, including genetic diversity.
6) Maintain a healthy forest that will produce a sustained yield of predominantly sawtimber-sized and other marketable products from both softwood and hardwood species.
7) Provide simultaneously for flexibility in locating future facilities and projects, and in protecting existing site users.

In support of DOE's natural resources mission, SRI is charged with planning and directing a Natural Resources and Wildlife Management Program (DOE-SRI Interagency Agreement 1995) that includes the following mission statements:

1) Conduct a program of vegetation management in SRS forest stands using silvicultural practices that maintain or enhance productivity, including the forest health and diversity of stand conditions, provide for a variety of wood products, allow for visual aesthetics, and support the industrial mission.
2) Conduct a wildlife, fisheries, and botany management program that includes monitoring and inventory of plants and animal populations and their associated habitats; manipulation of habitat to insure biological diversity, including all native flora and fauna; control of animal populations to reduce safety hazards and property damage; restore degraded ecosystems; survey for federally endangered or threatened species and species designated as sensitive or of special concern; and provide biological evaluations to assist in determining probable effects of proposed land-use changes within the SRS.
3) Conduct a cooperative research program with the USDA Forest Service, Southern Research Station, universities, state agencies, forest and related industries, and SRS organizations to support DOE and SRS missions, regulatory direction, and natural resource management needs. Plan, direct, administer, and manage research in the areas of ecosystem management and biodiversity; wetlands restoration and mitigation; endangered species recovery and monitoring; forest sustainability and operations; fuelwood biomass commercialization; forest industry competitiveness; and bioremediation of wastes. In addition, furnish advice and assistance for National Environmental Research Park programs and other research DOE may request and agreed to by the SRI.

A primary objective of SRI Wildlife, Fisheries, and Botany Operations Plan (Savannah River Forest Station 1993) is to attain viable populations of endangered species native to the SRS. Because the SRS is a federal site, DOE is mandated by the Endangered Species Act of 1973 as amended (U. S. Fish and Wildlife Service 1988) to proactively manage for endangered species.

Section (2) (c) of the Act states, "that all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authories in furtherance of the purposes of the Act." This affirmative conservation mandate is further clarified in the definition section [Section (3) (3)] where conserve, conserving, and conservation are defined, "to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary." Furthermore, under Section 7 (a) (2) of the Act, each Federal agency must insure that any action authorized, funded, or carried out by them is not likely to jeopardize the continued existence of a listed species.

The Federal Red-cockaded Woodpecker (*Picoides borealis*) [RCW] Recovery Plan (U. S. Fish and Wildlife Service 1985) specified the need for 15 viable RCW populations (>500 groups) in 5 physiographic provinces in 8 states to recover (i.e., delist) the species. Because the SRS RCW population is not recognized as a recovery population, it is relegated to one of support of the regional recovery of the species. In this support role, RCWs from the SRS are available to augment or to enhance the genetic diversity of other RCW populations, and to provide on-site research opportunities to address questions of region-wide interest. In addition, the SRS will serve as a repository for mitigated RCWs and provide suitable habitat for birds dispersing from nearby populations.

1.3 Plan Objective

The RCW is a federally endangered species endemic to the pine forests of the Southeast. Between 1977 and 1984, the number of RCW groups (1 or more birds per cluster) on the SRS declined from 16 to 5 (Jackson 1990). By December 1985, only 4 birds remained (Jackson 1990). At that time, DOE, in cooperation with the U. S. Forest Service, made a progressive commitment to recover the RCW on the SRS. In 1986, a management/research program was initiated for establishing a viable population of RCWs. This proactive decision by DOE should be recognized and commended, for without it, the SRS RCW population would in all likelihood be extinct today.

As part of this program, numerous research projects were supported by the DOE and SRI from 1986 to 1997 to address applied questions regarding RCW conservation strategies and technology. These site-specific results, coupled with new information from throughout the Southeast, presented a unique opportunity to revise the *Red-cockaded Woodpecker Management Standards and Guidelines for the Savannah River Site* (Savannah River Forest Station 1991). Consequently, it was the objective of this revision to synthesize site-specific RCW research, to corroborate these findings with those from other RCW studies, and to integrate this information into an ecologically sound and mission-compatible RCW management plan.

2.0 DESCRIPTION OF THE SAVANNAH RIVER SITE

2.1 Background

The longleaf pine (*Pinus palustris*) ecosystem dominated the presettlement[1] landscape of the southeastern United States (Sargent 1884, Croker 1979, Frost 1993). It has been estimated that longleaf pine forests covered 24 to 35 million ha (59-86 million acres) in predominantly coastal plain physiographic provinces (Fig. 2). This ecosystem evolved and was maintained through frequent, growing-season fires (Frost 1993). The area of the SRS is included in the historical range of the longleaf pine ecosystem.

2.2 Presettlement Vegetation of the Savannah River Site

Frost (1997) used a pyrographic method to determine presettlement vegetation for the SRS. In this method, Frost used species composition and structure, fire-frequency indicator species, pedological information (soil series), the significant effects of natural fires in structuring vegetation, and principles from landscape fire ecology to predict original vegetation. Incorporation of information from these 5 elements with historical records and remnant vegetation resulted in determination and mapping of presettlement vegetation that are superior to previous efforts for the SRS landscape.

Frost (1997) defined 11 presettlement vegetation types found on the SRS (Fig. 3). Of these, longleaf pine types (Xeric longleaf pine and longleaf-turkey oak; Dry-mesic and mesic longleaf pine savanna; Longleaf pine-pyrophytic woodland complex; Udorthents) dominated the site, covering an estimated 53,380 ha or 66.5% of the SRS (Table 1). These longleaf pine types were thought to be maintained by frequent (1-4 years) growing-season fires (Fig. 4) which occurred during the April-September convection storm season. He also subdivided the SRS into 9 spring and summer fire compartments (naturally occurring geographic burn units) on the basis of hydrologic features, topography, soil series, and vegetation, and their combined effect on fire behavior. Many of the presettlement fire compartments on the SRS may have burnt annually, ignited by lightning. Once started, these fires moved unabated across the presettlement landscape, fueled by fine fuels in the herbaceous layer.

Native Americans in the region also used fire extensively for land clearing and hunting, and may have increased the frequency of fire in some areas (Frost 1993). Their influence was particularly evident in coastal plain areas protected from natural fire, and in the Piedmont Region where Indian burning increased the frequency of fire in compartments missed by lightning (Frost 1993).

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[1] Presettlement versus pre-Columbian: According to Frost (1997) the use of the term presettlement is preferred because it is more precise than pre-Columbian, which just means before 1492. First exposure of the land to European influences came much later in most of the South: presettlement in east Florida was around 1565, in southeastern Virginia 1607, in the southern Appalachians 1800, and in central Alabama 1821 (Frost 1997). In the SRS region, the first settlers arrived along the Savannah River in the 1730s (Brooks and Crass 1991).

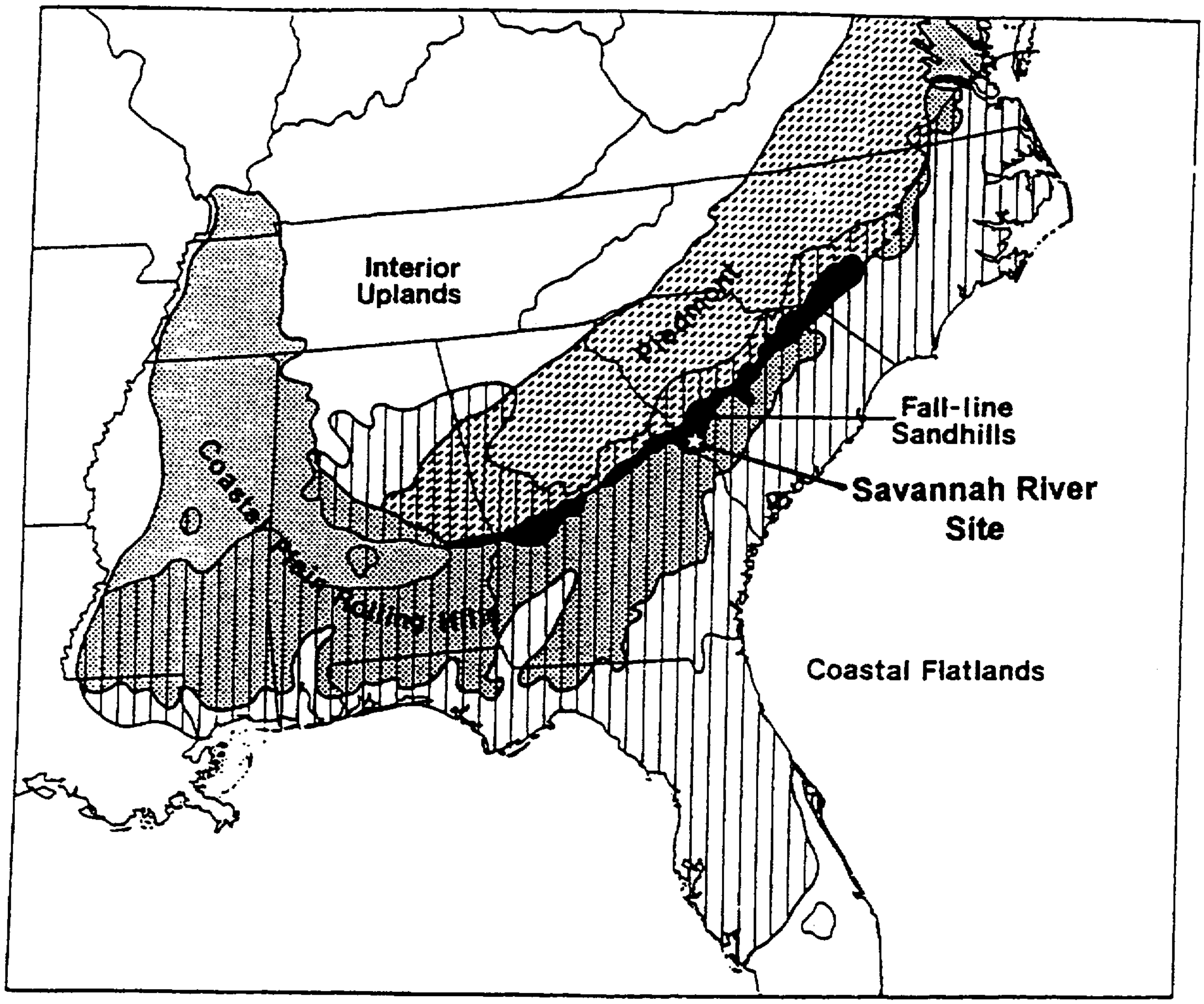

Figure 2. The longleaf pine ecosystem (vertical lines) was distributed across several physiographic provinces (modified from Hammond 1964 and Hodgkins 1965) and dominated the presettlement landscape (after Little 1971 and Frost 1993) of the southeastern United States (source Peet and Allard 1993).

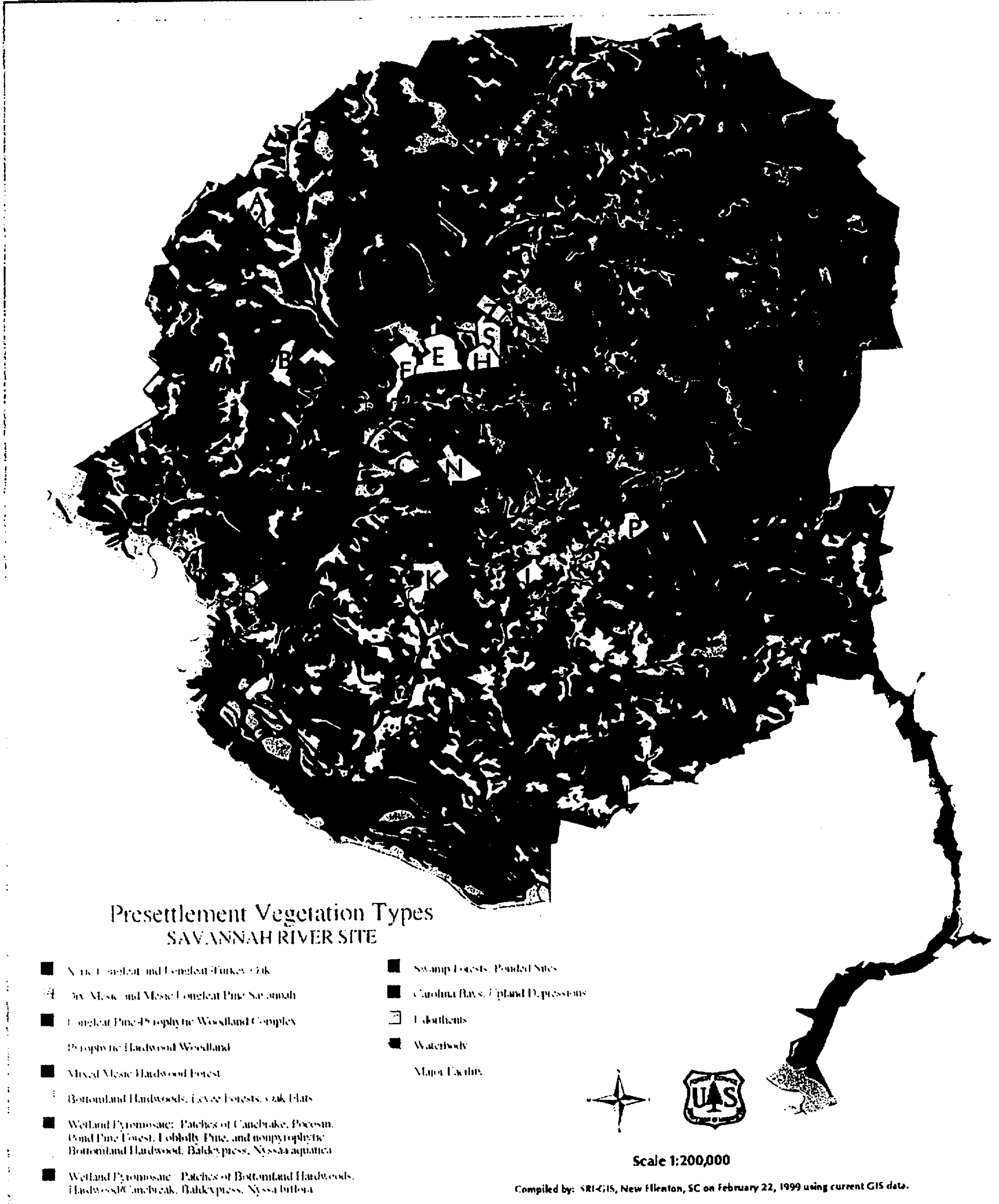

Figure 3. Presettlement vegetation types on the Savannah River Site as determined by Frost (1997).

Table 1. Potential natural vegetation (Imm et al. 1996) and presettlement vegetation (Frost 1996) on the Savannah River Site.

Potential Vegetation	Hectares/Acres	% Area	Presettlement Vegetation	Hectares/Acres	% Area
Longleaf pine-scrub oak	3,056 / 7,551	3.8	Xeric longleaf pine; Longleaf-turkey oak	3,056 / 7,551	3.8
Longleaf pine and savanna	15,521 / 38,353	19.4	Dry-mesic; Mesic longleaf pine savanna	15,521 / 38,353	19.4
Mixed yellow pines	27,000 / 66,716	33.6	Dry-mesic; Mesic longleaf pine savanna	27,000 / 66,716	33.6
Pine -hardwood	6,650 / 16,431	8.3	Dry-mesic; Mesic longleaf pine savanna Longleaf pine - Pyrophytic hardwood Pyrophytic hardwood woodland	1,852 / 4,577 2,947 / 7,282 1,850 / 4,572	2.3 3.7 2.3
Upland hardwood slope	3,801 / 9,391	4.7	Pyrophytic hardwood woodland Mixed mesic hardwood	2,582 / 6,379 1,219 / 3,012	3.2 1.5
Southern mixed hardwoods	2,345 / 5,794	2.9	Pyrophytic hardwood woodland Mixed mesic hardwood	1,166 / 2,880 1,179 / 2,914	1.4 1.5
Pine-bay hardwood forests	739 / 1,825	0.9	Bottomland forests	739 / 1,825	0.9
Blackwater bottomland	6,578 / 16,255	8.2	Bottomland forests	6,578 / 16,255	8.2
Bottomland Hardwood	4,595 / 11,355	5.7	Wetland pyromosaic; Pond pine Wetland pyromosaic: bottomland	2,455 / 6,067 2,140 / 5,288	3.0 2.7
Pine-bay hardwood swamp	610 / 1,508	0.8	Swamp forests	610 / 1,508	0.8
Muck swamp	725 / 1,792	0.9	Swamp forests	725 / 1,792	0.9
Swamp	3,557 / 8,789	4.4	Swamp forests	3,557 / 8,789	4.4
Carolina bays; Upland depressions	785 / 1,939	1.0	Carolina bays; Upland depressions	785 / 1,939	1.0
Udorthents	2,930 / 7,241	3.7	Udorthents	2,930 / 7,241	3.7
Surface water	1,379 / 3,407	1.7	Surface water	1,379 / 3,407	1.7
TOTAL	80,271 / 198,347	100.0	**TOTAL**	80,271 / 198,347	100.0

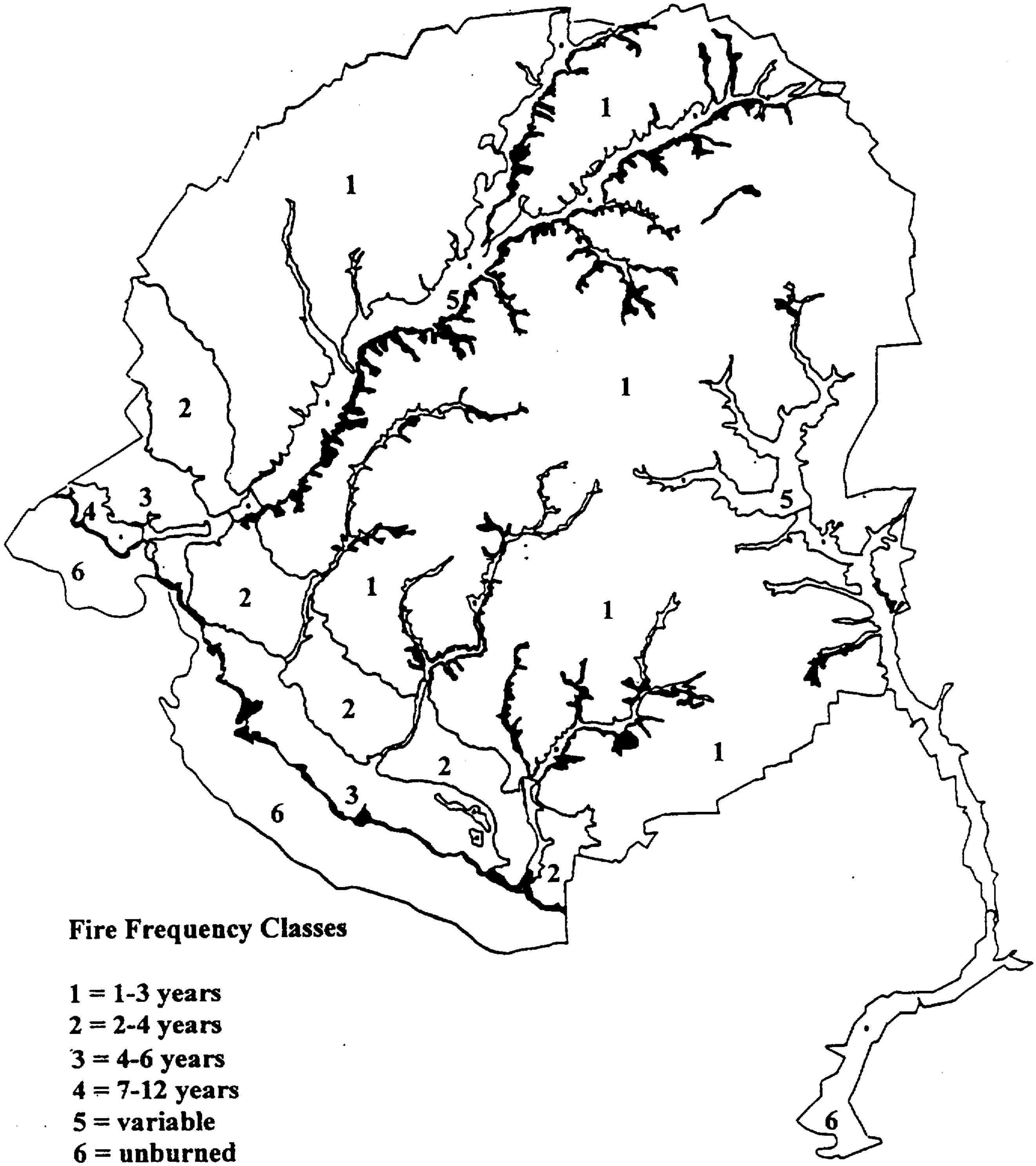

Figure 4. Presettlement fire regimes of the SRS, derived by combining historical records with presettlement vegetation.

2.3 Historic Land Use on the SRS between 1765-1950

The following summary of historical land use on the SRS is from White's (1997) historical documentation of ecologically important land-use activities in the SRS and surrounding area, termed the Central Savannah River Area (CSRA). The area now known as the SRS was settled during the 1760s when its primary land use was woodland livestock grazing and farming. The CSRA human population increased 300% from 1780-1865, largely associated with increased cotton production. Cultivated land increased from <5% of the land base in the 1820s to approximately 33% by 1860, with most of the farming occurring in the bottomlands. Forests during this period were heavily impacted by the clearing of land for agriculture, the expanding population's demand for lumber, fence rails, and fuelwood, and by free-ranging livestock populations, which peaked by 1850 (Frost 1993). Annual burning of forests and fields continued through this period.

Between 1865 and 1950, the SRS area underwent accelerated changes in land use. Human population in the area surrounding the SRS increased from approximately 8 per km^2 in 1870 to near 19 per km^2 in 1950. Following the Civil War, the system of tenant farming caused significant increases in erosional land use-practices (Trimble 1974). Areas in cotton, and cultivated land in general, dramatically increased during this time, peaking in the 1920s. Forests on the SRS during this period were impacted by: 1) the peak in naval stores production that occurred after 1880, 2) clearing of lands for agriculture, 3) cutting of longleaf pine to meet the fuelwood and construction needs of the railroad, and 4) railroad logging of swamps, lowland areas, and much of the accessible uplands, which occurred from 1910 through the 1930s. Longleaf forests on the SRS were further impacted by fire suppression efforts, which began in the early 1900s and favored hardwoods and less fire tolerant pines.

2.4 Vegetative Conditions on the SRS in 1950

The SRS was selected by the Atomic Energy Commission in 1950 for construction of a nuclear defense material production facility. An inventory of the 81,276 ha (200,831 acres) purchased for the site found 51.5% in mixed pine and scrub hardwood, 34% in old fields, and 14.5% in swamp and stream bottoms (Savannah River Forest Station History 1966). In concordance with earlier estimates, a recent analysis of a digital orthophoto representation of 1951 aerial photographs of the SRS (Sumerall and Lloyd 1995) by image analysis (Donald Von Blaricom, Strom Thurmond Institute, Clemson University, Clemson, South Carolina) found that the SRS was 44% forest, 34.9% agriculture/bare ground, 9.5% immature forest/old field/regeneration, 8.8% forest edge, and 2.8% brush/fallow/pasture at the time of purchase (Fig. 5). Accuracy of this analysis was greater than 80% when only forested and non-forested land use classes were used, but declined with the addition of other classes. A lack of past timber management on the area resulted in poor or high-graded stands in both uplands and bottomland forests. According to the Savannah River Forest Station History (1966):

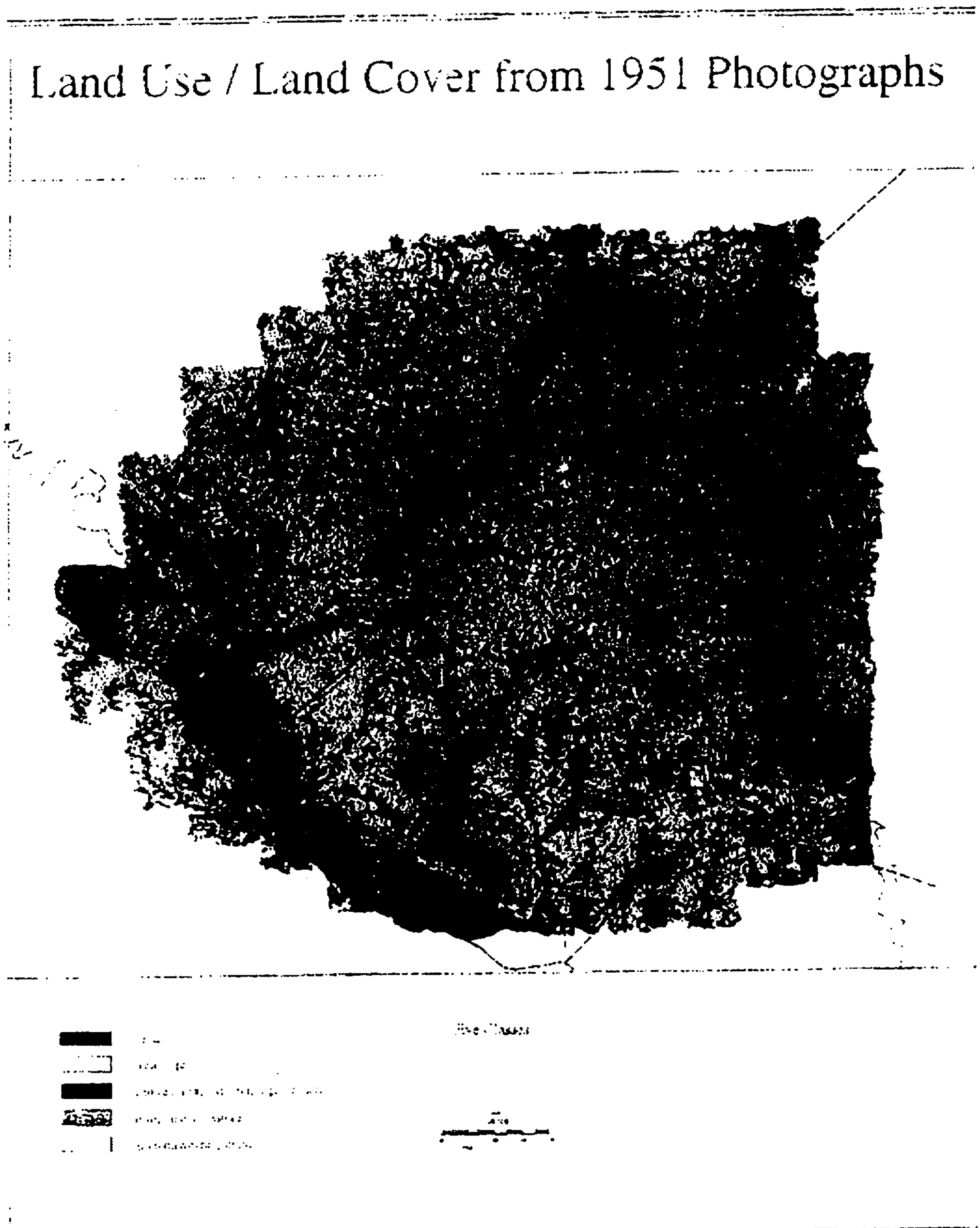

Fig. 5. Land use/cover estimates from a analysis of a digital orthophoto representation of 1951 aerial photographs of the SRS by image analysis (source D. Von Blaricom, Strom Thurmond Institute, Clemson University, Clemson, SC). Forest = 44%; Agriculture/bare ground = 34.9%; Immature forest/old field/regeneration = 9.5%; Forest edge = 8.3%; Brush/fallow/pasture = 2.8%

> these conditions were further degraded when the Atomic Energy Commission [AEC] came in to buy the land through the Real Estate Division of the Corps of Engineers. Rumors were allowed to go uncontradicted that a person would get the same for his land whether or not the timber was left, that there would be no taxes levied on timber cut under forced sale, and that AEC did not care whether or not the timber remained on the land. All of these factors resulted in the sudden removal of thousands of railroad cars of forest products according to the Industrial Forester of the Atlantic Coast Line Railroad. It left very little residual timber to manage when the area was finally taken over by AEC. Certain owners and operations were allowed to continue cutting well up into 1952 although the land had been under Declaration of Taking for over a year. This further reduced the supply of residual timber left on the land.

The AEC contracted with the Forest Service in 1951 to plant extensive areas on the SRS for erosion control and reforestation. Between 1952 and 1968, 100 million trees were planted and approximately 38,400 ha (94,886 acres) regenerated to pine (Savannah River Forest Station History 1966).

2.5 Current and Potential Vegetation on the SRS

According to the 1997 SRI Continuous Inventory of Stand Conditions database, the area of the SRS currently contains 64% pine forest, 22% hardwood forest, 6% in facilities, 6% pine/hardwood forest, and 2% in permanent grass openings. This dramatic increase in amount of area forested (62% in 1950) and timber quality can be credited to the Forest Service's early reforestation program, and to its continued management of forest resources on the SRS.

Early management by SRI stressed timber production, sustainable harvest, and erosion control, which provided other indirect benefits, such as wildlife habitat and research opportunities. A management philosophy that followed the natural biological tendencies of land and soils was first adopted on the SRS in 1973 (U. S. Forest Service 1973). Although emphasizing timber management, it also addressed concerns for wildlife, water, fire, recreation, and environmental research. However, as natural resource management evolved, other concerns, including multiple use, threatened and endangered species, and restoration of communities that originally occupied the SRS, became important in management decisions. To address these broad concerns, the Forest Service initiated an ecosystem management program in 1993 to meet desired habitat conditions to support and sustain wildlife, fish, and botanical population objectives; to sustain an even flow of forest products; and to maintain the health and productivity of the SRS forest ecosystem (Savannah River Forest Station 1993).

As part of this program, Imm et al. (1996) developed an ecosystem classification for the SRS to aid in the assessment of current land management and the development of future land management strategies. This classification followed criteria and methods developed by the Forest Service (Keys et al. 1995) and conformed to the ongoing multi-agency, national classification effort that includes: Ecological Society of America, The Nature Conservancy, Forest Service, Department of Defense, Department of Energy, U. S. Fish and Wildlife Service, Department of Interior, and others. Classification is hierarchical and inclusive of generalized Ecoregions, Sub-regions, Sections, Provinces, Divisions, and Domains. Each of these units are based on physiographic regions, topography, geology, soil groups, climatic units, and paleogeologic histories. In addition, the SRS classification is based on landscape and local factors, such as soil

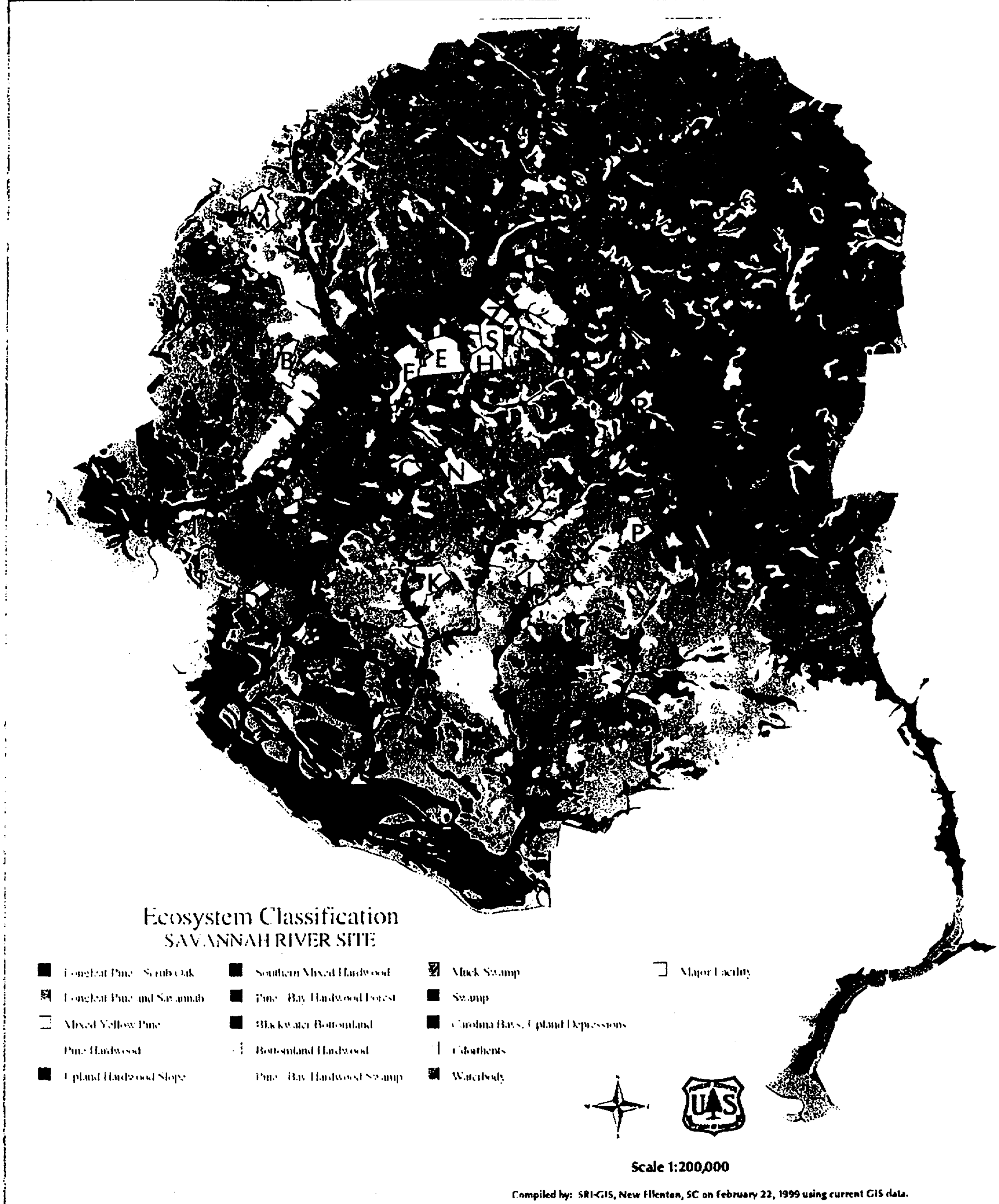

Figure 6. Ecosystem classification on the Savannah River Site as determined by Imm et al. (1996).

associations, landform, topography, and disturbance regimes (Imm et al. 1996). The resulting ecosystem classification predicts potential vegetation types for general site conditions (Fig 6). However, these potential vegetation types are not the only management option and can be modified to meet the needs and objectives of the land manager.

Forest management aligned to this ecosystem classification (Imm et al. 1996) could create a future SRS land base with the following composition: longleaf pine-scrub oak and longleaf pine savanna 23.2%, mixed yellow pine 33.6%, pine-hardwood 8.3%, upland hardwood slope 4.7%, southern mixed hardwoods 2.9%, pine-bay hardwood and blackwater bottomland 9.1%, bottomland hardwood 5.7%, swamp complex 6.1%, Carolina bays 1.0%, udorthents 3.7%, and surface water 1.7% (Table 1). Although an objective of the current management program is the restoration of communities that originally occupied the SRS, it is unrealistic to assume that management can duplicate, either in proportion or spatial arrangement, presettlement vegetation (i.e., Frost's 1997 presettlement vegetation map). Imm et al. (1996) stated:

> It is unrealistic to assume that we can recreate any forest or natural condition that formerly existed, particularly if one considers the large scale effects of : 1) past land-use history, 2) current placement of human facilities within the interior [of the SRS], and 3) alternative land management around the perimeter [of the SRS]. However, a suitable large-scale "natural" condition that includes economic, political, and social considerations is attainable and can incorporate natural conditions at smaller spatial and temporal scales.

Frost's (1997) description of presettlement vegetation assumed that natural processes occurred at frequencies and scales appropriate for the land condition. In contrast, Imm et al. (1996) ecosystem classification assumes a fire frequency of approximately 5 years, and that the scale and season of fire is limited by logistical and safety considerations. Moreover, future potential vegetation types are also influenced by existing seed source and seed pools *in situ* on the SRS.

3.0 MANAGEMENT AREAS ON THE SAVANNAH RIVER SITE

3.1 Current Management Areas

In 1986, the Forest Service initiated a management/research program for establishing a viable population of RCWs on the SRS. This program established 2 distinct management areas: Management Area 1 was a centrally located area of 33,658 ha (83,168 acres) that included all existing and proposed DOE production facilities; Management Area 2 encompassed Management Area 1 and provided 46,613 ha (115,179 acres) for RCW management, and also acted as a buffer between production areas and surrounding private lands (Fig 7). Because few (<10 individuals) RCWs were present on the SRS at the time management areas were established, emphasis was placed on centralizing facilities development and less consideration was given to the proposed long-term expansion of the RCW population. Moreover, because of the relatively young (<30 years old) forest on the SRS, the potential availability of suitable RCW habitat was projected from an existing CISC data base, and represented only a gross estimate of future forest conditions.

3.2 New Management Area Boundaries

In an effort to more closely align facilities planning with RCW and ecosystem management, planning and ecological criteria were considered concurrently to reapportion management areas. Planning criteria included infrastructure, depth to water table, and proposed DOE facility sitings (Figs. 8, 9, 10; Westinghouse-Savannah River Technology Center). This information was used to anticipate future development of the site, and to avoid or minimize potential conflicts between RCW management areas and mission-related development. On the basis of these criteria, the central and northwestern portions of the SRS are most suited for facilities development. These areas generally represent more xeric sites, in close proximity to existing facilities, and are connected by transportation corridors. Ecological criteria included current forest conditions, potential vegetative conditions as predicted by ecosystem classification (see Chapter 2), and the use of prescribed fire. Whereas Frost (1997) assumed the widespread occurrence of frequent, natural fires across the landscape; prevailing southwest winds and existing facilities, currently restrict or reduce the use of prescribed fire on some portions of the SRS (Fig. 11). On the basis of future forest conditions and the reliance on prescribed fire to produce these conditions, RCW habitat is most suited for the eastern two-thirds of the SRS.

Given the location of existing facilities, the need for future facilities development, and the spatial restrictions on the use of prescribed fire to maintain pine-dominated forest types, the SRS was reapportioned into 3 management areas: a RCW Habitat Management Area (HMA) containing 34,832 ha (86,069 acres); a Supplemental RCW HMA containing 19,493 ha (48,167 acres); and a Other-use Area of 25,946 ha [64,111 acres] (Fig. 12). RCW management in each of these areas will be discussed in detail in later chapters.

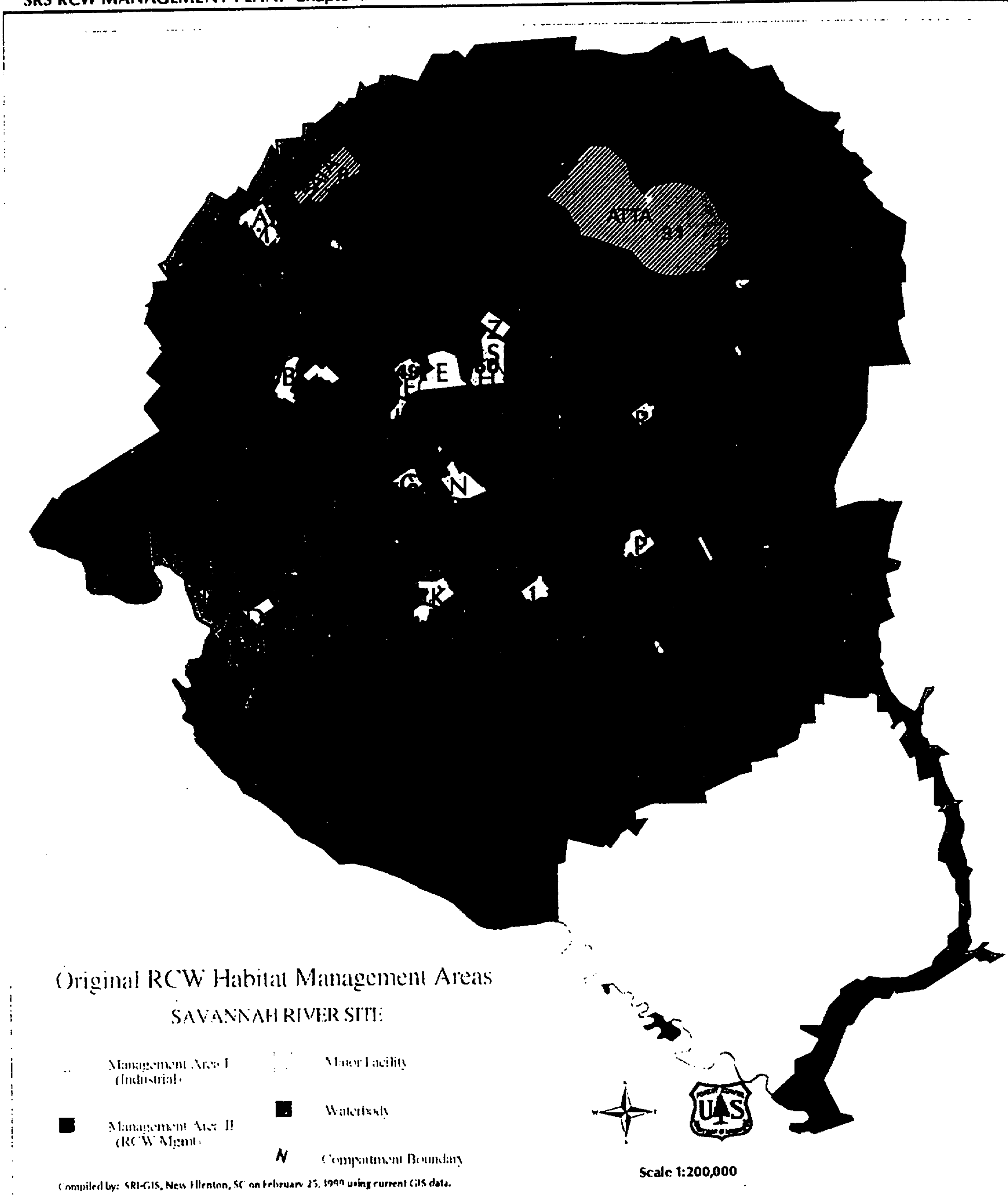

Figure 7. Original (1986) Management Areas, compartment boundaries, and major facilities on the Savannah River Site.

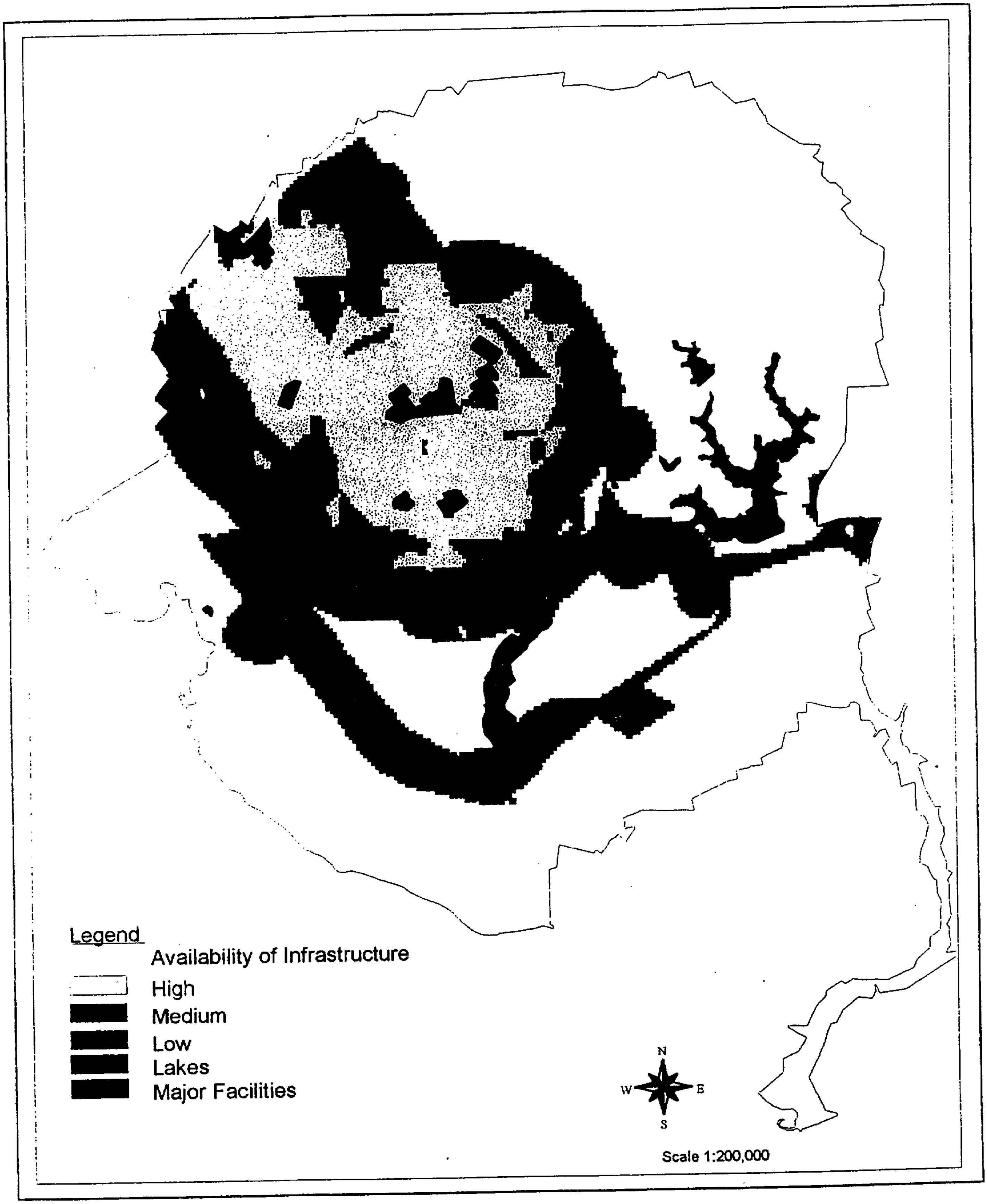

Figure 8. Availability of Infrastructure on Savannah River Site.

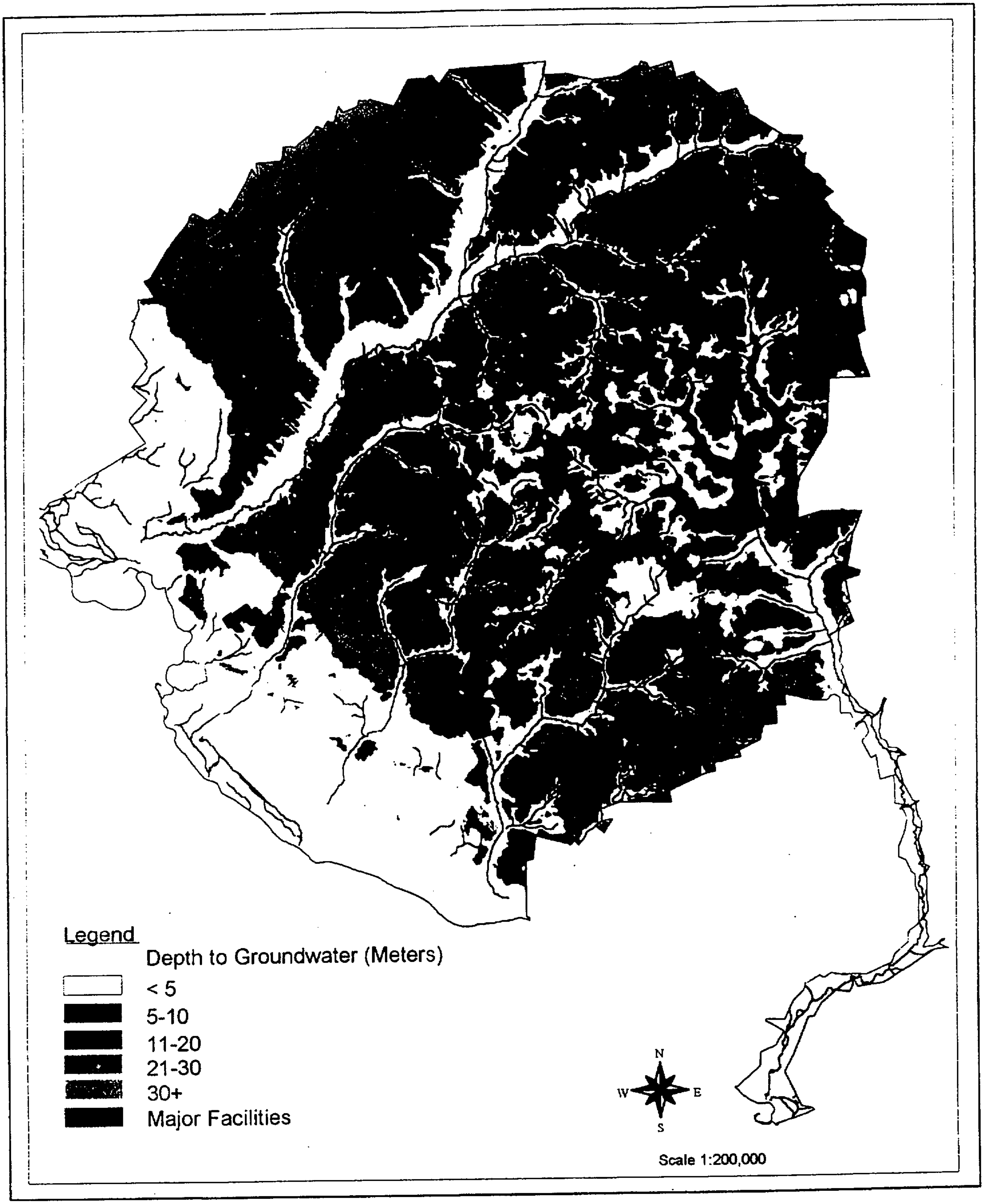

Figure 9. Depth to Groundwater on Savannah River Site.

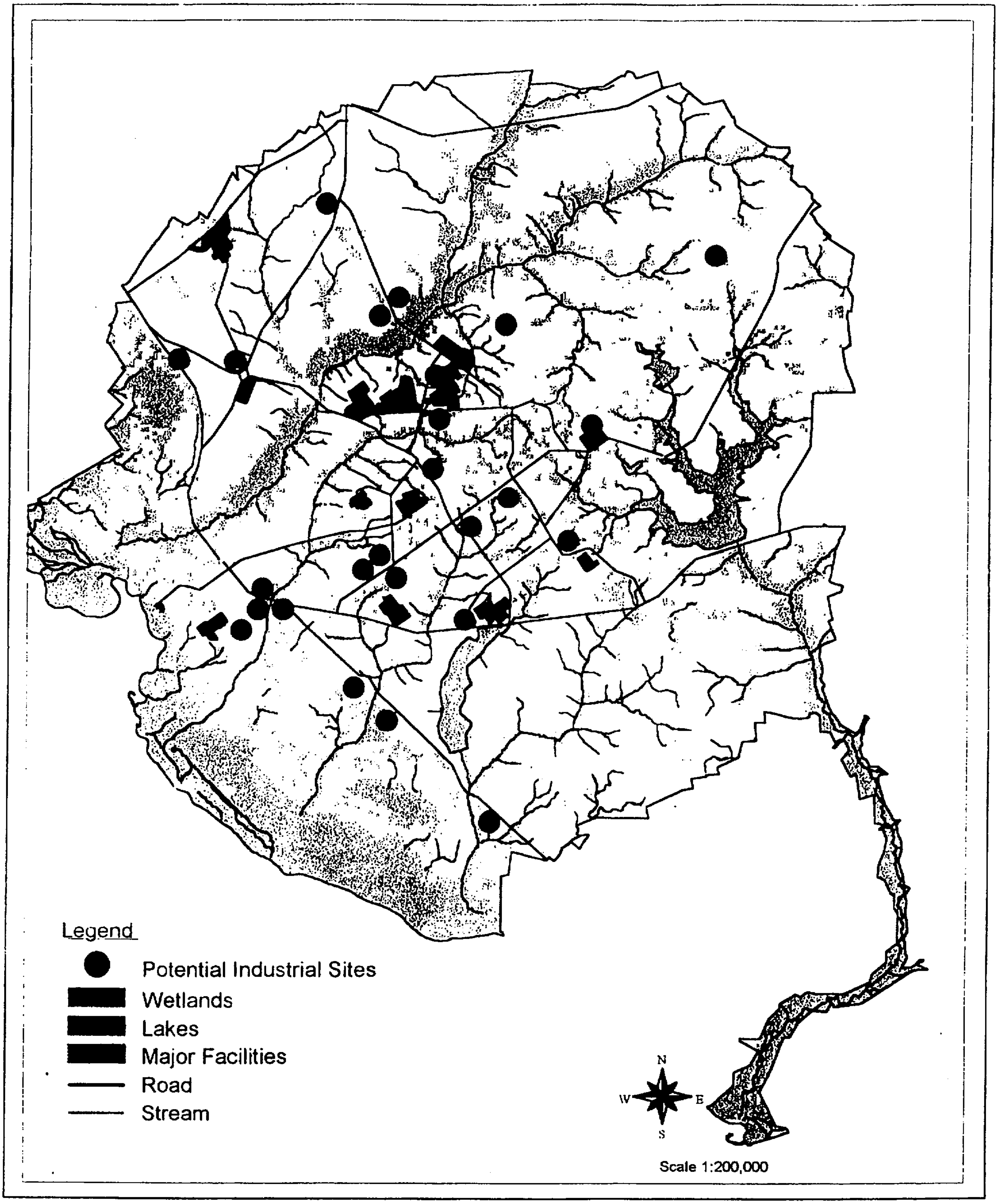

Figure 10. Potential Industrial Sites on Savannah River Site.

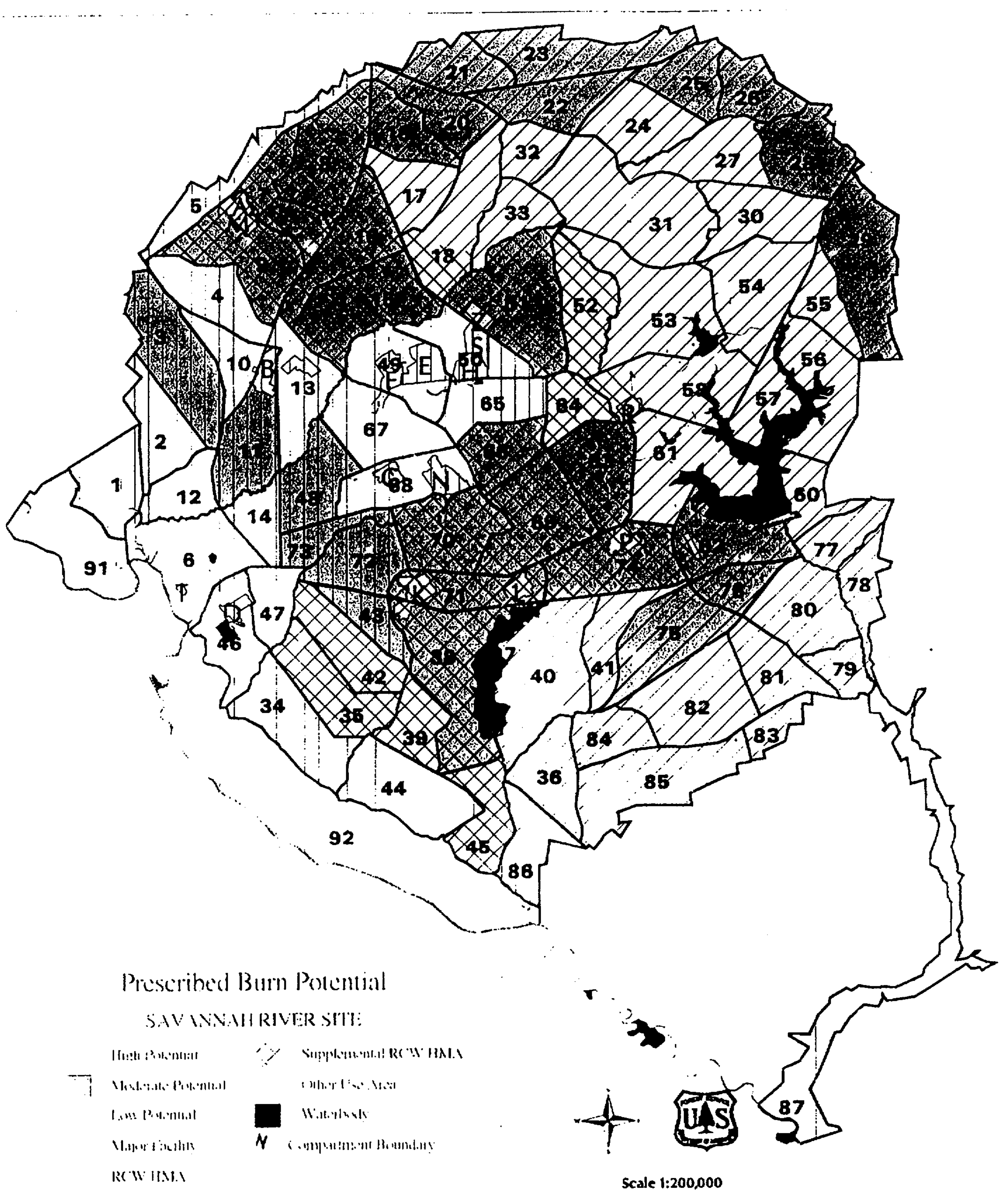

Figure 11. Potential use of prescribed burning on the Savannah River Site.

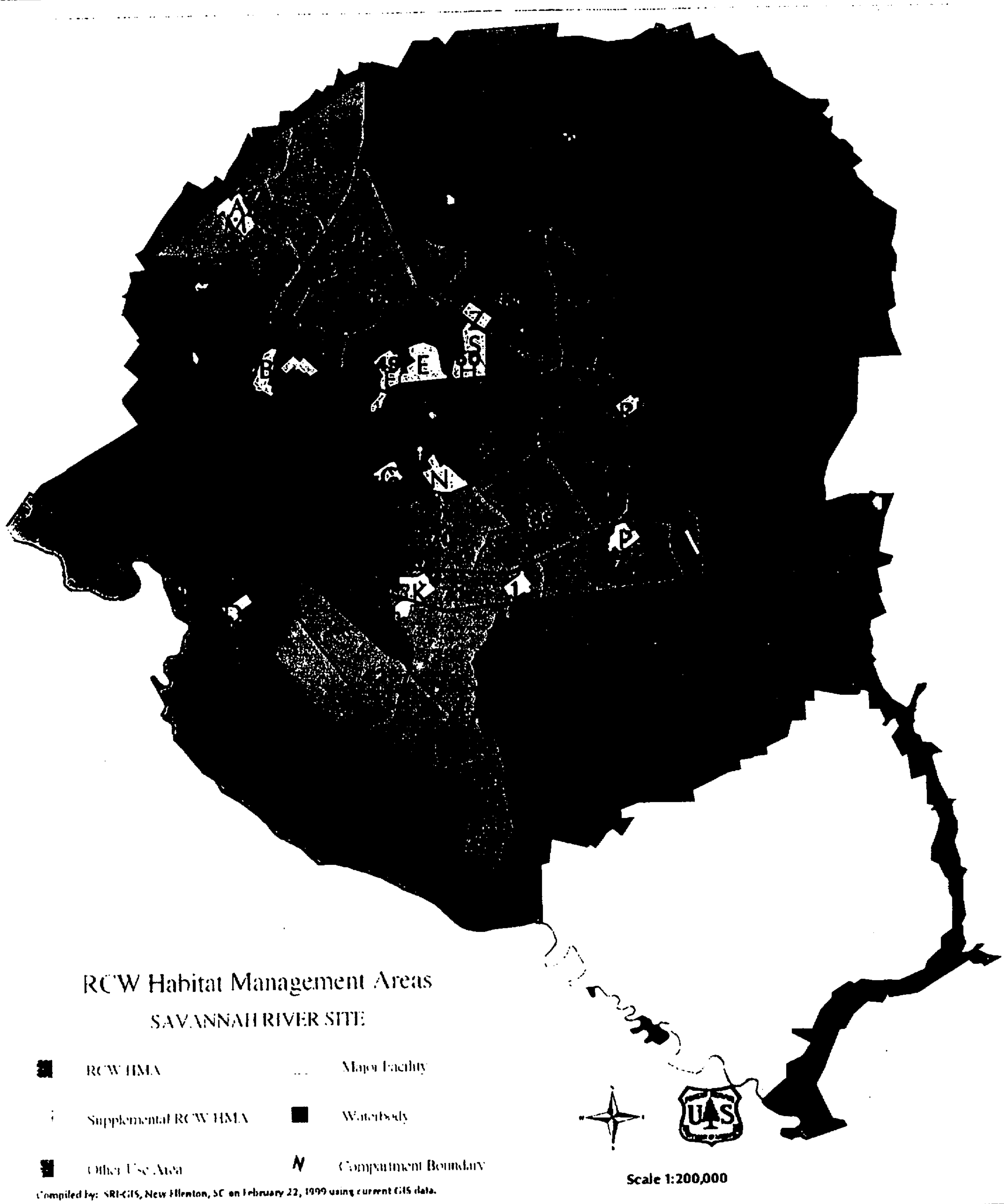

Figure 12. New management areas on the Savannah River Site: Red-cockaded Woodpecker Habitat Management Area; Supplemental RCW HMA; and Other Use Area.

4.0 RCW POPULATION STATUS, GROWTH, AND OBJECTIVES

4.1 Population Decline

Prior to its purchase in 1950, the SRS contained an unknown number of RCW groups (Norris 1963). Of 40 known clusters (active and inactive) surveyed in 1975, only 16 were active in 1977 (Jackson 1990). Between 1977 and 1984, the population continued to decline to 5 active clusters, 2 with breeding pairs and 3 with single males (Jackson 1990). By December 1985, only 4 birds remained in 3 clusters, a breeding pair and 2 single males. A lack of suitable and potential cavity trees, interspecific competition for cavities, and midstory hardwood encroachment were putative factors leading to cluster abandonment and population decline (Jackson 1990).

In an attempt to save the population from imminent extinction, the DOE in cooperation with the Forest Service developed a research and management program to establish a viable RCW population on the SRS. The program was initiated in 1986 and identified several steps to provide for short-term protection of the existing small population, and for the long-term expansion and eventual recovery of the SRS population to a viable level.

4.2 Population Growth

A major obstacle to the recovery of small RCW populations has been the rarity with which new groups form (Ligon et al. 1986). Between 1985 and 1995, the number of groups containing at least a paired male and female on the SRS increased from 1 to 20. This represents an annual increase of approximately 27% (exponential rate of increase $r = 0.27$; Caughley 1977) in the number of groups (Fig. 13). This rate of increase in groups is unprecedented, and represents the fastest recovering RCW population (Edwards and Stevens, unpubl. data). During the same period, the total number of RCWs increased from 4 to 89. This measure of total number of individuals was inclusive of all group members, including breeders, helpers, fledglings, and bachelor males, and was determined each year following the fledging of all young. The measure of new group formation provides a more useful metric than increase in number of individuals. Heppell et al. (1994) found that increases in fecundity and survival of RCWs in a population can result in increased number of individuals. These increases, however, in the absence of available clusters, result in only increased number of nonbreeding helpers rather than increased number of groups. Therefore, an increase in the number of individuals is not always indicative of population expansion (i.e., formation of new groups).

Rate of increase can be viewed as a measure of a population's demographic vigor, describing the average reaction of all members to the collective action of all environmental influences (Caughley 1977). It reveals how the population is coping under current conditions, but not how it will respond to environmental change, nor whether it will survive into the future (Caughley 1977). Such a rapid rate of increase as observed on the SRS is indicative of a small population where density is low and resources (e.g., cavities, territories, food) are relatively unlimited (Caughley and Sinclair 1994). Following the decline of the RCW population on the SRS in the early 1980s, management efforts focused on rehabilitating existing clusters (e.g., hardwood midstory removal, prescribed fire), providing suitable natural and artificial cavities (Allen 1991), and minimizing cavity competitors, all of which were believed to be limiting

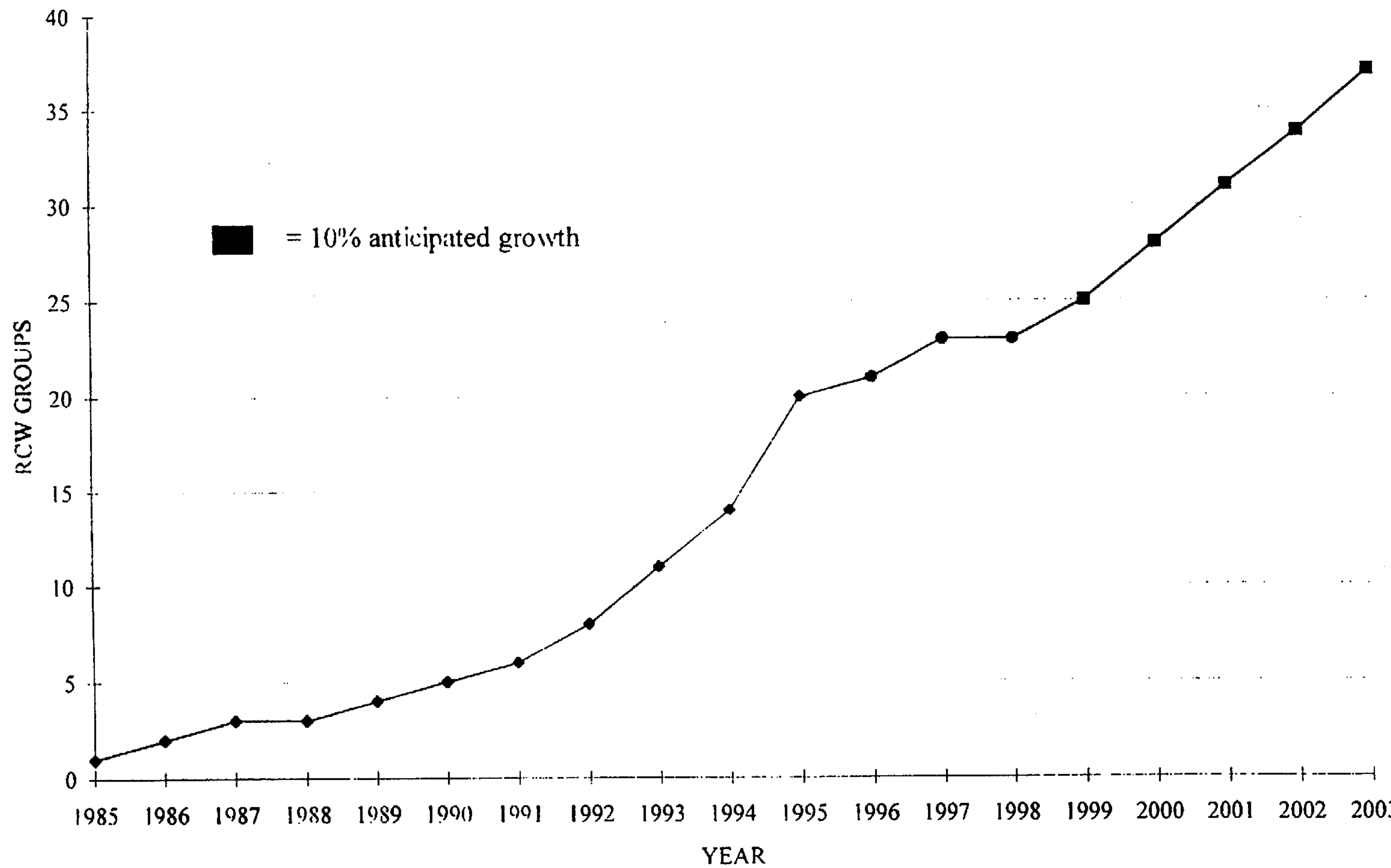

Figure 13. RCW population growth between 1985 and 1998 on the SRS. The red line represents a 10% increase from 1998 to 2003.

population growth and expansion. In addition, numerous intra- and inter-population translocations were conducted to augment the population and to aid in the establishment of new groups (Allen et al. 1993). These management practices produced suitable nesting and foraging habitat, and contributed to increases in reproduction, nesting success, and dispersal opportunities (i.e., suitable recruitment clusters).

Beginning in 1996, however, RCW population growth on the SRS began to slow (Fig. 13) with rates of increase from 1996 to 1998 at <10% (1996 = 5%; 1997 = 9.5%: 1998 = 0%). Various reasons could account for this observed decline in growth, including both demographic and environmental factors. The relatively high rate of increase experienced between 1985 and 1995 could only be predicted to continue as long as resources were maintained at optimal levels. But because pine stands on the SRS are relatively young, only a limited number of recruitment stands were available that contained trees suitable for installation of artificial cavities. This lack of recruitment clusters may have lowered the potential for expansion of the RCW population. Future recruitment cluster development will depend upon the rate at which younger pine stands enter into minimal (43 cm; 17 inch) DBH classes necessary for artificial cavity construction (Allen 1991); once this requirement is met, adequate forage must also be provided.

Other small (<50 groups) populations of RCWs have also shown substantial increases under varied levels of management. In Mississippi, Richardson and Stockie (1995) reported a 19% annual increase in active clusters (1 or more birds per territory) between 1986 and 1992 as a result of habitat enhancement, artificial cavity installation, and cavity competitor control. In Florida, Reinman (1995) observed an 11% annual increase in RCWs associated with augmentation efforts. In contrast, rates of increase in larger (>50 groups) populations, where management was less intensive but suitable unoccupied habitat remained, were minimal (E. Stevens, unpubl. data; Walters 1990; Hooper et al. 1991).

4.3 Population Objective

The short-term goal of the 1986 management program on the SRS was to reach 30 active (1 or more birds) RCW clusters by the year 2000. This goal should be obtained given the current trend in population increase (Fig. 13). For purposes of operations and management, and on the basis of recorded growth in the SRS and other managed RCW populations, we will anticipate a 10-15% annual increase in the number of groups over the next 5 years. At the 10% level, the SRS RCW population would increase to approximately 37 groups by the year 2003.

The long-term goal of the 1986 management program was to establish a viable RCW population on the SRS. The federal RCW Recovery Plan (U.S. Fish and Wildlife Serv. 1985) suggests a minimum of 250 breeding groups (i.e., 500 breeding individuals represent the minimum effective population size) in order for a population to be considered viable. It should be emphasized that 250 breeding groups is a suggested minimum viable population size (U.S. Fish and Wildlife Serv. 1985). It also emphasized that because not all groups breed successfully each year, more than 250 groups are needed to achieve minimum viable population size. Moreover, the Federal Recovery Plan recommends that forest managers with adequate habitat to support more than 250 groups establish population goals based on the potential carrying capacity of their properties.

In accordance with the Federal Recovery Plan, a long-term goal of 400 groups was established for the SRS in 1986. This number was determined according to federal guidelines by assuming a density objective of 1 RCW group per 81 ha (200 acres) of suitable habitat within the 46,613 ha (115,179 acres) in Management Area 2. Management Area 2 contained approximately 32,376 ha [80,000 acres] (CISC; 1997) of pine and pine/hardwood habitat, and therefore, the population objective was set at 400 groups (80,000 / 200 = 400).

Within the redelineated management boundaries and under ecosystem classification (Imm et al. 1996) the RCW HMA contains 26,422 ha (65,288 acres) of potentially suitable RCW habitat and the Supplemental RCW HMA contains 12,502 ha (30,892 acres) of potentially suitable habitat (Table 2). Four vegetative communities comprise the potentially suitable RCW habitat: longleaf pine and savanna; longleaf pine-scrub oak; mixed yellow pine; and pine-hardwood. Suitable habitat occurs on a variety of sites, from streams and drains (generally not suitable for RCW) to sandy soil inclusions (suitable for RCW habitat). The pine-hardwood community is associated with intermediate soils at the landscape level, and in many areas hardwoods dominate.

Assuming a density objective of 1 RCW group per 81 ha (1 per 200 acres), the maximum population objective for the RCW HMA is 326 groups. However, there is also variability in habitat capability based on ecological factors (e.g., soil properties, hydrology, topographic features) of a particular landscape, and these can influence whether the vegetation will be optimal, suitable, or marginal RCW habitat (U. S. Forest Service 1995). To allow for habitat variability and critical, future industrial development within the RCW HMA, and to increase management flexibility, we reduced the population objective from 326 to 315 groups. Because of differences in rotation lengths between the RCW HMA and the Supplemental RCW HMA, which are discussed in later chapters, the density objective in the Supplemental RCW HMA is 1 group per 121 ha (300 acres), resulting in a desired target of 103 groups. The population objective for the Other-use Area, formerly Management Area 1, remains at 0 groups. In summary, the combined population objective for the SRS is 418 groups.

Table 2. Area and population objectives for redelineated management areas on the SRS. RCW habitat was defined as: longleaf pine and savanna; longleaf pine-scrub oak; mixed yellow pine; and pine-hardwood types.

Management Area	Total Area (ha/acres)	RCW Habitat (ha/acres)	RCW Density Objective (groups/area)	Long-term Population Goal (number of groups)
RCW HMA	34,832 / 86,069	26,422 / 65,288	1 per 81 ha 1 per 200 acres	326 / 315 *
Supplemental RCW HMA	19,493 / 48,167	12,502 / 30,892	1 per 121 ha 1 per 300 acres	103
Other-use Area	25,946 / 64,111	0	0	0
Sitewide	80,271 / 198,347			418

* Reduced from 326 to 315 to allow for habitat variability and critical, future development.

5.0 POPULATION MANAGEMENT

5.1 Banding and Marking

During the breeding season, RCW groups will be monitored for reproduction (e.g., number of eggs, nest loss, number of helpers, etc.) and all nestlings will be banded between age 5 and 10 days with a U. S. Fish and Wildlife Service (USFWS) aluminum leg band and a unique three-band color combination for field identification. A follow-up check (fledge check) of the number and sex of nestlings that fledge will be conducted for each successful group. This 100% sample of reproduction will continue until the population reaches 50 active groups. At that time, a systematic sampling approach will be adopted to monitor each group once every 2 years unless more intensive monitoring is maintained for research purposes. SRI will consult with the USFWS prior to initiating this monitoring change. All adult RCWs are currently banded on the SRS, but in the rare instance where an unbanded alien enters the population, it will be trapped and banded. The need for this intensive banding program is to facilitate monitoring and translocation efforts.

5.2 Group Composition

RCW groups will be monitored every 2 months to determine membership and the presence or absence of previous members, and more often if circumstances warrant (e.g., breeding season, translocation efforts). For example, during breeding season group composition is monitored more intensively to identify the breeding pair, helpers, and any auxillary members of the group. For translocation efforts, it is often necessary to repeatedly locate the roost cavity of individual group members.

5.3 Translocation

The federal RCW Recovery Plan (U. S. Fish and Wildlife Serv. 1985) emphasizes restoration of populations within physiographic provinces throughout the range of the RCW to provide for region-wide, long-term survival. Restoration efforts include reestablishment of RCWs in areas from which they have been extirpated, and augmentation of existing small populations. Although installation of artificial cavities may be sufficient to increase the number of groups in relatively large populations (Copeyon et al. 1991), for the numerous small, remnant, or extirpated populations, translocating RCWs after habitat enhancement and cavity provisioning may be the only option to reduce demographic and genetic effects of small population size (Allen et al. 1993).

Because of the few remaining RCWs on the SRS in 1986, 2 of which were single males, a translocation program was begun to augment the population. Initial trials included translocating RCWs of various ages and breeding status into groups with resident birds of different ages and sexes, and into abandoned clusters. Translocation usually entailed the movement of a single RCW from a donor population to a single resident bird on the SRS (Allen et al. 1993). Donor populations include the Francis Marion National Forest, Carolina Sandhills National Wildlife Refuge, and Fort Jackson Military Base in South Carolina, Fort Bragg Military Base in North Carolina, and Apalachicola National Forest in Florida. On the basis of the success of initial (1986-1990) translocations, subsequent augmentation efforts concentrated on moving hatching-year and first-year females to resident, single males (Allen et al. 1993). Intrapopulation translocation of single birds and unpaired males and females were also conducted to establish new groups and to increase reproduction and genetic diversity.

A complete pedigree analysis of RCWs on the SRS (Haig et al. 1993), and a range wide survey of genetic variation among RCW populations (Stangel et al. 1992) helped guide decisions concerning donor populations and birds to be moved or to receive potential mates (i.e., to minimize mating between close relatives). On the basis of their population viability analysis, Haig et al. (1993) recommended that at least 3 females and 2 males be added to the population for each of 10 successive years (1993-2002) to insure its long-term survival. However, because of the small pedigree available at the time (1985-1990), this recommendation was based in large part on parameter estimates from a North Carolina population (Walters 1990) and from educated guesses about inbreeding depression and other risks (D. Tonkyn, pers. comm.). David Tonkyn of Clemson University is in the process of reexamining the genetic history and status of the SRS population. His reanalysis of demographic and genetic trends within the SRS population from 1985 through 1997 will allow for a reassessment of the translocation strategy proposed by Haig et al. (1993).

Future translocation efforts will focus primarily on juvenile female and male RCWs (Allen et al. 1993, Costa and Kennedy 1994), and will be conducted during October through March following standard translocation protocol (R. Costa, pers. comm.; Appendix D). The current SRI goal is 5 interpopulation translocations per year, supplemented by intrapopulation moves whenever possible. However, this goal has not been achievable due to the limited number of RCWs available from donor populations. Recent cooperative effort between SRI, DOE, USFWS, and Norfolk-Southern Railroad should facilitate the availability of RCWs from their land holdings to the SRS (E. LeMaster, pers. comm.). In addition, SRI is cooperating with multiple partners in the research and development of an experimental, mobile aviary to enhance the success of RCW translocations (Edwards and Franzreb 1995, Franzreb 1997a, Edwards et al. 1998).

5.4 Incidental Take

Under the previous SRS RCW Management Plan, timber management practices in Management Area 1 were relied upon to discourage natural colonization by RCWs. However, colonization was possible, and if it occurred, would require habitat protection. No options, other than formal consultation with the USFWS, were available to translocate or remove RCWs in the event that their cluster occupied a proposed development site.

Incidental take authorization from the USFWS will permit the removal of RCWs, their cavity trees, and habitat only in the Supplemental RCW HMA and Other-use Area after written notification of the USFWS Endangered Species Permit Coordinator. Prior to initiating activities leading to the "incidental take" of any RCWs or their habitat, DOE would minimize take through the following protocol:

1) Written notification of the USFWS.
2) If RCWs are not translocated to the RCW HMA on the SRS, DOE must give the USFWS a 60-day period of opportunity to translocate birds from the SRS to other recovering populations.
3) No cutting of habitat or moving of birds will occur during the RCW breeding season (March 1 - July 30).

The purpose of the incidental take authorization would be to provide DOE flexibility in future development of sites on the SRS. Removal of RCWs from these areas will not be mandatory, however, and should only be exercised after other feasible options have been considered.

Incidental take is not an option in the RCW HMA, but limited flexibility does exist for future development and for the relocation of existing groups. This flexibility is tempered, however, by a no-net-loss policy regarding habitat and number of groups. To meet the population objective of 315 groups, a minimum of 25,515 ha (63,000 acres) of suitable RCW habitat (81 ha per group) must be available within the RCW HMA. The spatial distribution, within current guidelines, of this required habitat and the management of any "excess" RCW habitat within the RCW HMA is under DOE discretion. Currently, the RCW HMA contains an estimated 26,422 ha of suitable RCW habitat. At the population objective of 315 groups, approximately 907 ha of "excess" RCW habitat (26,422 - 25,515 = 907) is available for alternative uses, if needed. Therefore, a proposed facility could require the development of up to 907 ha of unoccupied RCW habitat without formal notification of the USFWS. However, if the proposed siting impacted active clusters, not only would there have to be "excess" habitat available, but an equivalent number of new groups would also have to be established prior to the initiation of the proposed development (i.e., no net loss in the number of existing groups). Once this "excess" acreage is developed, no future siting can occur in the RCW HMA that would reduce the amount of RCW habitat below the required minimum (25,515 ha) without formal consultation with the USFWS (i.e., no net loss of habitat). One alternative to formal consultation, that is, informal consultation, is the annexation of RCW habitat and/or existing groups from the Supplemental RCW HMA. This option provides DOE with additional flexibility in that if circumstances warrant the immediate need for a site occupied by a RCW group(s), an active cluster could be annexed from the Supplemental RCW HMA without the delay associated with establishing a new group within the existing RCW HMA.

5.5 Safe Harbor Agreements

Efforts to increase the RCW population on the SRS would also increase the likelihood of birds becoming established in suitable habitat surrounding the SRS. Private landowners could view this as positive or as a potential threat to their property value and ability to manage their resources (e.g., timber). Although in some cases these concerns may be warranted, management options are available to minimize the risk to landowners while maintaining or increasing RCW habitat. One such option is Safe Harbor, which is a conservation agreement between the landowner and the U. S. Fish and Wildlife Service (Costa and Kennedy 1997).

Under a Safe Harbor cooperative agreement a landowner agrees to actively maintain suitable habitat (i.e., a safe harbor) for a number of RCW clusters equal to the number present when the agreement was formulated (Costa 1997; Costa and Kennedy 1997). In turn, the landowner receives an incidental take permit, authorizing a land management action or change that alters RCW occupied habitat (e.g., a timber sale that results in loss of habitat), for any additional RCW groups that may occupy the property in the future as a result of voluntary, beneficial land management (Costa 1997; Costa and Kennedy 1997). The South Carolina plan, *Habitat Conservation Plan to Provide Safe Harbor Assurances to Landowners in South Carolina*

Who Voluntarily Agree to Enhance Habitat for the Endangered Red-cockaded Woodpecker, has been formally reviewed by the U. S. Fish and Wildlife Service and the permit has been issued.

This plan will allow landowners surrounding the SRS to enter into Safe Harbor agreements under the Statewide Habitat Conservation Plan, which is administered by the South Carolina Department of Natural Resources (Appendix E). Prior to this landowners must establish their baseline or number of RCW clusters currently on their property. This requires that a person knowledgeable in RCW ecology (i.e., wildlife biologist, consultant, etc.) visit the property. The cost of establishing the baseline is the responsibility of the landowner. The DOE and SRI will facilitate this process by informing surrounding landowners of the existence of Safe Harbor and may provide some technical assistance for baseline determination. Establishment of a Safe Harbor program would help to alleviate negative concerns over an increasing RCW population on the SRS, provide habitat for additional clusters that would increase the potential SRS-surrounding area RCW population to a recovery level (500 groups), and aid in the regional recovery of the RCW.

6.0 NESTING HABITAT MANAGEMENT

The following discussion of nesting habitat management practices pertains to the RCW HMA and Supplemental RCW HMA. Unless otherwise stated, management practice guidelines are the same for both areas. No RCW management practices will be conducted in the Other-use Area.

6.1 Delineation of Recruitment Clusters and Replacement Stands

6.1.a *RCW HMA*

Recruitment clusters in the RCW HMA will be selected on a compartment basis when the population goal (based on a density of 1 cluster per 81 ha or 200 acres) is greater than the number of existing clusters (active and inactive). If inactive clusters are determined unsuitable for recruitment, then the cluster will be protected and an alternative recruitment cluster with suitable nesting habitat will be selected. All recruitment clusters will be at least, but not limited to, 4 ha (10 acres) in size. Where possible, areas between 10 and 16 ha (25-40 acres) will be selected. Where only a portion of a stand is designated as a recruitment cluster, the portion selected will be delineated on the compartment map and given a separate stand number. The oldest available stands containing a minimum pine basal area (BA) of 4.7 m^2 (50 ft^2) will be selected for recruitment clusters, with first priority being within 4.8 km (3 miles) of active clusters. Younger pine stands containing scattered relict longleaf or loblolly pine will also be considered as suitable recruitment areas if older stands are not available. The priority for selection will be (1) longleaf pine stands, (2) loblolly pine stands containing longleaf pine, (3) loblolly pine stands, and (4) slash pine stands containing sufficient longleaf pine. Recruitment clusters will be located no closer than 0.4 km (0.25 mile) from active clusters, inactive clusters serving as recruitment clusters, and other recruitment clusters. The number of recruitment clusters created annually will be based on an anticipated 10% growth in the number of existing groups.

Replacement stands will be selected for all active clusters. They will be located as close as possible and no more than 0.8 km from the cluster. Replacement stands will be at least 4 ha in size and preferably 20 to 30 years younger than the nearby cavity trees. Replacement stands will serve to replace existing cluster sites as clusters age and become unsuitable for RCW nesting.

6.1.b *Supplemental RCW HMA*

In the Supplemental RCW HMA supplemental recruitment clusters (SRC) will be established on a compartmental basis at a density of 1 cluster per 121 ha (1 per 300 acres) in all suitable habitat. SRCs will be approximately 4 ha (10 acres) in size. SRCs will be located 0.4 to 0.8 km from active and inactive SRCs, with their initial spatial arrangement in close proximity to the boundary between the RCW HMA and Supplemental RCW HMA. Selection of SRCs will be the same as discussed for recruitment clusters in the RCW HMA. An average of 1 to 3 SRCs will be established annually.

Replacement stands will be selected for all active clusters as discussed above.

6.2 Midstory Removal and Control

Mid-story tree/shrub removal and control will occur over the entire stand and in all active clusters, recruitment clusters and replacement stands. Mid-story hardwoods >2.5 cm (>1 inch) in diameter at the base will be killed, and possibly removed in accordance with maintaining proper fuel loading conditions. All hardwood mid-story trees within a 15-m (50 feet) radius of active and inactive cavity trees will be removed. Mid-story pine will also be controlled to remove physical barriers to cavity trees, potential cavity trees, and the line-of-sight between them. All slash will be removed from within 15 m (50 feet) of cavity trees. An average of 7.5 selected mid-story hardwoods per ha (3 per acre) may be retained throughout the remainder of the stand. No hardwood control will occur in hardwood "stringers" and riparian areas. No more than 12 within-canopy hardwoods per ha (5 per acre) will be retained in active clusters, recruitment clusters or replacement stands. Of these, none will be within 15 m of an active or inactive cavity tree, unless a cluster is naturally established in close proximity to a hardwood inclusion or stream. Priority for removal and control treatments will be (1) active clusters, (2) inactive clusters serving as recruitment clusters, (3) new recruitment clusters, and (4) inactive clusters.

6.3 Thinning

Over-story pine will be thinned to improve RCW nesting habitat. Clusters will be thinned to maintain an over-story pine BA of at least 4.7 m^2/ha (50 ft^2/acre). No more than 1.0 m^2 (10 ft^2) of the total over-story BA will be in hardwood species. The order of priority for retaining pine trees will be (1) relict trees, (2) potential cavity trees, (3) trees ≥25.4 cm (≥10 inches) in diameter at breast height (DBH) that are not potential cavity trees, and (4) trees <25.4 cm DBH. Longleaf pine will be the favored species for retention. All snags (pine and hardwood) will be left standing unless they obstruct a cavity tree entrance or pose a safety risk. Extensive use of RCW cavities by other vertebrates is well documented (Jackson 1978, Harlow and Lennartz 1983, Loeb 1993, Kappes and Harris 1995) and suggests that the availability of suitable cavities (in snags and RCW cavities) may be limited and represent an important component of the habitat. Replacement stands >40 years of age will be thinned following the aforementioned guidelines for clusters; thinning in replacement stands <40 years of age will follow guidelines for foraging habitat (see Chapter 7). In high-risk stands, stumps of felled trees will be treated as needed to prevent or control *annosum* root disease.

6.4 Artificial Cavities

Active clusters will be supplemented with artificial cavities if the number of existing cavities will not support the number of RCWs in the cluster or anticipated recruitment of juveniles into the cluster. All active clusters will contain at least 4 suitable cavities. Recruitment clusters will be provisioned with 4 artificial cavities, at least 2 of which will be ≥6.1 m (20 feet) at cavity height. Inactive clusters that are serving as recruitment clusters will be supplemented with artificial cavities to raise the number of suitable cavities to a minimum of 4. All cavity trees will be monitored at least annually and needed maintenance will be performed.

6.5 Cavity Restrictors

Cavity restrictors are metal plates placed around cavity entrances to prevent other woodpeckers and mammals from enlarging them. Cavity restrictors, either partial (Carter et al. 1989) or full, will be installed on artificial cavities, and as required on natural cavities. Restrictors will not be installed on cavities which have been enlarged internally to the point of being unsuitable for RCWs. Restrictors placed on active cavities will be initially monitored for RCW acceptance and to prevent RCW injury or death. Continued annual monitoring of all restrictors will be necessary to insure their proper placement and maintenance.

6.6 Predator and Cavity Competitor Control

Availability of suitable RCW cavities (natural and artificial) on the SRS has been limited by destruction and occupation by other species. Red-headed (*Melanerpes erythrocephalus*) and pileated (*Dryocopus pileatus*) woodpeckers are believed to have enlarged natural cavities in the original 21 clusters, and remain a problem in recruitment clusters. Cavity restrictors have been effective in reducing woodpecker damage, but have not prevented occupancy by red-bellied woodpeckers (*Melanerpes carolinus*) and flying squirrels (*Glaucomys volans*). Because of their preference for non-enlarged RCW cavities (Loeb 1993) and their prevalence on the SRS, flying squirrels were perceived in 1985 to be an immediate threat to population stability and growth. Between 1986 and 1996, an average of 209 (range 62-731) flying squirrels were annually removed from RCW clusters and recruitment clusters (Franzreb 1997b). Nest failure on the SRS between 1989 and 1995, attributed to all causes, including flying squirrels, averaged 12% [range 0-20%] (Edwards and Stevens, unpubl. data). In other RCW populations where flying squirrels were not removed, nest failure averaged 27% (LaBranche 1988 in North Carolina) and 18% (E. Stevens, unpubl. data from Georgia). It may be hypothesized that decreased flying squirrel-RCW interactions in nesting cavities during the breeding season may have improved nesting success on the SRS. Laves (1996) provided experimental evidence to show that removal of flying squirrels from RCW clusters during 2 breeding seasons significantly increased reproductive success. Laves (1996) hypothesized that the high numbers of flying squirrels in RCW clusters resulted in the birds spending more time and energy defending the nest cavity and their roost cavities, and therefore, had less time to invest in reproduction. It may be further speculated that year-round flying squirrel removal increased the availability of suitable cavities on the SRS, and thus improved adult and fledgling survival, and increased the likelihood of successful colonization of recruitment clusters. However, although flying squirrels are known to commonly use RCW cavities, their long-term effect on RCW nest success and population growth is uncertain (Loeb 1993, Conner 1996, Laves 1996).

Current flying squirrel control in RCW clusters on the SRS is labor intensive, expensive, and subject to negative public opinion. For these reasons, a non-lethal and efficient control alternative is desired. In a 12-month test of the effectiveness of flying squirrel excluder devices [SQED] (Montague 1995) to deter flying squirrel use of inactive, artificial RCW cavities, Loeb (1996) found only 1 occupied cavity in 442 cavity inspections (Appendix F). Although SQEDs were successful in excluding flying squirrels from inactive cavities, their effect on RCWs in active clusters is undetermined. Currently, active cavity trees in several clusters on the SRS have been equipped with SQEDs, and the behavioral response of resident RCWs is being monitored (LeMaster 1996). Preliminary results indicate no negative impact, and if this trend continues, SQEDs will be employed sitewide. This widespread use of SQEDs on the SRS will provide an efficient and economical means of minimizing cavity occupation by flying squirrels. During this test period a short-term study will also be conducted to determine the effect that the presence of SQEDs has on group reproduction (E. LeMaster, pers. comm.).

Under the previous SRS RCW Management Plan, all active and inactive RCW cavities were inspected monthly. Based on monthly use patterns of RCW cavities by flying squirrels (Fig. 14), this inspection schedule will be reduced to a minimum of 6 inspections per year, concentrated during the breeding season and dispersal period (Jan, Mar, Apr, May, Jul, Sep, Nov) in active clusters and every 2 months in inactive and recruitment clusters. If the SQED program proves successful, future climbing to remove flying squirrels will be discontinued, and only semiannual inspections will be needed for monitoring and maintenance.

6.7 Monumentation and Monitoring

Boundaries of active and inactive clusters and recruitment clusters will be maintained with flagging or reflective material on an annual basis. Cavity trees will be painted with a single band, white for natural cavities and yellow for artificial ones, and tagged with an identification number. Active, inactive, and recruitment clusters will be surveyed at least annually to obtain the following information:

1) Cavity tree status (active/inactive, alive/dead)
2) Number of usable cavities (determination of condition requires that the trees be climbed)
3) Cavity condition and need for repair or replacement
4) Are artificial cavities needed?
5) Are restrictors needed?
6) Is prescribed burning needed to control midstory?
7) Is mechanical or chemical control needed to control midstory?
8) Is the cluster at risk from pine beetle attack and requires thinning?
9) Are adjacent stands at risk from pine beetle attack and require thinning?

The number of groups (paired male and female) present will also be determined annually during the early part of the breeding season, usually in April and May. All monitoring data will be entered into a database, analyzed, and reported annually. This information will serve as the basis for determining RCW management needs and annual programs of work.

6.8 Cluster Status

On the basis of annual inspection, each cluster will be assigned to 1 of 6 status categories (U. S. Forest Service 1995), and this information will be used to update the CISC database:

1) Active - a cluster that is occupied by RCW in a given survey year. A cluster is determined to be active when there are nesting or roosting red-cockaded woodpeckers present, or when one or more cavity trees exhibit fresh pitch wells and clear resin flow, reddish under-bark

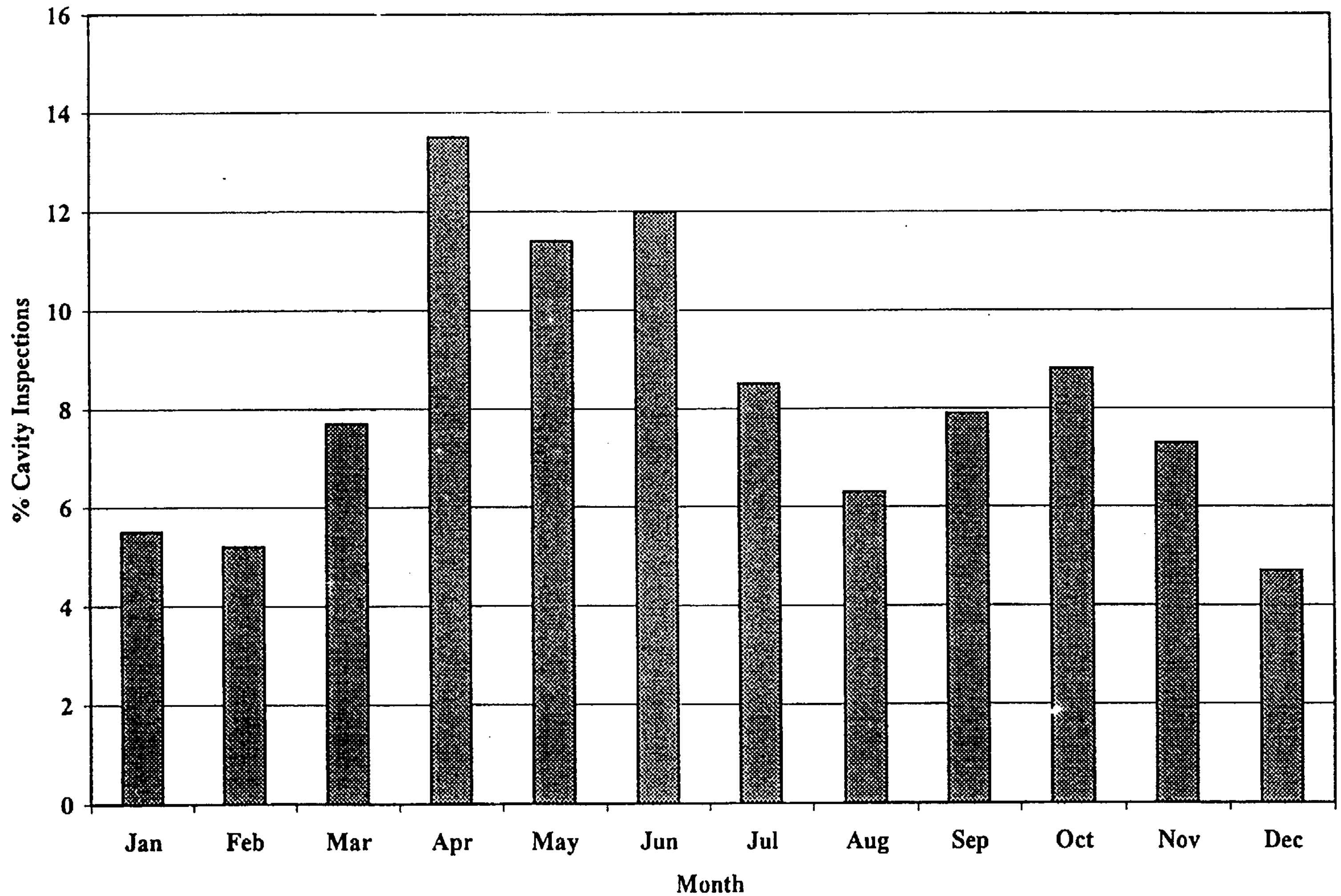

Figure 14. Percent of monthly inspections of natural and artificial RCW cavities that contained 1 or more flying squirrels, 1986-1994 on the SRS (Source Lotter 1997).

appearance and/or fresh chipping is present at the cavity entrance or plate. This determination is generally made at the end of the breeding season.

2) Inactive - a cluster is determined to be inactive when there are no red-cockaded woodpeckers present and when none of the cavity trees exhibit active resin wells or other signs (see number 1 above). Inactive status is warranted and determined when a specific cluster is unoccupied in a given year. Clusters classified as inactive should have cavities suitable for use by RCW. Inactive clusters with <4 suitable cavities will be supplemented with artificial cavities. These sites will receive high priority for management because recently inactive clusters have a higher rate of reoccupation than abandoned clusters (Doerr et al. 1989).

3) Abandoned - a cluster which has not been used by RCW for an extended period of time. A 10-year period of inactivity is necessary to declare a cluster abandoned. Abandoned clusters should not be managed as clusters unless identified as a replacement stand or recruitment cluster.

4) Historic - a cluster in which the cavity trees no longer exist. This classification includes destroyed clusters, once the cavity trees are gone. These clusters are known only from historic records. If not suitable as, or identified as, a potential replacement or recruitment stand, they are not managed as a cluster.

5) Destroyed - a RCW cluster in which the cavities have been made unusable by enlargement or rot, or the cavity trees have died. A cluster will not be declared destroyed until a follow-up survey during a subsequent nesting season is completed to confirm the lack of new cavity trees within 402 m (0.25 miles) of the cluster. Artificial cavities may be utilized to reestablish the cluster if birds are present. A destroyed cluster is not otherwise managed as a cluster, unless it is identified as a replacement stand or recruitment cluster.

6) Invalid - a stand misidentified as a red-cockaded woodpecker cluster. It has been found that in older survey information, trees with pileated woodpecker feeding holes or sapsucker (*Sphyrapicus varius*) feeding holes were occasionally misidentified as RCW cavity trees. If such a misidentification is confirmed by a biologist, the cluster is deleted from the cluster inventory and not managed as a cluster. A cluster will not be declared invalid until a follow-up survey is completed to confirm the lack of new cavity trees within 305 m (1,000 feet) of the cluster.

6.9 Heavy Equipment and Concentrated Human Use

The use of heavy equipment (e.g., logging decks) and concentrated human use (e.g., pine-straw baling) will not be permitted in active clusters except to benefit RCWs, and then only outside of the nesting season; such activities in recruitment clusters and replacement stands will be minimized to protect RCW habitat.

6.10 Nesting Season Disturbance

Potentially disturbing activities within an active cluster will be scheduled before or after the nesting season. Habitat improvement activities will also be conducted outside of the nesting season, unless such activities are necessary for the continued survival of the RCW group. An exception to these limitations is the use of prescribed burning, which can be conducted year round.

6.11 Southern Pine Beetle (SPB) Suppression and Control

Treatment control of SPB infestations will follow the SPB Record of Decision (U. S. Forest Service 1987) in an attempt to minimize the impact of SPBs on active and recruitment clusters, replacement stands, and foraging habitat. Standards and guidelines set by the SPB Record of Decision include:

1) Cutting of trees vacated by SPB is prohibited unless they pose a safety threat.
2) Cutting of infested, inactive or relict cavity trees is allowed within a designated treatment buffer zone only to protect the rest of the cluster.
3) Cutting of uninfested trees within 61 m (200 feet) of a cavity tree is allowed only to protect cavity trees.
4) No cut-and-remove operations will be conducted during the RCW nesting season.
5) Minimal disturbance, such as cutting or chemical treatments, will be allowed during the nesting season, if necessary to protect cavity trees.
6) No pile-and-burn control techniques will be used within clusters.
7) All decisions to cut pines in nesting habitat will be coordinated with and approved by a wildlife biologist.

6.12 Prescribed Burning

The open, park-like structure of pine forests preferred by RCWs was historically maintained by frequent, naturally occurring fires (Frost 1993). These fires primarily occurred during the growing season (spring and summer), although some did occur at other times of the year under favorable conditions (Streng et al. 1993). The open midstory conditions that are created as a result of fire are important to RCW use of clusters (Lennartz et al. 1983, Conner and Rudolph 1989, Loeb et al. 1992), and encroachment of dense hardwood midstory in active clusters may cause cluster abandonment (Beckett 1971, Van Balen and Doerr 1978, Lennartz et al. 1983).

In RCW clusters, prescribed fire is the most natural and cost effective method of controlling mid-story vegetation. Frequent (≤4 years) fires during the growing season have been shown most effective in hardwood control (Waldrop et al. 1992, review by Streng et al. 1993). However, both longleaf and loblolly pine are susceptible to fire damage (e.g., crown scorch and root damage). During prescribed burning in RCW clusters, appropriate guidelines should be followed to minimize the risk of tree damage and mortality: crown scorch of <33% for loblolly pine and <50% for longleaf pine (T. Waldrop, pers. comm.; Komarek 1974, Waldrop and Van Lear 1984). In a critical review of the fire literature, Streng et al. (1993) found little evidence to suggest that burning season had any consistent effect on southern pine (longleaf, loblolly, slash) growth or mortality. Moreover, fall defoliation, which could result during early winter burns, may be more harmful to southern pines than defoliation in other seasons (Weise et al. 1989).

In the absence of fire, mechanical and chemical alternatives can be applied to control midstory, but not with the effectiveness or overall benefits of fire (RCW Summit 1990). For example, growing season fires promote the development of a grass/herbaceous ground cover that has a negative effect on the spread of *annosum* root disease (Tainter and Baker 1996), a common pathogen on the SRS (F. Tainter, pers. comm.).

The following guidelines will be used when prescribing and conducting burning in RCW nesting habitat on the SRS:

1) Prescribed burning will be conducted at least once every 4 years in active RCW clusters in the RCW HMA and Supplemental RCW HMA.

2) Growing-season fires will be emphasized in longleaf pine habitats. However, habitat goals may require burning whenever conditions permit. After midstory is controlled and the native herbaceous vegetation is re-established, a combination of growing-season and non-growing-season fires may be used to prevent and control mid-story encroachment, especially in clusters where loblolly pine is dominant.

3) Prescribed burning in replacement stands, and active and recruitment clusters will receive priority over foraging habitat.

4) Burning prescriptions and cycles will minimize the risk to cavity trees. Cavity trees will be protected by raking away or back burning adjacent fuels, use of fire retardants, etc.

5) Natural or artificial firebreaks (e.g., streams, roads) will be used when reasonable to minimize the need for plowed contol lines, to reduce potential for disturbances of the hydrology of certain wetlands, or the disturbance of existing plant communities. When needed, excavated fire control lines (e.g., disc, dozer blade) will be kept >61 m (200 feet) from cavity trees unless an emergency or site specific circumstance, such as location of property boundary, dictate the need to locate them closer. If conditions dictate that control lines be placed within 61 m of cavity trees, a light disc (preferred) or dozer blade will be used in place of a fire plow to lightly scrape away fuels, or "wetlines" and/or chemical retardents may be employed.

6) If habitat conditions or constraints preclude the use of prescribed fire, mechanical or herbicide treatments will be used as alternatives for control of mid-story and under-story vegetation. However, fire will be the primary method used in the RCW HMA.

7) Based on current research at SRS and observations at other locations, root damage resulting from the use of prescribed fire in areas where fuel accumulation is high may cause significant tree mortality. Mortality is often delayed a year. Following a mechanical removal of the midstory, a dormant season burn will proceed any summer burn. In addition, each stand will be analyzed, and burning schedule and technique will be modified to fit fuel load and existing conditions.

7.0 FORAGING HABITAT MANAGEMENT

The following discussion of foraging habitat management practices pertains to the RCW HMA and Supplemental RCW HMA. Unless otherwise stated, management practice guidelines are the same for both areas. No RCW management practices will be conducted in the Other-use Area.

7.1 Background

7.1.a *Foraging Ecology*

RCWs forage primarily in pine dominated habitats (Hooper and Lennartz 1981, U. S. Fish and Wildlife Service 1985, Porter and Labisky 1986), and tend to prefer longleaf pine over other southern pines such as slash pine (Hovis and Labisky 1985). Within forested stands, RCWs forage on the tallest and largest diameter stems (Hooper and Lennartz 1981, DeLotelle et al. 1983, Porter and Labisky 1986, Engstrom and Sanders 1997). Quality of foraging habitat is believed to increase in older stands (i.e., >30 years of age) and where larger (>25 cm or 10 inches) diameter stems are available (Hooper and Lennartz 1981, U. S. Fish and Wildlife Service 1985, Walters 1990, Epting et al. 1995), although the selection of stands with larger pine stems may be correlated with cavity tree selection (Hooper and Harlow 1986). Hardesty et al. (1997) found that RCWs foraged on smaller (15-20 cm or 6-8 inches; 20-25 cm or 8-10 inches) diameter longleaf pine trees significantly less than were available. Hooper and Harlow (1986) concluded that RCW use of forested pine stands 30-115 years old was independent of stand age. In contrast, Hardesty et al. (1997) found that RCWs foraged on longleaf pine trees <50 years old significantly less than were available and on trees >150 years old significantly more than available. Hooper and Harlow (1986) also found that the number of pines greater than either 36 or 48 cm DBH did not influence RCW selection of pine stands for foraging any more than the number of pines 24-35 cm DBH. In contrast, Engstrom and Sanders (1997) found RCWs to forage on larger pines (30-90 cm in 10-cm size classes) significantly more than expected on the basis of availability. They concluded that large and old pine trees are used preferentially by RCWs and should be retained throughout forage habitat. Similarly, Hardesty et al. (1997) concluded that the availability of larger and older pine trees, and perhaps groups of trees, was an important indicator of RCW foraging and nesting habitat quality. RCW foraging area (i.e., home range) varies indirectly with the quality of habitat available (Hooper et al. 1980, Hooper et al. 1982, Porter and Labisky 1986, DeLotelle et al. 1987, Epting et al. 1995).

7.1.b *Federal Guidelines*

Current RCW forage requirements for federal lands are specified in the *Federal RCW Recovery Plan* (U. S. Fish and Wildlife Service 1985) and the *Guidelines for Preparation of Biological Assessments and Evaluations for the RCW*, also known as the "Bluebook" (Henry 1989). According to these guidelines (hereafter referred to as Bluebook), 51 ha (125 acres) of foraging habitat per RCW group is recommended to ensure recovery of RCW populations where other ecological criteria are also met. The cluster area is considered part of foraging habitat.

Moreover, for each active and recruitment cluster, the following habitat conditions are also required:

1) Forage habitat must be within 800 m (0.5 miles) of the geometric center of the cluster.
2) Forage habitat includes only pine and pine-hardwood stands.
3) At least 789 m^2 (8,490 ft^2) of forage basal area must be in pine stems ≥12.7 cm DBH (5 inches).
4) Forage habitat contains at least 6,350 pine stems ≥25.4 cm (10 inches) DBH or larger and 30 years old or older.
5) Forage habitat must be continuous and contiguous with the cluster. The Bluebook defines contiguous as having no separation in forage habitat >100 m (330 feet).

These foraging requirements were based on research on the Francis Marion National Forest in South Carolina (U. S. Fish and Wildlife Service 1985). The requirement for 6,350 stems ≥25.4 cm (10 inch) DBH was based on RCW reproductive output increasing as the number of available pine stems increased to 6,350. This standard was adopted for federal lands to enhance recovery of RCW populations. It was not intended to represent the minimum amount of foraging habitat necessary for reproduction and long-term site occupancy (Hooper and Lennartz 1995).

Research conducted following the Bluebook guidelines (DeLotelle and Epting 1992, Hooper and Lennartz 1995, Beyer et al. 1996, James et al. 1997) provided evidence to suggest that these foraging requirements may be conservative, and that adherence to these guidelines may, under some circumstances, limit management activities that would otherwise benefit RCWs, other resources, or ecosystem restoration. These studies found that reproductive success of RCW groups was not strongly related to variation in available foraging habitat. Hooper and Lennartz (1995) concluded that under the following circumstances RCW populations may benefit by having foraging habitat reduced below Bluebook guidelines:

1) Recovery areas where the risk from hurricanes, or other catastrophic events makes it especially desirable to have forested stands distributed temporally and spatially across the landscape as soon as practical.
2) Thinning of pine stands to reduce SPB hazard.
3) Removal of trees infested with SPBs in order to avoid a major epidemic.
4) Conversion of off-site pine species to longleaf pine.

Moreover, Beyer et al. (1996) suggested that the quantity of foraging habitat provided to individual RCW groups in larger populations could be reduced below Bluebook guidelines without adversely affecting group size or reproductive success. Engstrom and Sanders (1997), however, argued that Bluebook guidelines were developed on the basis of research conducted in forests that had significantly modified tree species composition, age structure, and landscape arrangement, and therefore, may not be optimum (i.e., preferred habitat conditions may not be present for RCWs to select from). Their research on RCW foraging in an old-growth longleaf pine forest found that it provided excellent habitat for RCWs. Further research is necessary to determine which old-growth characteristics are important and should be maintained or mimicked in forests managed for RCW (Lennartz and Lancia 1989, Engstrom and Sanders 1997).

In response to the above and other recent evaluations of Bluebook guidelines, the U. S. Fish and Wildlife Service has allowed forage requirements to be reduced by 33% (i.e., 4,200 stems >25 cm or 10 inch DBH) for the following ecological reasons:

1) for off-site conversion of pine species,
2) where pine stocking is >23 m^2/ha or 100 ft^2/acre,
3) for SPB control and prevention,
4) to establish new recruitment clusters, and
5) in general, for ecological restoration.

Further deviations from Bluebook guidelines on federal properties can only be granted by the U. S. Fish and Wildlife Service and on the basis of site-specific forage data that has been peer reviewed and accepted for publication (R. Costa, pers. comm.).

7.1.c *Fragmentation and Isolation*

Spatial distribution of foraging habitat is important to RCW cluster status (Thomlinson 1995) and population stability (Rudolph and Conner 1994). Several studies have examined the relationship between forest habitat loss and RCW population parameters. Conner and Rudolph (1991) examined the relationships between RCW group size and measures of forest habitat loss and fragmentation in 3 National Forests in Texas. They defined forest habitat loss as the percent of forested habitat removed within 400 m (0.25 miles) and 800 m (0.5 miles), respectively; fragmentation was defined as the sum of angular measures of non-mature forest habitat as viewed from the cluster center out to 800 m. These populations were small, had relatively isolated groups, and occupied a range of nonfragmented to highly fragmented habitats. Conner and Rudolph (1991) found:

1) As measures of forest fragmentation and habitat loss increased, group size in small populations decreased. Also, number of harvest units within 400 m, angular sum of harvest units within 800m, and percentage of nonforest area within 400 m and 800 m were significantly higher in habitat around RCW clusters occupied by small groups than around clusters occupied by large groups.
2) Number of RCWs per group decreased significantly as the amount of fragmentation and foraging habitat loss within 400 m and 800 m of active clusters increased.
3) Analyses of small and large populations indicated that isolation (number of active clusters within 2 km or 1.2 miles of each cluster) and percentage of forest removal within 800 m were significantly higher around inactive clusters than active clusters. The effect of single versus multiple forest openings was not determined, however.
4) Forest habitat loss had little or no relationship with group size in dense populations, which suggested that small populations were more vulnerable to forest removal than larger, dense populations. The population threshold at which forest habitat loss had significant effect was not determined, however.

In other studies of habitat loss, Wood et al. (1985) and Hooper and Lennartz (1995) also found that population parameters (e.g., number of nestlings, group size) did not differ significantly before and after removal of foraging habitat. Hooper and Lennartz (1995) suggested that RCWs are not sensitive to loss of foraging habitat (to a point), except at low population densities, and that low population density may be a major factor inhibiting expansion of some small populations. Rudolph and Conner (1994) further examined the relationship between RCW population parameters and forest fragmentation at an intermediate scale. They found significant positive correlations of population measures and area of forest greater than 60 years of age, and concluded that RCW population density was greater in areas with more mature forests. They concluded that these findings support their earlier dispersal-efficiency hypothesis and argued the following:

> We have argued elsewhere (Conner and Rudolph 1991) that reduced dispersal efficiency rather than loss of foraging habitat is the primary cause of the relationship between forest fragmentation and RCW population parameters in small populations with isolated clusters. The persistence of a similar relationship at an intermediate scale supports this interpretation. The habitat occupied by this population is a mosaic of mature forest habitat and non-forest or young pine plantation habitats. The relative proportions of these habitats and their distributions result in a landscape consisting of a mature forest matrix highly fragmented by islands of unsuitable RCW habitat. The suitable habitat is not fragmented in the sense of complete isolation between patches. Broad connections and corridors typically remain between most areas of suitable habitat. It is difficult in such situations to differentiate between effects due to habitat loss and those due to habitat fragmentation.
>
> We hypothesize that the levels of fragmentation observed may be sufficient to reduce the efficiency with which dispersing juvenile females locate groups lacking females (Walters et al. 1988). The result is a population with an increased proportion of groups failing to breed in a given year due to absence of potentially breeding females. The observed result is a reduction in average group size due to absence of breeding females and lost reproductive potential correlated with the level of habitat fragmentation.

Further, Engstrom and Mikusinski (1998) found that the number of active clusters surrounding each active cluster, termed neighborhood, was significantly greater than in the neighborhood around inactive clusters. In contrast to isolated clusters, they suggested that in dense populations any opening created by the death of a breeder is filled by one of a high number of potential colonists from surrounding groups. Thomlinson (1995, 1996) also determined that isolated clusters had a higher incidence of abandonment. Letcher et al. (1998) provided further evidence for the importance of habitat fragmentation and group isolation in RCW management. They used a spatially-explicit simulation model to show how spatial distribution and number of territories (cluster and associated foraging habitat) affected population dynamics. They found that populations were stable (i.e., self sustaining) when territories were highly aggregated, even with as few as 25 territories; when territories were highly dispersed, more than 169 territories were required to achieve stability.

7.2 SRS RCW Forage Research

7.2.a *Forage Habitat*

Nix and McKee (1997) examined aerial photographs of habitat surrounding RCW groups at the SRS ($n = 20$) to estimate the quantity of forage within 800 m (0.5 mile) of each cluster.

The number of pine stems ≥24.4 cm (9.6 inches) DBH available within 800 m of each cluster averaged 8,123 (range 3,193-11,984). Sixteen groups (80%) had forage habitat estimates above the 6,350 stems required by the Bluebook. However, this analysis did not account for overlap among groups (see Bluebook for procedure; Lipscomb and Williams 1996); in 17 of 20 groups, the 800-m radii overlapped with 1 or more other groups.

A more intensive examination of foraging within home-range areas of 7 groups of RCWs on the SRS is near completion (K. Franzreb, unpublished data). Preliminary results suggest proportional use of 20-25 cm (8-10 inch) DBH pines and greater than expected use of 30+ year old pines, based on availability (K. Franzreb, pers. comm.). In addition, more rigorous analyses of the relation between forage availability and reproduction are planned to develop site specific forage guidelines for the SRS. Based on currently available information, RCW reproductive output among groups on the SRS remains high (2.3 fledges per successful nest during 1985-1996; Franzreb 1997) and the population appears to be in good health.

7.2.b *Prey Availability*

RCWs spend the majority of their foraging time searching for arthropods on the boles and branches of live pine trees (Ligon 1968, Skorupa 1979, Hooper and Lennartz 1981, Porter and Labisky 1986). Whereas considerable research has been conducted to determine diameter and age of pine stems selected by foraging RCWs, little is known of how availability of prey is affected by these factors. Currently, only 2 studies have addressed this question. Hooper (1996) examined arthropod presence on longleaf pine (22-127 years old) in winter and found arthropod biomass per m^2 declined with increasing age on the lower, mid- and upper bole; increased with tree age on dead limbs; and increased with tree age on live limbs until 80 years, when it declined with increasing age. He found total arthropod biomass for the whole tree increased with tree age up to 86 years, when it declined with increasing tree age. Hanula and Franzreb (1997) provided a more extensive examination of prey availability in longleaf pine stands on the SRS. They hypothesized that the tree bole represents only a substrate on which RCWs forage and that prey availability was more likely dependent on other environmental factors (e.g., understory plants and structure) and only indirectly correlated with tree diameter and age. Their results showed that in 50-70 year-old longleaf pine stands a large portion of the arthropod community on the bark is crawling up the tree from the forest floor or flying from detritus or living vegetation (i.e., not permanent residents on the bark). On the basis of these findings, they suggested that an alternative strategy may be to manage for arthropod habitat (e.g., snags and coarse-woody debris) in the understory or on the forest floor then to simply provide bark surface area in the form of >25 cm (10 inch) DBH trees.

Hanula also investigated the relationship of stand age and prey biomass in 20 to 90 year-old longleaf pine stands on the Escambia Experimental Forest in Alabama. Preliminary results showed that once stands reach 40-50 years of age there is little difference in insect biomass between them and older-aged stands (Hanula, unpublished data). James et al. (1997) working on the Apalachicola National Forest in Florida found that RCW productivity was highly positively correlated with open, park-like stands and especially, increasing herbaceous cover. They hypothesized that RCW productivity may instead be nutritionally regulated by the effect of fire frequency on nutrient flow through plants and into arthropod populations.

RCWs on the SRS feed on a variety of prey, especially wood roaches, ants, centipedes, and spiders (Hanula and Franzreb 1995). On the SRS, wood roaches and centipedes are most abundant on dead trees (Hanula, unpublished data), and therefore, practices such as frequent thinning or salvage to minimize wood volume loss may be detrimental to RCW prey availability and also reduce snag habitat for other cavity dwellers.

7.3 Foraging Habitat Management on the SRS

7.3.a *Forage Requirements*

Foraging habitat will be designated for each active, inactive, and recruitment cluster. Foraging habitat will be provided for all clusters in the RCW HMA as required by the Bluebook (see Section 7.1.b). Deviation from these forage habitat requirements is possible on a cluster-by-cluster basis at SRS for RCW population enhancement and ecological restoration as discussed in Section 7.1.b. Sitewide deviations from Bluebook guidelines can only be granted by the U. S. Fish and Wildlife Service on the basis of significant, site-specific foraging data. Specific areas for foraging will not be permanently designated. Suitable forage habitat for each cluster and recruitment stand will be spatially apportioned on the basis of age class distributions, pine stocking levels, and RCW population density.

Bluebook requirements for forage availability represent only a target in the Supplemental RCW HMA, but the goal to meet is to ensure the success of supplemental recruitment clusters (SRCs). Each SRC will be surrounded by 117 ha (290 acres) of designated forage and potential habitat. Given a 50-year rotation and 10-year entry schedule, each of 5 age classes will contain approximately 24.3 ha (60 acres) (Fig 15). Hypothetically, each RCW group should have access to adequate (approximate to Bluebook guidelines) forage within the 48.6 ha (120 acres) contained in the 2 oldest (30+ years) age classes (Fig. 15).

7.3.b *Rotation Length*

Rotation lengths for longleaf and loblolly pine in the RCW HMA will be 120 and 100 years, respectively. An optional 80-year rotation length for loblolly pine will be allowed where the risk of SPB infestation is high or the site is not capable of sustaining this species as a stand to age 100 years. Pine species may be managed on a 50-year rotation length in the Supplemental RCW HMA, where industrial use and timber production will be emphasized (see Savannah River Forest Station Operations Plan).

7.3.c *Prescribed Burning*

The open, park-like structure of pine forests preferred by RCWs was historically maintained by frequent, naturally occurring fires (Frost 1993). These fires primarily occurred during the growing season (spring and summer), although some did occur at other times of the year under favorable conditions (Streng et al. 1993). Within the RCW HMA, prescribed burning will be conducted in pine stands 2-3 times during each 10-year planning period. Growing season burns will be emphasized in habitats that were naturally maintained by growing-season fires (i.e., longleaf pine habitats). However, habitat goals may require burning whenever conditions permit.

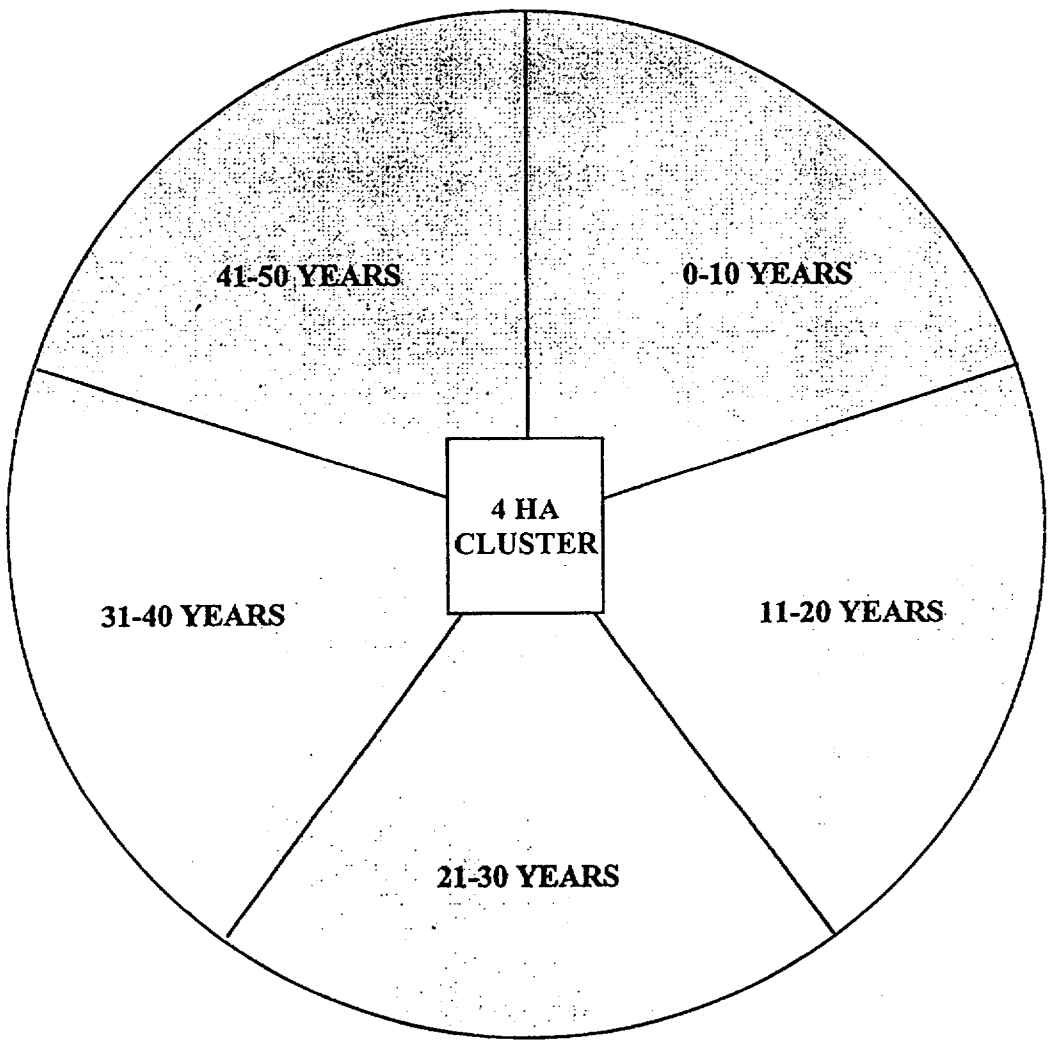

Figure 15. Hypothetical forage availability in supplemental recruitment clusters. Each age class represents 24.3 ha or 60 acres.

After midstory is controlled and native herbaceous vegetation is re-established, a combination of growing season and non-growing season fires may be used to prevent and control mid-story encroachment. The objective of prescribed fire will not be to eliminate hardwoods, but to reduce the midstory to enhance RCW forage habitat. In most cases, hardwood stands within the burn areas will not be plowed around; low-intensity fire within hardwood areas will be acceptable. Due to weather constraints on burning, any growing-season burns probably will be limited to early spring, late summer, or early fall. If constraints on prescribed burning result in the inability to manage the longleaf pine habitats, SRI may substitute mechanical and/or chemical treatments for fire, understanding that these methods are less effective and do not provide the overall benefits of fire (RCW Summit 1990). Natural or artificial fire control lines (e.g., streams, roads) will be used when reasonable to minimize the need for plowed control lines, thus reducing the potential for disturbances of the hydrology of certain wetlands, and the disturbance of existing plant communities. Prescribed burning in foraging stands within the Supplemental RCW HMA will be of lower priority than in the RCW HMA, but will still be conducted 1-2 times during each 10-year planning period.

Numerous legal, logistic, and environmental barriers to the use of fire exist on the SRS: state laws governing smoke management, public safety and liability issues, employee safety and health concerns, funding and personnel considerations, risk aversion, and public education about the value of and need for prescribed fire. Alternatives for overcoming these barriers on the SRS will be developed and analyzed (see U. S. Forest Service 1995 for a discussion). An intensive prescribed burning program, emphasizing growing-season fires where appropriate, is critical to the survival and recovery of the RCW on the SRS.

7.3.d *Southern Pine Beetle Suppression and Control*

Treatment control of SPB infestations will follow the SPB Record of Decision (U. S. Forest Service 1987) to minimize the impact of SPBs on foraging habitat. Standards and guidelines set by the SPB Record of Decision include:

1) Cutting of trees vacated by SPB is prohibited unless they pose a safety threat.
2) Cutting of uninfested trees within 61 m (200 feet) of a cavity tree is allowed only to protect cavity trees.
3) All decisions to cut pines in foraging habitat will be coordinated with and approved by a wildlife biologist.

7.3.e *Thinning*

RCW HMA.--Thinning will be used to improve RCW habitat and to reduce the threat of SPB infestations. Thinning will not reduce the foraging habitat below Bluebook guidelines within 800 m (0.5 miles) of active clusters and recruitment clusters within 2.4 km (1.5 miles) of an active cluster. Exceptions to the Bluebook guidelines will be based on long-term ecological considerations discussed in Section 7.1.b. In addition, sanitation and salvage cuts may reduce forage below Bluebook guidelines only if needed to prevent or control the potentially adverse effects of the spread of tree disease or insects. Stands will be thinned to a BA of 5.6 to 7.4 m^2 per ha (60-80 ft^2 per acre). The order of priority for retaining trees during thinnings will be (1) relict trees; (2) potential cavity trees; (3) trees >25.4 cm DBH (10 inches) that are not potential cavity trees; and (4) trees <25.4 cm DBH. Longleaf pine will be the favored species for retention. For recruitment clusters >2.4 km (1.5 miles) from an active cluster, foraging habitat can be reduced to 50% of the Bluebook requirements or a minimum of 3,175 pine stems ≥25.4 cm DBH and at least 30 years old, and a minimum of 976 m^2 (4,250 ft^2) of pine BA for purposes of ecological restoration discussed in Section 7.1.b. This forage habitat must be contiguous and continuous with the recruitment cluster. If a recruitment cluster beyond 2.4 km of an active cluster becomes active, Bluebook foraging requirements must be provided for that cluster and all recruitment clusters within 2.4 km of the new cluster.

Supplemental RCW HMA.--Thinning will be used to improve forested stand conditions, reduce the threat of SPB infestations, and improve RCW habitat. Because Bluebook requirements for forage represent only a target in the Supplemental RCW HMA, these requirements will be used only as a guide in deciding thinning operations which affect supplemental recruitment clusters. Normal thinning guidelines (5.5 to 7.4 m^2 per ha or 60-80 ft^2 per acre) will be followed as stated in the *Resource Management Operations Plan of the Savannah River Site* (Savannah River Forest Station 1993).

7.3.f *Regeneration*

Regeneration of pine types in the RCW HMA will be in accordance with the following guidelines:

1) Priority for regeneration will be the conversion of off-site pine species, primarily slash pine and off-site loblolly pine.
2) A priority will be to retain the oldest available longleaf and loblolly pine stands with regeneration coming from the dominant age classes.
3) The size of pine regeneration harvest cuts will range between 4 and 16.2 ha (10-40 acres) and average 10.1 ha (25 acres) in size over the habitat unit.
4) No regeneration harvest will reduce foraging habitat within 800 m (0.5 miles) of active clusters or in recruitment clusters within 2.4 km (1.5 miles) of active clusters to below Bluebook guidelines (see Section 7.1.b).
5) No regeneration harvest will result in the isolation of an active RCW cluster or fragmentation of its forage habitat. Specific criteria are not identified to control habitat fragmentation or cluster isolation. However, the harvest restrictions within 400 m (0.25 miles) of a cluster, the BA required in shelterwood cuts, the retention of relicts and inclusions in other regeneration areas, and the small regeneration harvest cut size (average 10.1 ha), are intended to minimize potential habitat fragmentation and reduce the amount of unsuitable habitat among active clusters.
6) All relict trees will be retained in regeneration harvest areas. Where relicts are limited, a minimum of 15 relict and/or potential RCW cavity trees (>43 cm or 17 inch DBH) per hectare (6 per acre) will be retained. All 0.4 ha and/or larger clumps of longleaf pine containing at least 3.7 m^2 per ha (40 ft^2 per acre) will be retained as inclusions where available.
7) No pine stands within 400 m (0.25 miles) of an active cluster will be regenerated by

clearcutting. This includes regeneration cutting to restore desirable species. Only thinning to enhance RCW habitat, shelterwood or seed tree harvests, or uneven-aged management will occur, if other applicable guidelines, including foraging habitat, are met. An exception would be the planting or seeding of stands destroyed by catastrophic events such as hurricanes, tornados, fire, etc.

8) The only use of clearcutting will be the conversion of off-site species, with particular emphasis being longleaf pine on longleaf sites currently occupied by another pine species.

9) In irregular-seedtree and irregular-shelterwood harvest cuts, 1.9-2.8 m^2 per ha (20-30 ft^2 per acre) of pine BA will be retained, inclusive of at least 15 longleaf pine trees/ha (longleaf pine reserve trees) where available. Longleaf pine reserve trees may be clumped or scattered throughout the stand and priorities for selection include: (1) relict trees, (2) potential cavity trees, and (3) other trees >25.4 cm DBH. If residuals are clumped, a minimum of 1 clump per 2 ha (5 acres) is required. Seedtree and shelterwood areas will be considered as foraging habitat. Residuals trees will not be harvested.

10) Tree disease problems that may have potentially adverse effects on RCW habitat will be addressed through informal consultation with the USFWS.

Forage habitat surrounding Supplemental RCW HMA clusters ~~will~~ can have regeneration harvests by even-aged management. Regeneration cuts will be between 4 and 32.4 ha (10-80 acres) and average 16.2 ha (40 acres). During regeneration, an attempt will be made to retain adequate forage and to avoid RCW cluster isolation or forage habitat fragmentation.

8.0 RESEARCH NEEDS

Much has been learned during the past 10-15 years from the research conducted on the RCW and its habitat. However, there are still some questions which need to be addressed so as to more effectively manage for this species and implement the intent of this management plan. A first step is to analyze the population dynamics of the SRS population. This would then be compared to population growth. Dispersal patterns and rates are of particular interest. Simply put, where do fledglings go once they leave their natal area? Artificial cavity sites should also be analyzed to determine what properties of individual cavity trees, surrounding habitat, and the surrounding landscape promote occupancy of sites through dispersal. Additionally, we need to be able to better predict population growth for the SRS population. Through the use of a spatially-explicit simulation model, we could determine how management activities such as recruitment cluster placement and translocations might contribute to population growth.

There is also ongoing research which when completed should prove useful in the management of the SRS RCW population. Tom Lloyd and others are currently working on, *A GIS Implemented Model Linking Red-cockaded Woodpecker Population Growth and Forest Dynamics Using Spatial Information about Forest Composition and Structure*. This model will allow us to spatially simulate harvesting activities and to dynamically evaluate impacts to the actual RCW habitat suitability around active clusters. In addition, completion to the examination of foraging components with RCW home-range areas (Franzreb, unpublished data) should provide much needed insight to the specific habitat requirements associated with foraging. Other ongoing research which needs to continue and should soon answer several questions include the mobile aviary project and flying squirrel excluder devices (SQEDs). Can the use of a mobile aviary increase the efficiency and cost effectiveness of translocating RCWs? We must also continue to examine nonlethal methods for controlling cavity competitors. With the continuation and completion of these ongoing RCW research projects, as well as the possible implementation of research that targets population dynamics and predictive models, the SRS should be able to effectively implement this management plan.

GLOSSARY

Active cluster: A cluster that is occupied by RCW in a given survey year. A cluster is determined to be active when there are nesting or roosting RCW present, or when one or more cavity trees exhibit fresh pitch wells and resin flow, reddish under-bark appearance and/or fresh chipping is present at the cavity entrance.

Basal area: Of a tree: the cross-sectional area of the trunk, including bark, at breast height, approximately 1.2 m or 4.5 feet above the ground. Of an hectare of forest: the sum of basal areas of individual trees.

Cavity tree: A tree that contains one or more RCW cavities or starts (natural or artificial), either active or inactive.

Clearcutting: An even-aged harvest/regeneration method that results in a new even-aged stand after one harvest entry.

Cluster: The aggregate of cavity trees used by one group of RCWs for nesting and roosting. This includes all the cavity trees (active and inactive) plus at least a 60-m zone around them. When this area is less than 4 ha (10 acres), additional area of the best nesting habitat contiguous to the cavity trees is delineated to establish a minimum 4-ha stand.

DBH: Abbreviation for tree stem diameter at breast height, approximately 1.4 m (4.5 ft) above the ground.

Demographic isolation: RCW groups that are separated by more than 8 km (5 miles) of suitable RCW habitat or 4.8 km (3 miles) of unsuitable habitat.

Even-aged stand: An aggregate of trees which are about the same age, usually within 10 years or 1/5 of the rotation of each other.

Forest: A plant community dominated by trees and other woody plants. From a forestry standpoint, a forest is a collection of stands administered as a unit, and may be composed of even-aged or uneven-aged stands or both.

Forest management: Applying forest ecology principles and practices and business techniques in the care of a forest so that it provides the products, services, and values desired by the owner. This may be very narrow, as in management solely for pulpwood, or very broad as in management to maximize environmental benefits.

Forestry: The science, art, and practice of managing and using trees, forests, and their associated resources for human and environmental benefit. Forestry is applied ecology.

Fragmentation: The process by which a natural landscape is broken up into small parcels, isolated from one another in a matrix of lands dominated by human activities.

Group: A social unit of one or more RCWs that inhabits a cluster (formerly called a clan). A group may include a solitary, territorial male; a mated pair; a pair with helpers; or a pair with both helpers and young.

Hardwood: An imprecise term describing broadleaf, usually deciduous, trees such as oaks, maples, elms, ashes, etc. The term does not necessarily refer to the hardness of the wood, and some hardwoods are evergreen.

Inactive cluster: A cluster is determined to be inactive when there are no RCW present and when none of the cavity trees exhibit active resin wells. Active resin wells are noted by recent pecking and clear, fresh resin flowing from the well, reddish under-bark appearance or fresh chipping or cavity entrance or plate.

Midstory: A strata of smaller trees that occur under the dominant overstory. The midstory can include small pines, but it is usually associated with hardwoods such as oaks and sweetgum.

Irregular seedtree: A method of cutting for regeneration very similar to the standard seedtree, except that the final removal cut may occur later in the rotation or not at all.

Irregular shelterwood: A method of cutting for regeneration very similar to the standard shelterwood, except that the final removal cut may occur later in the rotation or not at all.

Natural stand: A stand of trees resulting from natural seed fall or sprouting.

Off-site species: Trees that have been planted or become established (typically because of fire suppression) on a site that historically had other species present. Generally, off-site stands of slash and loblolly pine are on sites that historically supported longleaf pine.

Pine beetle: Any number of beetle species associated with pine beetle infestations which kill individual trees, stands, or major portions of forests. Of particular concern is the southern pine beetle (SPB) *(Dendroctonus frontalis).* Ips beetle *(Ips* spp.), and, to a much lesser extent, black turpentine beetle (*Dendroctonus terebrans*), are also potential problems.

Pine stand: A stand of trees in which 70% or more of the basal area of the dominant and codominant trees are pine species.

Pine-hardwood stand: A stand of trees in which 51-69% of the basal area of the dominant and codominant trees are pine species.

Prescribed burn: The controlled use of fire to achieve forest management objectives (e.g., wildlife habitat enhancement or hazard fuel reduction).

RCW recovery: RCW recovery will occur when there are 15 viable populations distributed throughout the major physiographic provinces and forest types where the bird formally occurred.

Recruitment cluster: A stand of trees at least 4 ha (10 acres) in size identified and managed as potential nesting habitat. The number required equals the population objective minus the number of active clusters. When possible, recruitment clusters should be located within 1.2 km (0.75 miles) from existing active clusters. Foraging habitat must be provided now or in the future around recruitment clusters. Recruitment clusters will contain at least 4 suitable cavities.

Replacement stand: Replacement stands will be selected for all active clusters. They will be located as close as possible and no more than 0.8 km from the cluster. Replacement stands will be at least 4 ha in size and preferably 20 to 30 years younger than nearby cavity trees. Replacement stands will serve to replace existing cluster sites as the cluster ages and becomes unsuitable for RCW nesting.

Regeneration: Young trees (seedlings and saplings) which will grow to become the older trees of the future forest (i.e., reproduction). Also, the process of forest replacement or renewal which may be done artificially by planting or seeding, or through natural seed fall or sprouting.

Regulation: The procedures whereby the stands in a forest are organized, harvested, and regenerated to eventually provide a more or less constant periodic flow of goods and services (sustained yield). The two main methods are (1) area control in which the areas occupied by stands are manipulated and (2) volume control in which the stand volumes are manipulated. Forests of even-aged stands can be regulated by both methods or a combination of the two. Uneven-aged stands and forests of uneven-aged stands are usually regulated by some variant of volume control.

Relict tree: On the SRS, a pine tree remaining from the original forests that were logged during the period prior to 1950. These trees are often more than 70 years old and exhibit characteristics of high quality RCW cavity trees.

Rotation: The number of years defined in a forest management plan necessary to grow an even-aged stand to a specified economic, biological, or socially determined condition (i.e., from the year of establishment to its final harvest).

Salvage cut: a cut made for the primary purpose of removing trees that have been or are in imminent danger of being killed or damaged by injurious agencies other than competition between trees.

Sanitation cut: a cut that involves the elimination of trees that have been attacked or appear in imminent danger of attack by dangerous insects and fungi in order to prevent these pests from spreading to other trees.

Seedtree: An even-aged regeneration method in which new trees become established from seed produced by trees retained from the previous stand.

Shelterwood: A method of regeneration by which an even-aged stand is created and maintained. At final harvest the parent stand is removed in two or more cuttings over several years so that new seedlings can become established beneath the cover (shelter) of the parent trees before their removal.

Silviculture: The art, science, and practice of establishing, tending, and reproducing forest stands having desired traits. It is based upon ecological principles.

Slash: Trees or shrubs, or their parts, which have been felled/cut and left on site (i.e., logging/thinning debris).

Stand: An aggregation of trees occupying a specific area and sufficiently uniform in species composition, age, arrangement, and condition so as to be distinguishable from the forest on adjoining areas.

Sustained yield: Management of forest land to produce a relatively constant flow of timber, other goods, services, or benefits in perpetuity.

Thinning: Intermediate cuts made in immature even-aged stands to reduce the number of residual stems per hectare and improve their growth and quality. Several types of thinning are recognized. One is low thinning and several degrees are commonly applied in which the lower crown classes (suppressed and intermediate, and sometimes codominant) are removed and dominants and codominants are left. In uneven-aged stands, all of the types of cuts commonly applied during the life of an even-aged stand may be applied in a given selection cut and this type of thinning is best termed "free" thinning.

Tree: A woody plant having a well-defined stem, a more of less definitely formed crown, and usually a total height of at least 3 m or 10 feet.

Uneven-aged stand: A stand containing more than two age classes of trees. Practically, age is not considered but if a plot of the number of trees by DBH class reveals a reverse J-shaped distribution, the stand is considered uneven aged. In contrast, a similar plotting for an even-aged stand will reveal a bell-shaped or normal distribution of age classes.

Unsuitable RCW habitat: Habitat that is either hardwoods, hardwood-pine, swamp, or pine forest type that has an established rotation of <30 years of age.

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APPENDICES

Appendix A:

The RCW: Notes on Life History and Management

General Report SA-GR 9

MARCH 1980

THE RED-COCKADED WOODPECKER: NOTES ON LIFE HISTORY AND MANAGEMENT

By

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INTRODUCTION

The red-cockaded woodpecker was once a common bird in the mature pine forests of the Southeast. It lived from east Texas to Florida and north to Missouri, Kentucky and Maryland. Today, its range and population have been reduced through loss of habitat.

Unlike other woodpeckers, the red-cockaded roosts in cavities in live southern pines. It needs older pine trees for its cavities, and extensive pine and pine-hardwood forests to meet its foraging requirements. Much of the South has been cleared for agriculture or other incompatible uses. Much of the remaining pine forests are not suitable for the red-cockaded. Each year, more areas become unsuitable. Because of the drastic loss and continued decline of habitat, the bird is considered in danger of extinction.

In 1970, the red-cockaded was declared an endangered species. It now has the same protection given the better-known bald eagle and whooping crane. But protection alone is not enough. On Federal and State lands, forestry practices are giving the bird a better chance for survival by creating a favorable habitat. Other landowners can take positive steps to enhance its survival, especially if the red-cockaded already lives on their land. This publication describes the needs of the red-cockaded and outlines steps to aid the bird.

DESCRIPTION

The red-cockaded is slightly larger than a bluebird, about 7¼ inches (18.3 cm) long (figure 1). The back and top of the head are black. Numerous, small white spots arranged in horizontal rows on the back give a ladder-back appearance. The cheek is white. The chest is dull white with small black spots on the side. Males and females look almost alike, except males have a small red streak above the cheek. The red streak is rarely seen and then only with a powerful binocular in bright sunlight. Juvenile males have a small red patch on the very top of the head until fall.

All other southern woodpeckers of similar size have one or more of the following characteristics: conspicuous red on the head, a prominent white vertical streak on the back, a prominent white patch on the wing, or brown feathers.

LIFE HISTORY

Social Organization. – Among woodpeckers, the red-cockaded has an advanced social system. These birds live in a group called a clan. The clan may have from two to nine birds, but there is never more than one breeding pair. Young birds frequently stay with their parents for several months. The other adults are usually males called helpers. Some clans have no helpers, but others have as many as three. The helpers are typically the sons of the breeding male and can be from 1 to 3 years old. Young birds hatched in the spring disappear from the clan throughout the year, but a male sometimes remains with the clan to become a helper. The helpers assist in incubating eggs, feeding young, making new cavities, and defending the clan's area from other red-cockaded woodpeckers. A breeding male may live for several years. When he dies, one of his helper sons may inherit the status of breeding male.

The Colony. – A clan nests and roosts in a group of cavity trees called a colony. The colony may have one or two cavity trees to more than 12, but it is used only by one clan (figure 2). Cavities are made in live pines. Typically, within any colony, some cavities are still under construction (figures 3-5), some are finished and in use (figures 6, 7), and some have been abandoned (figures 9-13). In most colonies, all the cavity trees are within a circle about 1,500 feet (457 m) wide. In some colonies, all the trees are within 300 feet (9 m), but in others they may be ½ mile (.8 km) apart.

*See page 6

Each clan member tries to have a cavity for roosting. Only one bird roosts in a cavity. Birds without cavities in live trees often roost in scars on pine trees, in crotches between limbs or in cavities in dead trees. Red-cockadeds with cavities defend them from other red-cockadeds and other animals. Only the red-cockaded typically makes cavities in live pines, but 11 other birds, 5 mammals, 2 reptiles, and bees are known to use the cavities. Some animals use the cavity after it is no longer suitable for the red-cockaded. But others compete vigorously with the red-cockaded for its cavity. Some of the major competitors are the bluebird, red-bellied woodpecker, red-headed woodpecker, pileated woodpecker, and flying squirrel.

Nesting Behavior. – The red-cockaded woodpecker nests between late April and July. Only the breeding male courts and mates with the female. The female usually lays two to four eggs in the breeding male's roost cavity. Clan members take turns incubating the eggs during the day, but the breeding male stays with the eggs at night. The eggs hatch in 10 to 12 days. Nestlings are fed by the breeding pair and helpers. Adults bring food to the nest from up to 700 yards (640 m) away. Young birds leave the nest in about 26 days. Adults continue to feed the young after they leave the nest, but less so as summer progresses.

Feeding Behavior. – The clan spends much of its time looking for food as it travels about its territory. Most of the searching is concentrated on the trunks and limbs of live pine trees. There the birds scale the bark and dig into dead limbs for spiders, ants, cockroaches, centipedes, and the eggs and larvae of various insects. Repeated feeding visits are sometimes made to lightning-struck pines that are infested with beetles. The birds also spend time on cypress and hardwoods. Near farmland, they will feed on corn earworms. On occasion, they will eat fruits such as blueberry, sweetbay magnolia, wild cherry, poison ivy, and wax myrtle. They drink water from flooded holes in trees and from the ground.

The Territory. – The clan defends year round a territory surrounding the colony. Territories range from less than 100 acres (40.5 ha) to more than 250 acres (101 ha). The total area used by a clan can be as large as 1,000 acres (404.7 ha). A clan tries to keep other red-cockaded woodpeckers out of its territory, but will frequently trespass on its neighbors' territories. Defense can be mild encounters between clans, but at times fighting erupts with two opposing birds grasping each other's beak and falling to the ground.

Cavity Construction. – The red-cockaded woodpecker is the only bird that makes nesting and roosting cavities in live southern pines. Most other woodpeckers select dead trees or dead parts of live trees to make their cavities. These other birds generally make new cavities each year and many do so in less than 2 weeks. The red-cockaded takes months and even years to excavate a cavity. Compared to dead wood, the sapwood and heartwood of the living pine is indeed tough. The abundant resin or pitch flow that occurs once the sapwood is penetrated creates another barrier. Seldom is a cavity completed in 1 year and most take several years of work. Generally, clans have several cavities under construction at the same time with some closer to completion than others. Many cavities that are started are never completed. Once completed, a cavity is used for several years.

The most intensive work on cavities occurs in summer after the young leave the nest. A bird may spend an hour or more excavating. Although work occurs any time during the day, most is in the morning. As fall progresses the birds spend less time working on cavities, and work essentially stops in winter. Spring sees a renewed interest in cavity construction. At this time, some clans show more interest than others and some defer cavity work altogether until the young leave the nest. Most cavities are between 20 and 50 feet (6.1 and 15.2 m) above ground. A few have been found over 60 feet (18 m) and some as low as 4 feet (1.2 m). Generally, the cavity is below any live limbs. It is common to find a tree with several cavities, but the birds may not use all the cavities at a given time.

Before a cavity is completed it is called a start hole (figures 3-5). A start hole progresses from a thumbnail size area where the bark has been removed, to a tunnel 6 inches (15.2 cm) or more into the tree. The tunnel is excavated at an upward slope so the resin or pitch will drain from the hole. The heartwood doesn't have flowing resin. Once the birds have tunneled through the sapwood and into the heartwood a sufficient distance, they excavate downward forming a gourd-shaped chamber about 6 to 10 inches (15.2 to 25.4 cm) deep and 3 to 5 inches (7.6 to 12.7 cm) wide. A bird sometimes roosts in a start hole before the chamber is fully developed.

Cavity Maintenance. – Before the cavity is completed, the birds flake away the bark several feet above and below the cavity entrance. The smoother surface possibly makes it harder for snakes to reach the cavity. Scattered about the trunk near the cavity entrance, numerous small holes called resin wells are chipped through the bark (figures 5-8). Resin flow from these holes eventually coats the trunk with pitch. Birds regularly peck at resin wells to stimulate resin flow.

The cavity entrance would grow shut if the birds did not remove the growing tissue from around the hole. In time, the birds expose the sapwood for several inches around the entrance. This exposed area is called the plate (figure 7). Pitch from the plate and resin wells thoroughly coats the trunk. From a distance, the cavity tree looks like a candle

RED-COCKADED HABITAT

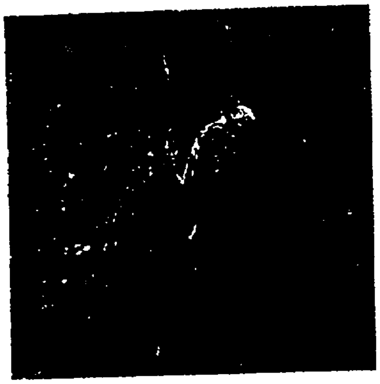

Figure 1.-Red cockaded woodpecker.

Red-cockaded cavities are made in live pines. Figures 1-17 show live pines. Cavity trees in open, mature pine stands are preferred (figure 2), but pine seed trees and relict pines in young stands are commonly used. In pine stands with hardwood midstories, active cavities tend to occur above the hardwood crowns and where hardwoods are sparsest. Hardwoods near the cavity typically lead to abandonment.

Figure 2.-Colony site. Note other cavity in center background.

CAVITIES UNDER CONSTRUCTION

Figure 3.-New start hole. Note 1-inch wide round hole and scaling.

Figure 4.-Advanced start hole, 2 inches wide. Note round hole, symmetrical excavation into sapwood and resin icicle.

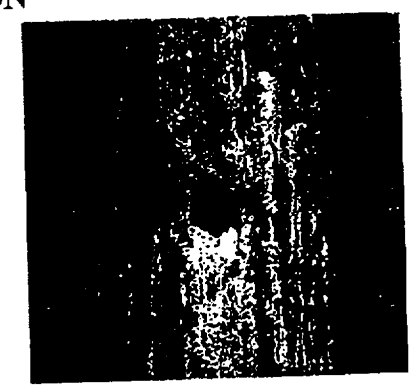

Figure 5.-Cavity nearly completed. Note resin wells and icicle.

ACTIVE RED-COCKADED CAVITIES

Figure 6.-Cavity 2 inches wide with numerous resin wells.

Figure 7.-Cavity 2 inches wide with plate and resin wells.

ACTIVE RESIN WELLS

Figure 8.-Close-up of resin well, 1-inch wide. Note red bark of active resin well.

Red bark on the edge of recently chipped resin wells and plate is a reliable sign a cavity is active (figures 5-8). A binocular is helpful. Caution: Look at the bark and not the resin - old resin sometimes looks red (figures 9, 10).

ABANDONED TREES

Abandoned cavity trees are clues active trees might be nearby. Resin dries and grays on abandoned trees. Bark at the edge of resin wells and plate turns brown or is hidden by dry resin. Red-cockaded woodpeckers rarely roost in abandoned cavities. Active and abandoned holes can occur on the same tree.

Figure 9.–Inactive start hole. Note dull sapwood and symmetrical hole. Red color is dried resin.

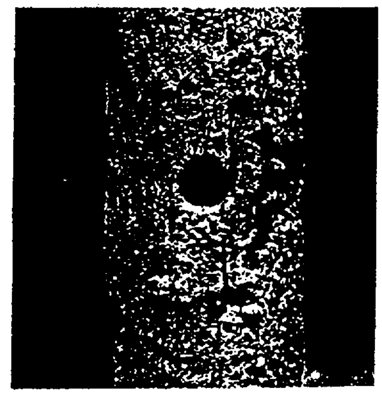

Figure 10.–Abandoned cavity. White resin covers resin wells and plate.

Figure 11.–Abandoned cavity. Note dull bark on resin wells and edge of plate. Reddish color on plate is dried resin.

Figure 12.–Enlarged cavity 5 inches wide. Note extensive coverage of old resin.

Figure 13.–Enlarged cavity 5x8 inches. Note old plate and resin wells.

Figure 14.–Yellow-bellied sapsucker holes ¼-inch wide.

Figure 15.–Asymmetric feeding hole of pileated woodpecker.

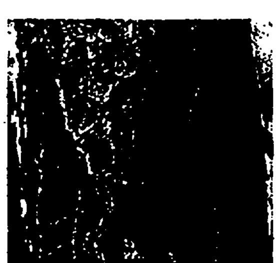

Figure 16.–Branch hole. Note lack of icicle.

Figure 17.–Asymmetric tree wound with sparse resin flow.

MISTAKEN FOR RED-COCKADED

If a hole does not have one or more of the following it is likely not to have been made by a red-cockaded: symmetrical hole, scaling, icicle, resin wells, or plate. Look for positive signs of red-cockaded activity. Binoculars are often needed. Sapsucker holes are smaller and more regularly spaced than resin wells (figure 14). Pileated woodpecker feeding holes are generally asymmetric (figure 15) and, if they penetrate sapwood, are tapered and ragged. Resin flow is light and scattered compared to distinct icicle of start holes (figures 3-5). Pileated work is common in pine stands with dense hardwood cover. Branch holes lack an icicle (figure 16). Tree wounds are asymmetric (figure 17). **Caution:** Sapsucker holes sometimes occur on red-cockaded trees and red-cockadeds can excavate cavities through branch holes. In both cases, positive sign of red-cockadeds is present.

Nontheless, the highest populations of the bird are on areas with active, prescribed burning programs for the control of hardwoods in pine stands. Also, territories tend to be smaller in areas with hardwood control.

MANAGEMENT SUGGESTIONS[1]

Governing Factors. – The potential for managing privately-owned forests to provide a favorable habitat for the red-cockaded woodpecker depends on (1) goals of the owner (2) current condition and natural capabilities of the land (3) size of the forest (4) forest conditions on adjacent land (5) occurrence of the red-cockaded on the owner's land and adjacent lands.

Landowners who have a red-cockaded colony can do much to enhance its survival regardless of the size of their property. But, because the birds forage over large areas, forest conditions on adjacent land may ultimately determine the fate of a colony. On larger forests, particularly those 200 acres (80.9 ha) or bigger, the bird can be maintained with greater assurance. Each individual colony is important to the survival of the species, but large ownerships of several hundred or thousand acres have the potential of sustaining significant populations of this endangered species. Land that has little or no pine forests has little potential as a red-cockaded woodpecker habitat. On areas without red-cockaded woodpeckers, but with pine forests, improvement of the habitat may encourage the red-cockaded to move into the area.

Objectives. – A successful management plan for the red-cockaded woodpecker must do five things: (1) retain existing cavity trees (2) provide trees for new cavities (3) provide adequate foraging habitat (4) control hardwoods in the colony site (5) provide future colony sites.

Colony Site. – Defer harvesting of existing colony sites. If the colony is in a larger stand that will be harvested, designate an uncut 200-foot (61 m) buffer zone around each cavity tree. Leaving only the cavity trees is not adequate, as the buffer is needed to provide replacement cavity trees. Do not isolate colony sites from foraging stands of pole size and larger pines. The colony site should be surrounded by or directly adjacent to foraging stands.

Control of hardwoods in the colony site is vital. Do not allow hardwoods to exceed 15 feet (4.6 m) or so in height, especially within 50 feet (15.2 m) of cavity trees. In colony sites lacking past hardwood control, it may be necessary to remove hardwoods by cutting. Prescribe burning, when properly applied, is an effective means of controlling small hardwoods. When using fire, rake around the base of the cavity trees to remove litter and resin, otherwise the tree may catch fire and destroy the cavity.

Thin stands containing colony sites back to 50 to 80 square feet (4.6 to 7.4 m^2) of basal area per acre. Leave the older trees for future cavity trees. Unless a safety hazard, do not remove dead or abandoned cavity trees as other animals may use them instead of the good cavity trees.

In colony sites infested with southern pine beetles, the infested trees, except cavity trees, may be cut and removed, burned or sprayed with an approved pesticide. Do not use pesticides (such as organophosphates) toxic to vertebrates.

Foraging Areas. – Manage the available acreage as a foraging habitat. Favor pine stands on suitable sites. Plant pines at a 10x10 foot or 12x12 foot (3x3 m or 3.7x3.7 m) spacing to aid rapid stand development. Birds continue to use seed tree areas for foraging until seed tree removal. Regeneration areas of 10 to 30 acres (4 to 12 ha) have less impact on the bird than larger ones. Avoid isolating colony sites from foraging areas when regenerating stands. Thinning of sapling and pole stands improves diameter growth and opens up stands to a condition more suitable to the woodpecker. Control hardwoods by prescribed burning.

Rotation Age. – In general, the longer the rotation age, the greater the opportunity the red-cockaded has to maintain existing colonies and to create new ones. The minimum rotation age necessary to provide an adequate number of cavity trees to sustain a viable population of Red-cockadeds is not known. As a safe minimum, the National Recovery Team recommends 100-year rotations for longleaf and 80-year rotations for other pines. Some opportunity for cavity replacement is provided by shorter rotations of 80 years for longleaf and 70 years for other pines, but it is not certain if these rotations can supply an adequate number of cavity trees. When it is not feasible to have long rotations over the entire ownership, leaving small, scattered stands of older pines will benefit the bird.

THE AUTHORS

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[1]The suggestions are based upon those recommended by the National Recovery Team for the Red-cockaded Woodpecker.

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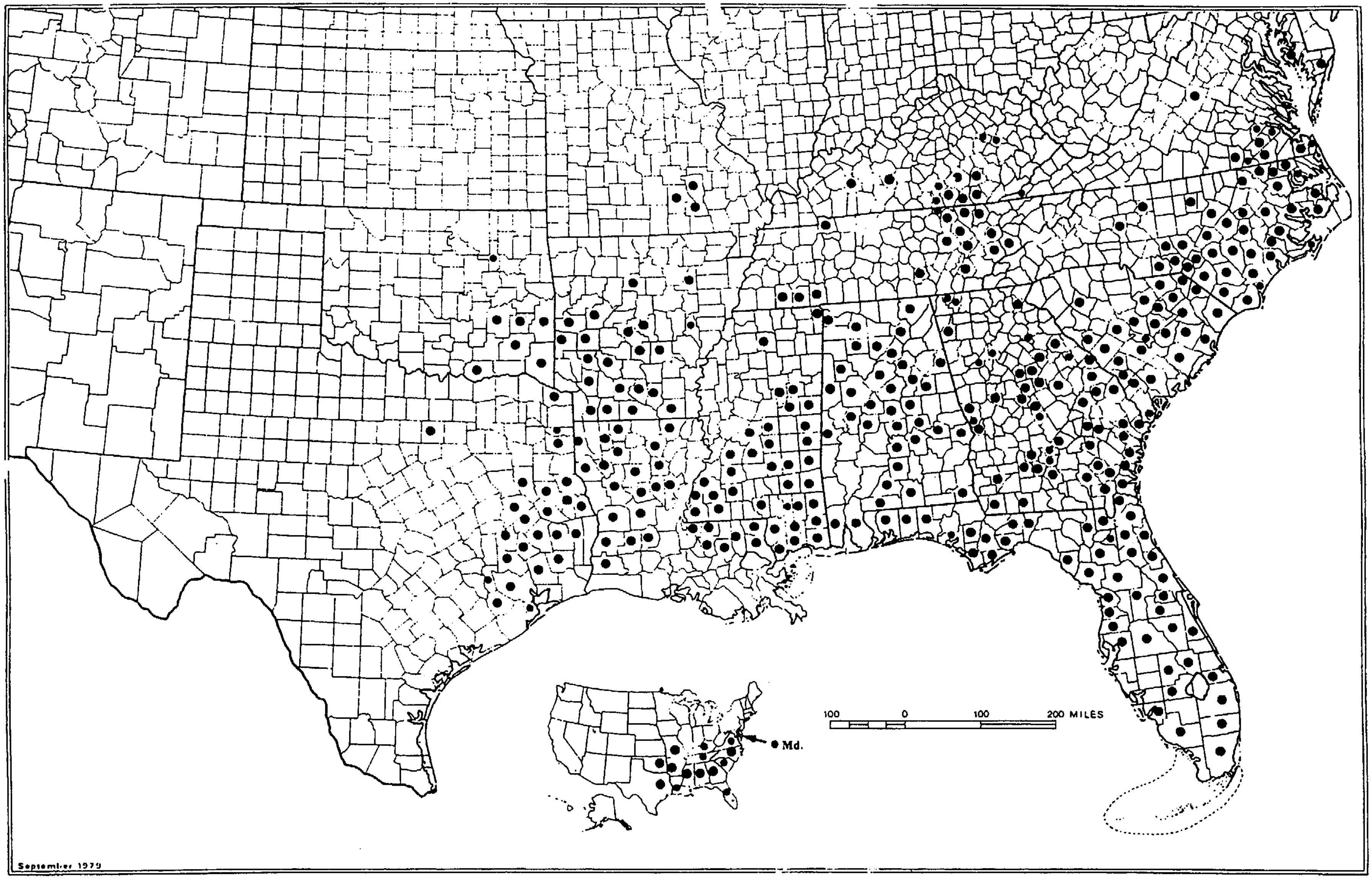
Historical distribution of red-cockaded woodpecker, by county and state.



Appendix B:

1991 RCW Management Standards and Guidelines

United States Department of Agriculture
Forest Service
Savannah River Forest Station
P.O. Box 710, New Ellenton, SC 29809-0710
(803) 725-2441

Reply To: 2670

Date: August 22, 1991

Subject: Savannah River Site RCW Management Standards and Guidelines

To: Mr. Steve Wright
Director
Environmental Division, DOE-SR

Attached is the RCW Management Standards and Guidelines for the SRS as requested by the Department of Energy (Letter from Wright to Alcock, 12/90). Also included, is a Biological Evaluation (BE) addressing the effects on threatened and endangered species as a result of implementing the Standards and Guidelines (S&G). The BE findings recommend concurrence from the Fish and Wildlife Service for any alternative chosen within the S&G, to meet the Section 7 consultation requirements of the Endangered Species Act.

The RCW S&G contains 3 alternatives from which DOE can make a decision. Once the Fish and Wildlife Service has been notified of the decision by DOE and they concur with the determination of the BE, then the SRFS can implement the S&G.

The RCW Management S&G and BE do not cover the 30,000 acre landscape research project that presently is being developed. Another set of Research S&G will be developed for these 30,000 acres that will be selected at random from the Management Area 1 (inner core) and the RCW Management Area (outer perimeter). The research S&G will undergo separate Section 7 consultation with the Fish and Wildlife Service.

The RCW S&G is a product of interdisciplinary team review and input. These S&G are now ready for your decision.

JOHN G. IRWIN
Forest Manager

Comparison of Alternatives for Red-cockaded Woodpecker Management Standards and Guidelines

Parameters	Alternative 1	Alternative 2	Alternative 3
Total Acres (Pine/Pine-Hardwood)	133,900	133,900	133,900
Management Area 1 (50 year rotation):			
Acres	54,927	54,927	54,927
RCW Objective: (# of Colonies)	0	0	0
Existing Active RCW Colonies	0	0	0
Management Area 2 (80 year rotation):			
Acres	30,015	42,817	-
RCW Objective: (# of Colonies)	150	215	-
Existing Active RCW Colonies	0	3	-
Management Area 3 (120 year rotation):			
Acres	48,952	36,150	-
RCW Objective: (# of Colonies)	250	185	
Existing Active RCW Colonies	8	5	-
RCW Management Area (rotation - 80 yr. loblolly, 120 yr. longleaf):			
Acres	-	-	78,967
RCW Objective: (# of Colonies)	-	-	400
Existing Active RCW Colonies	-	-	8
Maximum acres regenerated per 10 years	17,896	18,343	17,537

Savannah River Forest Station
June, 1991

Red-cockaded Woodpecker Management

Standards and Guidelines

Savannah River Site

Introduction

In 1986, a management/research program for establishing a viable population of red-cockaded woodpecker (RCW) was initiated on the Savannah River Site. Forest and habitat management activities have been conducted in accordance with Forest Service (USFS) RCW Handbook, FSH 2609.23R (March, 1985). Research has included genetic studies, the successful development of translocation techniques, the successful development of an artificial cavity insert, and intensive monitoring of the population. The U.S. Fish and Wildlife Service (USFWS) made the biological opinion "that the proposed management and research activities at SRP, and associated cumulative effects, are not likely to jeopardize the continued existence of the RCW (G. Henry letter to C.G. Halsted, 2/21/86)".

The population on SRS in 1985 was four birds in three colonies. There was one breeding pair in 1985. Due primarily to the translocation research techniques during the past 5 years, the population has increased to 6 breeding pairs and a total of 27 birds currently, located in 8 colony sites. The success of the translocation research is unquestioned and the technology is being transferred throughout the southeast.

Questions have arisen concerning the effects of forest and habitat management (FSH 2609.23R) on the RCW throughout the southeast.

The USFS received non-jeopardy opinion from the USFWS in 1985 for management activities in FSH 2609.23R. However, population trends for National Forests across the southeast have continued to decline for all populations (except the Ocala NF) since the late 1970's and 80's. For this reason the Forest Service decided to change management direction from the current handbook chapter. The Regional Forester in his decision (J. Alcock, 5/9/90) to implement the "Interim Standards and Guidelines" stated that the continued implementation of the current FSH 2609.23R would likely adversely affect the RCW in populations with less than 50 active colonies and may adversely affect those populations with 50 - 250 active colonies. Preliminary indications point to two primary reasons for the decline. The first primary reason for the decline is mid-story encroachment. The second primary reason is the lack of potential cavity trees. Other potentially significant problems are the lack of existing suitable cavities, colony isolation, foraging habitat fragmentation, and population fragmentation. The USFWS (Letter from P. Morgan to J. Alcock, 4/16/90) concurred with the Regional Forester's findings and stated the guidelines are significant improvement in the management of the RCW.

The USFS recommended to the Department of Energy (DOE) for the SRS to be included in the "Interim Standards and Guidelines" until the final EIS outlining the long-term management direction for RCW was completed in approximately 2-3 years (Letter from J. Irwin to B. Gould, 6/6/90). However, DOE made the decision not to be included in the regional guidelines (Letter from S. Wright to J. Alcock, 12/90). DOE directed the USFS to develop management guidelines for the SRS that had the flexibility to design and implement a landscape biological diversity research project.

The standards and guidelines that follow will be implemented with the objective of providing short-term protection of the existing small population and provide for the long-term expansion and recovery of the SRS population to a viable level in a management/research setting. These guidelines will address the issues concerning the lack of potential cavity trees for the short and long term, mid-story encroachment, and nesting/foraging habitat fragmentation. The guidelines apply to the SRS area under resource management by the SRFS and do not apply to areas that are existing or proposed for facility construction or to other areas pertaining to the primary mission of the SRS.

These guidelines will not apply to the approximately 30,000 acres that will be part of a landscape research program dealing directly with RCW nesting and foraging habitat ecology and RCW population studies, that are now under development. The specific location of the research project, as it relates to the current management area boundries, is not known, but will be selected randomly from the 133,891 acres of pine forest on the SRS. Sixty percent of the landscape research area may contain short rotation (40 to 50 year) timber management, in order to experimently isolate longleaf forest patches of different sizes. A different set of standards and guidelines will be developed for the landscape research area, along with seperate Section 7 consultation with the USFWS. Part of the overall SRS RCW population objectives will be contained within the landscape research areas and additional new areas that may be added to the RCW Management Area from Management Area 1, as mitigation, because of possible adverse effects on RCW due to the "short rotation experiments". The acreage managed on rotations of 80 plus years (includes uneven-aged acres managed for nesting habitat) within the RCW Management Area will not drop below the current level of 78,967 acres, except in the case of acres needed to support the primary mission of the SRS.

The RCW program will be a cooperative effort between agencies and institutions that will include the DOE - SRS, Savannah River Forest Station (SRFS) - USFS, Southeastern Forest Experiment Station (SEFES) - USFS, Savannah River Ecology Lab (SREL), the South Carolina Wildlife and Marine Resources Department (SCWMRD), and the USFWS.

Program Objectives

There are three overall objectives for the program. The first objective in the short-term is to protect the current population from decline and expand the population to 30 active colonies by the year 2000. The second objective for the long-term is to develop and restore habitat for the SRS RCW population that can support a viable population of 250 successful annual breeding colonies (effective population size). To better insure viability, habitat will be provided to support a population level of 400 colonies (maximum level based on 1 colony per 200 acres of suitable habitat). This objective is in keeping with the idea that additional active colonies will be necessary, considering the number of non-breeding active colonies and the colonies that fail to fledge young, to meet the effective population size. These objectives will be accomplished in the RCW Management Area at a density of 1 colony per 200 acres of pine forest habitat. Presently there are 8 active colonies of which 6 are successfully breeding and nesting and 2 (25%) are non-breeding. The third objective is to conduct research to answer questions regarding the effects on the RCW of forest fragmentation and patch size, foraging habitat requirements, and to continue developing techniques in the area of translocation and artificial cavities for use on the SRS and across the southern region.

Existing SRS Pine Forest Conditions

There is approximately 133,900 acres of existing pine and pine-hardwood forest type on the SRS (Table 1.) Presently there is 4,378 acres (3.3%) of the pine acreage greater than 60 years of age. The dominant age classes are in the 31 - 40 age class with 59,883 acres (44.7%) and the 0 - 10 age class with 23,257 acres (17.4%) of the pine acreage. Suitable RCW nesting habitat presently occurs only in scattered, isolated pockets of older aged stands and in younger stands that contain scattered relict pines. It is estimated that there is presently less than 1,000 acres of suitable nesting habitat available on the SRS.

Existing SRS RCW Population Status

Presently there are 32 colony sites (Table 2.) on the SRS. Of these colony sites, there is a total of 8 active colonies (6 breeding colonies) and 24 inactive colonies. A total of 27 birds (as of 6/91) reside within the 8 active colonies. There are 18 adults (12 males and 6 females) and 9 juveniles (3 males and 6 females). Of the 15 adult birds, 3 are from the Francis Marion National Forest and one is immigrant from an unknown location. The population trend is on tha increase due to translocation techniques, artifical cavity placements, and mid-story control.

The SRS population is divided into six sub-populations (Figure 1.), based on criteria in the RCW Conservation Strategy (Escano, 1991). Two of the sub-populations contain active colonies (Table 3).

Management Strategies

The SRS will be divided into two or three separate management areas that will have different forest management strategies and objectives in pine forest types (Figure 2). The reason for this division is to provide the flexiblity to design a long-term research program. Management Area 1 will be managed on a 50 year pine rotation. Management Area 2 will use a pine rotation of 80 years. Management Area 3 will emphasize a pine rotation of 120 years. The RCW management area consists of areas 2 and 3. The RCW Management Area may consist of a longleaf rotation of 120 years and a loblolly rotation of 80 years.

STANDARDS AND GUIDELINES

Alternatives

Six alternatives were developed to address issues regarding RCW management and recovery on the SRS. Three alternative were not included for further analysis.

Alternatives Considered But Not Included For Further Analysis

The three alternatives considered, but not included in the analysis for further consideration. The first was to continue managing the RCW using the 1985 RCW Handbook Chapter (2609.23R) . This alternative was not considered further because the Forest Service has determined and the USFWS has concurred that the 1985 2609.23R practices would adversely affect RCW populations below 50 active colonies. The other two alternatives were variations of and intermediate between Alternatives 1 and 2 that are included in this document. The two alternatives were not included because they did not differ greatly from alternatives 1 and 2 that are included.

Alternative Descriptions

Alternative 1

Alternative 1 splits the RCW Management Area into areas 2 and 3 (Figure 2). Area 3 (120 year pine rotation on the area regulated acres) encompasses all active colonies of the SRS RCW population. Area 3 will contain 62% of the pine forest habitats in the RCW Management Area. Area 2 (80 year pine rotation on the area regulated acres) will contain 38% of the pine forest habitats in the RCW Management Area.

Management Area 1

The pine forest type acreage is 54,927 for this management area (Table 4). There is 7,403 acres of longleaf, 27,622 acres of loblolly, 18,040 acres of slash, 43 acres of sand pine, and 1,819 acres of pine-hardwood.

The RCW population objective for Management Area 1 is 0 colonies. A portion of this management area will contain some recruitment stands for research purposes. Colony/recruitment guidelines are included in the standards and guidelines to cover possible recruitment into the area or any recruitment stands that are included in Area 1 for research purposes. This management area contains sub-population 3 (Figure 1), that includes 4 inactive colony sites.

RCW Management Area (Includes Area's 2 and 3)

Management Area 2

The pine forest type acreage is 30,015 for this management area (Table 5). There is 8,503 acres of longleaf, 15,300 acres of loblolly, 4,818 acres of slash, 6 acres of other pine, and 1,388 acres of pine-hardwood.

The long-term RCW population objective for Management Area 2 is **150 active colonies** for Alternative 1. The population density objective for this area is 1 colony per 200 acres. Management Area 2 contains sub-populations 1 and 6 (Figure 1.) that contain 4 colony sites (0 active and 4 inactive colony sites) for this alternative.

Management Area 3

The pine forest type acreage is 48,952 for this management area (Table 7). There is 21,268 acres of longleaf, 20,541 acres of loblolly, 5,791 acres of slash, 165 acres of other pine, and 1,187 acres of pine-hardwood.

The long-term RCW population objective for Management Area 3 is **250 active colonies** for Alternative 1. The population density objective for this area is 1 colony per 200 acres. Management Area 3 contains sub-populations 2, 4, and 5 (Figure 1.) that contain 23 colony sites (8 active and 15 inactive colony sites) for this alternative. Sub-populations 2 and 4 contain active colony sites.

Alternative 2

Alternative 2 splits the RCW Management Area into areas 2 and 3 (Figure 3). Area 3 (120 year pine rotation on the area regulated acres) encompasses 5 active colonies in sub-population 2 of the SRS RCW population. Area 3 will contain 46% of the pine forest habitats in the RCW Management Area. Area 2 (80 year pine rotation on the area regulated acres) will contain 54% of the pine forest habitats in the RCW Management Area. Area 2 will encompass 3 active colonies in sub-population 4.

Management Area 1

The forest conditions and population objectives are the same as alternative 1.

RCW Management Area (Includes areas 2 and 3)

Management Area 2

The pine forest type acreage is 42,817 for this management area (Table 6). There is 15,937 acres of longleaf, 19,866 acres of loblolly, 5,881 acres of slash, 6 acres of other pine, and 1,127 acres of pine-hardwood.

The long-term RCW population objective for management area 2 is 215 active colonies. The population density objective for this area is 1 colony per 200 acres. Management Area 2 would contain 10 colony sites (3 active colonies and 7 inactive colonies) for this alternative. Sub-populations 1, 4, and 5 would be located in management area 2 for this alternative. Sub-population 4 contains 3 active colonies.

Management Area 3

The pine forest type acreage is 36,150 for this management area (Table 8). There is 13,834 acres of longleaf, 15,975 acres of loblolly, and 4,728 acres of slash, 165 acres of other pine, and 1,448 acres of pine-hardwood.

The long-term RCW population objective for management area 3 is 185 active colonies. The population density objective for this area is 1 colony per 200 acres. Management Area 3 contains sub-populations 2 and 6 (Figure 1.) that contain 18 colony sites (5 active and 13 inactive colony sites) for this alternative. Sub-population 2 contains 5 active colony sites.

Alternative 3

In alternative 3 the RCW Management Area will contain 100% of the pine forest habitat managed for RCW expansion (Figure 4). All existing active colony sites (8 total) are included. The longleaf pine management types on the area regulated acres will be managed on a 120 year rotation. A minimum of 75% of the total pine acres in the RCW Management Area will be longleaf management type. The loblolly management types on the area regulated acres will be managed on a 80 year rotation. One hundred percent of the population objective will occur in this area.

Management Area 1

The forest conditions and population objectives are the same as alternative 1.

RCW Management Area (areas 2 and 3 combined)

The pine forest acreage is 78,967 for this management area (Table 9). There is 29,771 acres of longleaf, 35,841 acres of loblolly, 10,609 acres of slash, 171 acres of other pine, and 2,575 acres of pine-hardwood.

The long-term RCW population objective for this management area is 400 active colonies. The population density objective for this area is 1 colony per 200 acres. This management area contains sub-populations 1, 2, 4, 5, and 6 (Figure 1) that contains 28 colony sites (8 active and 20 inactive colony sites for this alternative. Sub-populations 2 and 4 contains 8 active colony sites.

Standards and Guidelines Common To Alternatives 1 - 2 That Differ By Management Area

Management Area 1

Reforestation

–Provide early successional habitats totaling between 8 to 22 percent of the pine management type area regulated acres per habitat unit. A maximum average of 20 percent of the pine management type area regulated acres will be maintained in early successional habitat for Management Area 1.

–Priority for pine regeneration will be the conversion of off-site pine stands.

–The size of the pine regeneration harvest cuts will range between 10 and 80 acres. The cuts will average less than 40 acres in size.

Colony/Recruitment Management

Mid-story removal and control - Mid-story hardwoods will be removed on an entire stand basis. A minimum of 10 acres should be treated. Hardwood control in hardwood stringers and riparian areas will be limited to 50 feet of cavity trees. Pine mid-story removal will be controlled to remove physical barriers to the cavity trees, potential cavity trees, and the line of site between them.

Thinning - Overstory pine will be thinned to reduce the risk of southern pine beetle (SPB) and improve nesting habitat. Colony sites will be thinned to a spacing of 20-25 feet. No more than 20 square feet of the total overstory basal area will be hardwood species.

Replacement stands - These stands will be selected for all active colony sites, if colonization were to occur. They will be located as close as possible and no more than 1/2 mile from the colony site.

Monumentation - The boundaries for the colony site will be maintained on an annual basis using flagging or reflective material. The cavity trees will be painted with a single white band and tagged showing the identification number.

Research set-asides - Habitat manipulations and protection measures will be conducted in set-asides necessary to protect and enhance colony sites. Work will not be conducted to encourage colonization into these research areas.

Foraging Habitat Management

A minimum of 6350 pine stems 10" or greater in DBH and 8500 square feet of pine basal area will be provided within 1/2 mile of active colony sites, inactive colony sites serving as recruitment stands, and all recruitment stands. These requirements will be applied to pine stands older than 30 years of age. Stands with less than 30 BA of pine will not be considered suitable for foraging. Stands that contain greater than 50% of the BA in hardwood will not be considered suitable for foraging.

Prescribe Burning

Pine forest will be prescribe burned 1 to 2 times per 10 year period. The annual target acreage for management area 1 should be between 2,000 and 4,000 acres. The major objectives will be fuels management and wildlife. The burns will be conducted during the fall or winter (non-growing season).

Management Area 2

Reforestation (even-aged management)

–Provide early successional habitats (0-10 years) totaling between 4 to 16 percent of the pine management type area regulated acres per habitat unit. A maximum average of 12.5 percent of the pine management type area regulated acres will be maintained in early successional habitat for Management Area 2.

–Priority will be to retain the oldest available longleaf and loblolly pine stands, with regeneration coming from the dominant age classes.

–Priority for pine regeneration will be the conversion of off-site slash pine stands. A minimum of 33 percent of the slash pine acreage will be converted to longleaf or loblolly pine within a compartment during a 10 year planning period. This may require exceeding the 16% percent upper limit on early successional habitats in rare instances. Conversion at these levels will occur only if foraging requirements are met for the population objectives in a compartment.

–Regeneration harvest will not reduce foraging habitat within 1/2 mile of colonies or recruitment stands to below 6350 tress greater than 10" DBH or 8500 square feet of pine basal area in stands greater than 30 years old.

–Regeneration practices will not result in colony isolation or foraging habitat fragmentation.

–The size of the pine regeneration harvest cuts will range between 10 and 40 acres. The cuts will average less than 25 acres in size.

–All relict trees will be retained in regeneration harvest. Where relicts are limited, retain a minimum of 6 relict and/or potential cavity trees per acre where available. All one acre and larger clumps of longleaf pine containing at least 40 square feet of basal area will be retained as inclusions when available.

–In shelterwood/seedtree harvest cuts, retain between 30-40 square feet of basal area of seedtrees during the initial cut for a least 10 years. All relict trees will be retained throughout the next rotation. After 10 years the seedtrees can be removed with the following exceptions; all relicts will be retained and if the number of relicts are limited, a minimum of 6 relicts and/or potential cavity trees per acre will be retained.

Reforestation (uneven-aged management)

–A modified group selection cutting can be used on selected longleaf and loblolly pine forest. The main objective will be to maintain the integrity of the longleaf-bluestem plant community for research purposes. Strategies for the group selection cutting must produce trees as old an 80 year old rotation would produce, retain relict and potential cavity trees, maintain pine basal areas in the 60 to 100 square feet per acre range outside the regeneration patch cuts, and maintain a herbaceous understory, with little or no mid-story effects. If loblolly stands are used, herbicides will be required to maintain an open understory due to the negative effects on regeneration by fire.

Prescribe Burning

Pine forest will be prescribe burned 2 times during the 10 year planning period. The annual target burning acres should be between 4,000 and 6,000 acres. The objectives will be to improve habitat for the RCW and other wildlife species, the maintenance of open understory, pine plant communities, and fuels management. The burns will be conducted during the fall or winter (non-growing season), with every third burn (every 12-15 years) conducted during the growing season. Existing forest conditions will probably limit the use of large scale growing season burns for the next 10 to 15 years. Due to weather constraints in burning, the growing season burns will probably be limited to early spring and late summer or early fall. If constraints on prescribe burning results in the inability to manage the longleaf/bluestem system, mechanical and/or chemical treatments may be substituted for fire.

Management Area 3

Reforestation (even-aged management)

–Provide early successional habitats (0-10 years) totaling between 4 to 12 percent of the pine management type area regulated acres per habitat unit. A maximum average of 8.5 percent of the pine management type area regulated acres will be maintained in early successional habitat for management area 3.

–Priority will be to retain the oldest available longleaf and loblolly pine stands, with regeneration coming from the dominant age classes.

–Priority for regeneration will be the conversion of off-site slash pine. A minimum of 33 percent of the existing slash pine acreage will be converted to longleaf or loblolly pine during a 10 year planning period. This may require exceeding the 12% percent upper limit on early successional habitats in rare instances. Conversion at these levels will occur only if foraging requirements are met.

–No regeneration harvests will reduce the foraging habitat within 1/2 miles of colonies or recruitment stands to below 6350 pine stems greater than 10" DBH or 8500 total square feet of pine basal area per acre in stands greater than 30 years old.

–Regeneration practices will not result in colony isolation or foraging habitat fragmentation.

--The size of the regeneration harvest cuts will range between 10 and 40 acres. The cuts will average less than 25 acres in size.

–All relict trees will be retained in regeneration harvest. Where relicts are limited, retain a minimum of 6 relict and/or potential cavity trees per acre where available. All one acre and larger clumps of longleaf pine containing at least 40 square feet of basal area will be retained as inclusions when available.

–In shelterwood/seedtree harvest cuts, retain between 30-40 square feet of basal area of seedtrees during the initial cut for a least 10 years. All relict trees will be retained throughout the next rotation. After 10 years the seedtrees can be removed with the following exceptions; all relicts will be retained and if the number of relicts are limited, a minimum of 6 relicts and/or potential cavity trees per acre will be retained.

Reforestation (uneven-aged management)

–A modified group selection cutting can be used on selected longleaf and loblolly pine forest. The main objective will be to maintain the integrity of the longleaf-bluestem plant community for research purposes. Strategies for the group selection cutting must produce trees as old a 120 year old rotation would produce, retain relict and potential cavity trees, and maintain a herbaceous understory, with little or no mid-story effects. If loblolly stands are used, herbicides will be required to maintain an open understory due to the negative effects on regeneration of fire.

Prescribe Burning

Pine forest will be prescribe burned 2 times during the 10 year planning period. The annual burning target for this management area should be between 6,000 and 10,000 acres. The major objectives will be to improve habitat for the RCW and other wildlife species, restoration and maintenance of the longleaf-bluestem plant community, and fuels management. The burns will be conducted during the fall or winter (non-growing season), with every third burn conducted for an area during the growing season. Existing forest conditions will probably limit the use of large scale growing season burns for the next 10 to 15 years. Due to weather constraints in burning, the growing season burns will probably be limited to early spring and late summer or early fall. If constraints on prescribe burning results in the inability to manage the longleaf/bluestem system, mechanical and/or chemical treatments may be substituted for fire.

Standards and Guidelines For Alternative 3 That Differ By Management Area

Management Area 1

Same as Alternatives 1 - 2.

RCW Management Area (Areas 2 and 3 combined)

Reforestation (even-aged management)

--Longleaf pine management type area regulated acres will be managed on a 120 year rotation and loblolly pine management type area regulated acres will be managed on a 80 year rotation.

--Provide early successional habitats (0-10 years) totaling between 4 to 14 percent of the pine management type area regulated acres per habitat unit. A maximum average of 9.5 percent of the combined overall pine management type regulated acres will be maintained in early successional habitat for the RCW Management Area. The 9.5 percent level is based on the assumption that a minimum of 75 percent of the area regulated pine acreage will be managed for longleaf pine for the RCW Management Area.

--Priority will be to retain the oldest available longleaf and loblolly pine stands, with regeneration coming from the dominant age classes.

--Priority for regeneration will be the conversion of off-site slash pine. A minimum of 33 percent of the slash pine acreage will be converted to longleaf or loblolly pine during a 10 year planning period. This may require exceeding the 14% percent upper limit on early successional habitats in rare instances. Conversion at these levels will occur only if foraging requirements are met.

--No regeneration harvests will reduce the foraging habitat within 1/2 miles of colonies or recruitment stands to below 6350 pine stems greater than 10" DBH or 8500 total square feet of pine basal area per acre in stands greater than 30 years old.

--Regeneration practices will not result in colony isolation or foraging habitat fragmentation.

--The size of the regeneration harvest cuts will range between 10 and 40 acres. The cuts will average less than 25 acres in size.

--All relict trees will be retained in regeneration harvest. Where relicts are limited, retain a minimum of 6 relict and/or potential cavity trees per acre where available. All one acre and larger clumps of longleaf pine containing at least 40 square feet of basal area will be retained as inclusions when available.

--In shelterwood/seedtree harvest cuts, retain between 30-40 square feet of basal area of seedtrees during the initial cut for a least 10 years. All relict trees will be retained throughout the next rotation. After 10 years the seedtrees can be removed with the following exceptions; all relicts will be retained and if the number of relicts are limited, a minimum of 6 relicts and/or potential cavity trees per acre will be retained.

Reforestation (uneven-aged management)

--A modified group selection cutting can be used on selected longleaf and loblolly pine forest. The main objective will be to maintain the integrity of the longleaf-bluestem plant community for research purposes. Strategies for the group selection cutting must produce trees as old a 120 year old rotation would produce, retain relict and potential cavity trees, and maintain a herbaceous understory, with little or no mid-story effects. If loblolly stands are used, herbicides will be required to maintain an open understory due to the negative effects on regeneration of fire.

Standards and Guidelines Common To All Alternatives and RCW Management Areas

Thinning

Thinning will be accomplished to improve RCW habitat and to reduce the threat of southern pine beetle infestations. Stands will be thinned to a basal area of between 60 and 100 square feet per acre. The thinnings will not reduce the foraging habitat within 1/2 mile of colonies or recruitment stands to below 6350 trees greater than 10" DBH or 8500 total pine basal area in stands greater than 30 years old. The thinnings will retain trees the most suitable for future nesting. The order of priority for retaining trees are (1) relict trees; (2) potential cavity trees; (3) trees 10 inches DBH and greater that are not potential cavity trees; and (4) trees less than 10 inches DBH. Longleaf pine will be the favored species for retention.

Southern Pine Beetle Treatments

Treatment control for southern pine beetle infestations will follow the guidelines in the SPB Record of Decision and EIS. The goal will be to protect the RCW colony sites and potential nesting habitat.

Colony Management (Active and Inactive)

Mid-story removal and control - Mid-story hardwoods will be removed on an entire stand basis. Hardwoods two inches and larger at the base of the stem will be removed. A minimum of 10 acres should be treated. Hardwood control in hardwood stringers and riparian areas will be limited to 50 feet of cavity trees. Pine mid-story removal will be controlled to remove physical barriers to the cavity trees, potential cavity trees, and the line of site between them. Priority for treatments are (1) active colony sites, (2) inactive colony sites serving has recruitment stands, and (3) inactive colony sites.

Thinning - Overstory pine will be thinned to reduce the risk of southern pine beetle (SPB) and improve nesting habitat. Colony sites will be thinned to a spacing of 20-25 feet. No more than 10 square feet of the total overstory basal area will be hardwood species. The order of priority for retaining trees are (1) relict trees; (2) potential cavity trees; (3) trees 10 inches DBH and greater that are not potential cavity trees; and (4) trees less than 10 inches DBH. Longleaf pine will be the favored species for retention.

Replacement stands - These stands will be selected for all active colony sites. They will be located as close as possible and no more than 1/2 mile from the colony site. The replacement stands will be at least 10 acres in size.

Monumentation - The boundaries for the colony site will be maintained on an annual basis using flagging or reflective material. The cavity trees will be painted with a single white band and tagged showing the identification number.

Research set-asides - Habitat manipulations and protection measures will be conducted in SRS research set-asides necessary to protect and enhance colony sites if colonization should occur. However, treatments will not be conducted to encourage colonization into these research areas.

Competitor Control - A program of controling southern flying squirrels will continue by (1) removing all squirrels from cavities and (2) placing squirrel boxes at some cavity tree bases to attract squirrels that would then result in capture. Other problem animal individuals threatening RCW suitability will be controlled on a case by case basis, such as rat snakes and pileated woodpeckers.

Artificial cavities - Active colony sites will be supplemented with artificial cavities if the number of existing completed cavities will not support the RCW numbers in the colony site or anticipated recruitment of juveniles into the colony. Inactive colony sites (serving as recruitment stands) will be supplemented with artificial cavities to raise the number of available cavities to a minimum of four.

Cavity Restrictors - Cavity restrictors will be placed on all natural cavities and artificial cavities.

Recruitment Stand Management

Selection - Recruitment stands will be selected on a compartment basis when the population goal (based on a density of 1 colony/200 acres) is greater than the number of existing colonies, if the colonies are active or the inactive colonies containing suitable nesting habitat greater than 10 acres. If the inactive colony sites are determined not suitable for recruitment, then the colony site will protected and a recruitment stand with the more suitable nesting habitat will be selected. The recruitment stands will be at least, but not limited to, 10 acres in size. Emphasis should be placed on identifying larger areas (25 to 40 acres) for recruitment stands, especially in Area 2 (80 year rotation). Emphasis should be placed on identifying and tracking all potentially suitable nesting habitat. Habitat treatments for recruitment stands and other suitable nesting habitat not identified as recruitment stands should be the same to encourage RCW population expansion, with the top treatment priorities being within 3 miles of active colony sites. The oldest available stands containing a minimum BA of 40 sq.ft. will be selected for recruitment stands. Younger pine stands containing scattered relict longleaf or loblolly should also be considered as suitable recruitment areas if older stands are not available. The priority for selection are (1) longleaf pine stands; (2) loblolly pine stands containing longleaf pine; (3) loblolly pine stands; and (4) slash pine stands containing sufficient longleaf pine.

Spacing - Recruitment stands will be placed between 1/4 and 3/4 miles from active colonies, inactive colonies serving as recruitment stands, and other recruitment stands.

Mid-story removal and control - Mid-story hardwoods will be removed on an entire stand basis. Hardwoods greater than 2 inches at the base will be removed. A minimum of 10 acres should be treated. Hardwood control in hardwood stringers and riparian areas will be not occur. Pine mid-story removal will be controlled to remove physical barriers to potential cavity trees. The retention of 1/2 acre clumps of upland or scrub oak hardwood is acceptable at a rate of 1 clump per 10 acres. Priority for treatments will be (1) stands within 3 miles of active colony sites and (2) stands greater than 3 miles from active colony sites. Inactive colony sites serving as recruitment stands will be given top priority regardless of distance from active colony site.

Thinning - Overstory pine will be thinned to reduce the risk of southern pine beetle (SPB) and improve nesting habitat. Colony sites will be thinned to a spacing of 20-25 feet, but maintain an overstory pine basal area of at least 60 sq. ft. No more than 20 square feet of the total overstory basal area will be hardwood species. The order of priority for retaining trees are (1) relict trees; (2) potential cavity trees; (3) trees 10 inches DBH and greater that are not potential cavity trees; and (4) trees less than 10 inches DBH. Longleaf pine will be the favored species for retention.

Monumentation - The boundaries for the colony site will be maintained on an annual basis using flagging or reflective material. The artificial cavity trees will be painted with a double white and yellow band and tagged showing the identification number.

Artificial cavities - Place 3 - 4 artificial cavities per 10 acres of recruitment area and suitable nesting habitat not identified has recruitment stands. This density of artificial cavities will be implemented within 3 miles of existing active colony sites.

Cavity Restrictors - Cavity restrictors will be placed on all artificial cavities.

Augmentation

Single male colonies should be augmented with sub-adult females by translocating birds from within the population, as well from identified donor populations. The movement of male and sub-adult female birds and the movement of groups of birds should be performed on an experimental basis to further the expansion of the population. Birds will be located in areas with suitable nesting and foraging habitat to support the new colony.

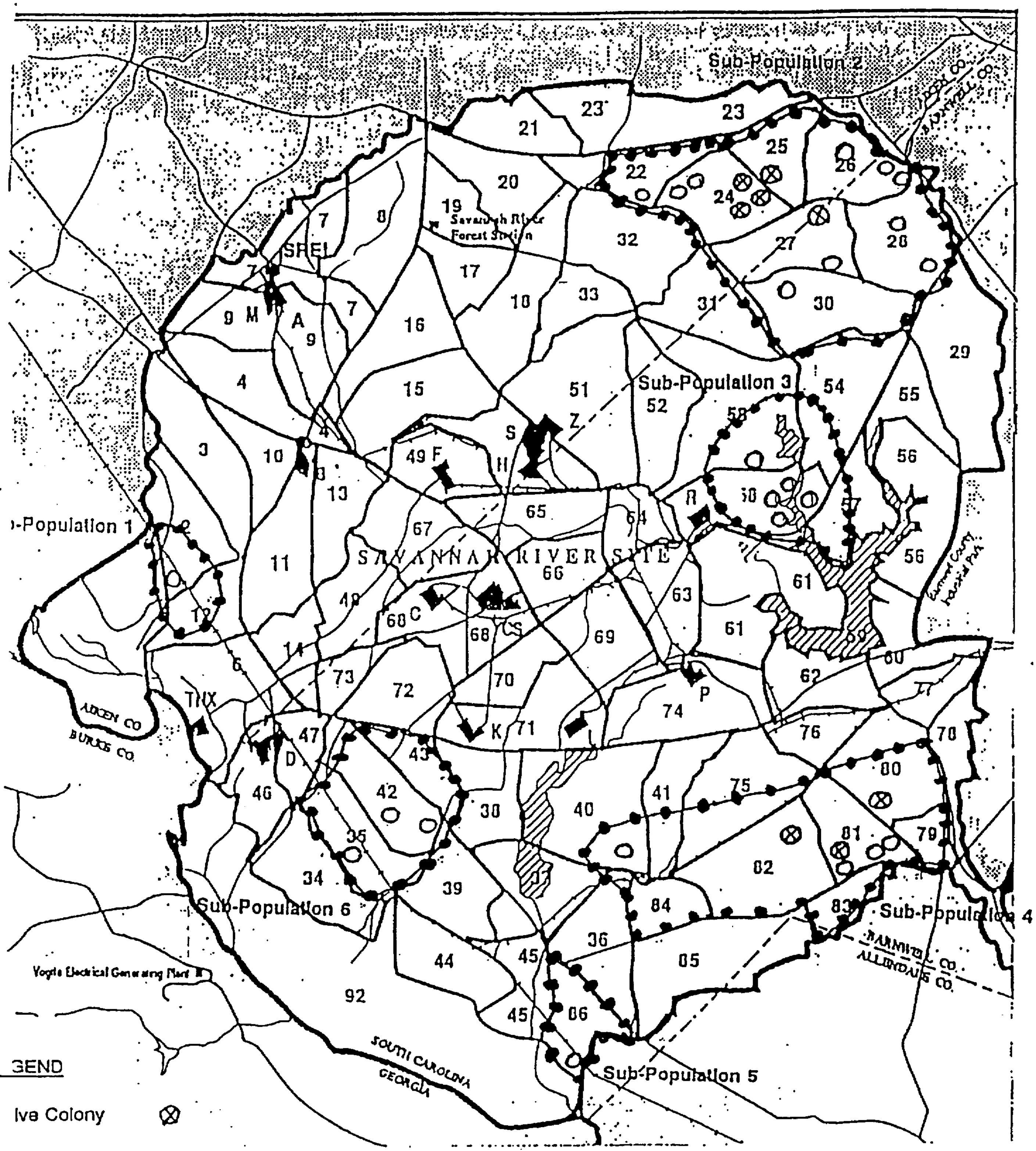
Foraging Habitat Management

A minimum of 6350 pine stems 10" or greater in DBH and 8500 square feet of pine basal area will be provided within 1/2 mile of active colony sites, inactive colony sites serving as recruitment stands, and all recruitment stands. These requirements will be applied to pine stands older than 30 years of age. Stands with less than 30 BA of pine will not be considered suitable for foraging. Stands that contain greater than 50% of the BA in hardwood will not be considered suitable for foraging.

Monitoring

All the colony sites will be inventoried annually to determine the status of the colony. Clan checks will be conducted throughout the year to maintain accurate records of individual bird status and location. The objectives of the clan checks are to maintain accurate population trend data and to support translocation efforts. Recruitment stands that are considered suitable for RCW nesting will be inventoried to determine and document status. Recruitment stands within 3 miles of active colony sites will be surveyed annually and those outside 3 miles of colony sites will be surveyed every 3 years. Priority will be given to checking artificial cavities annually within the recruitment stands for RCW activity. All compartments entered for prescriptions will given a 100% survey in all suitable RCW habitat. Prior to timber sales, the cutting units involved will be inventoried to determine the presence or absence of RCW. RCW records will be maintained in a GIS/Oracle database.

Figure 1. Subpopulation and colony locations for the Savannah River Site red-cockaded woodpecker population.



LEGEND
Active Colony
Inactive Colony
Sub-Population Boundary
1 2 3 4 miles

Figure 2. Alternative 1 - red-cockaded woodpecker (RCW) habitat management direction at Savannah River Site.

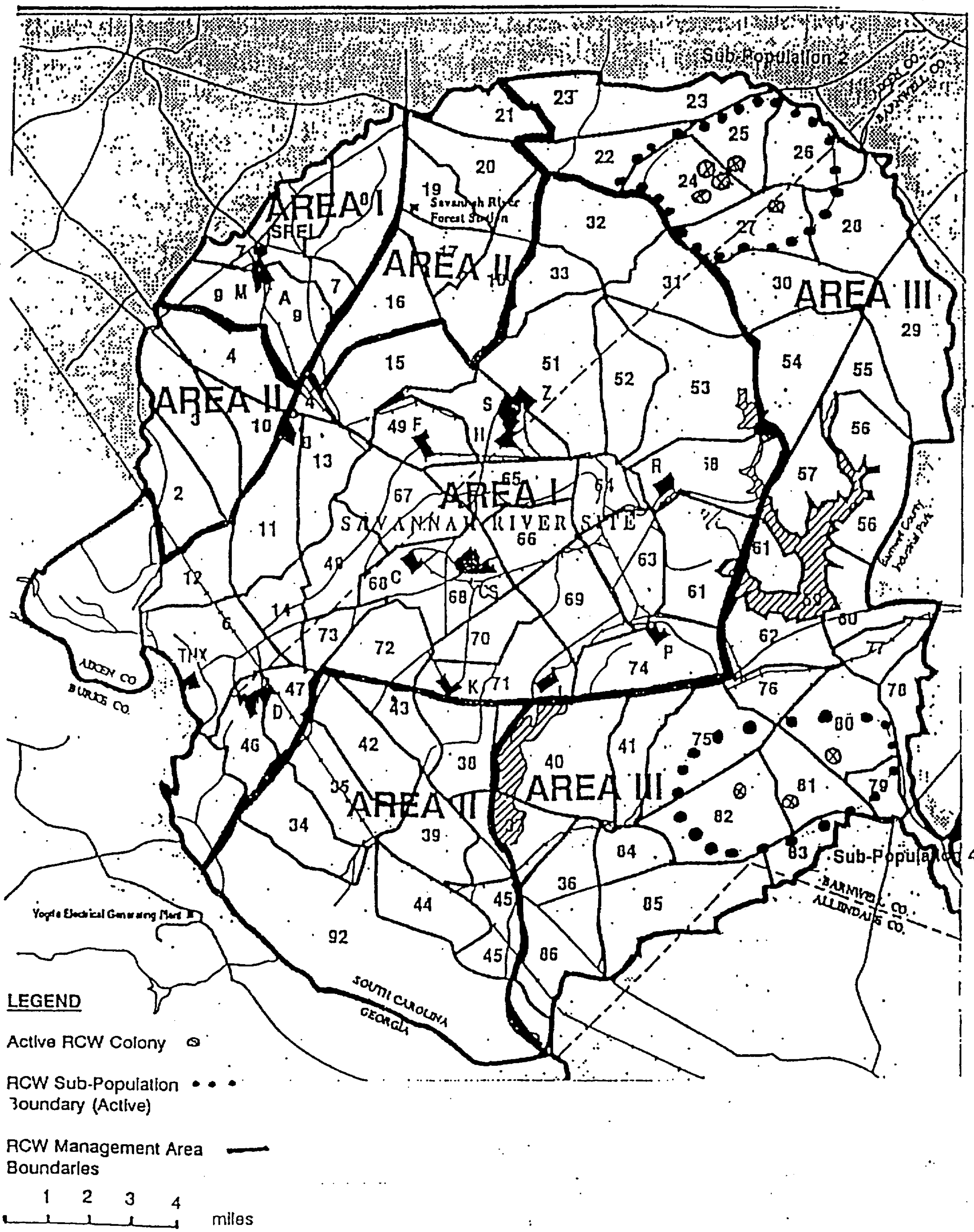
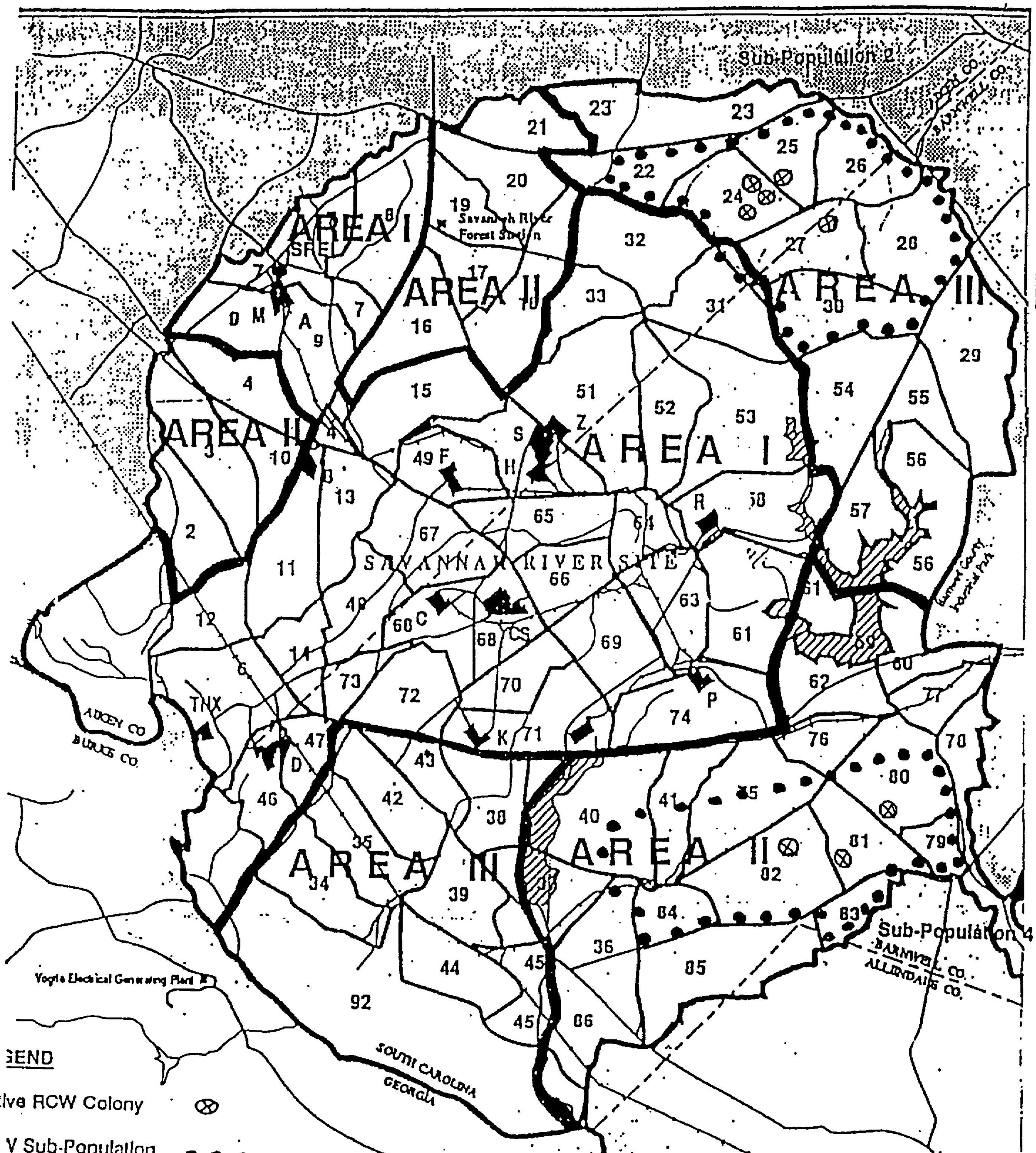


Figure 3. Alternative 2 - red-cockaded woodpecker (RCW) habitat management direction at Savannah River Site.



LEGEND

Active RCW Colony

RCW Sub-Population Boundary (Active)

RCW Management Area Boundaries

1 2 3 4

miles

Figure 4. Alternative 3 - red-cockaded woodpecker (RCW) habitat management direction at Savannah River Site.

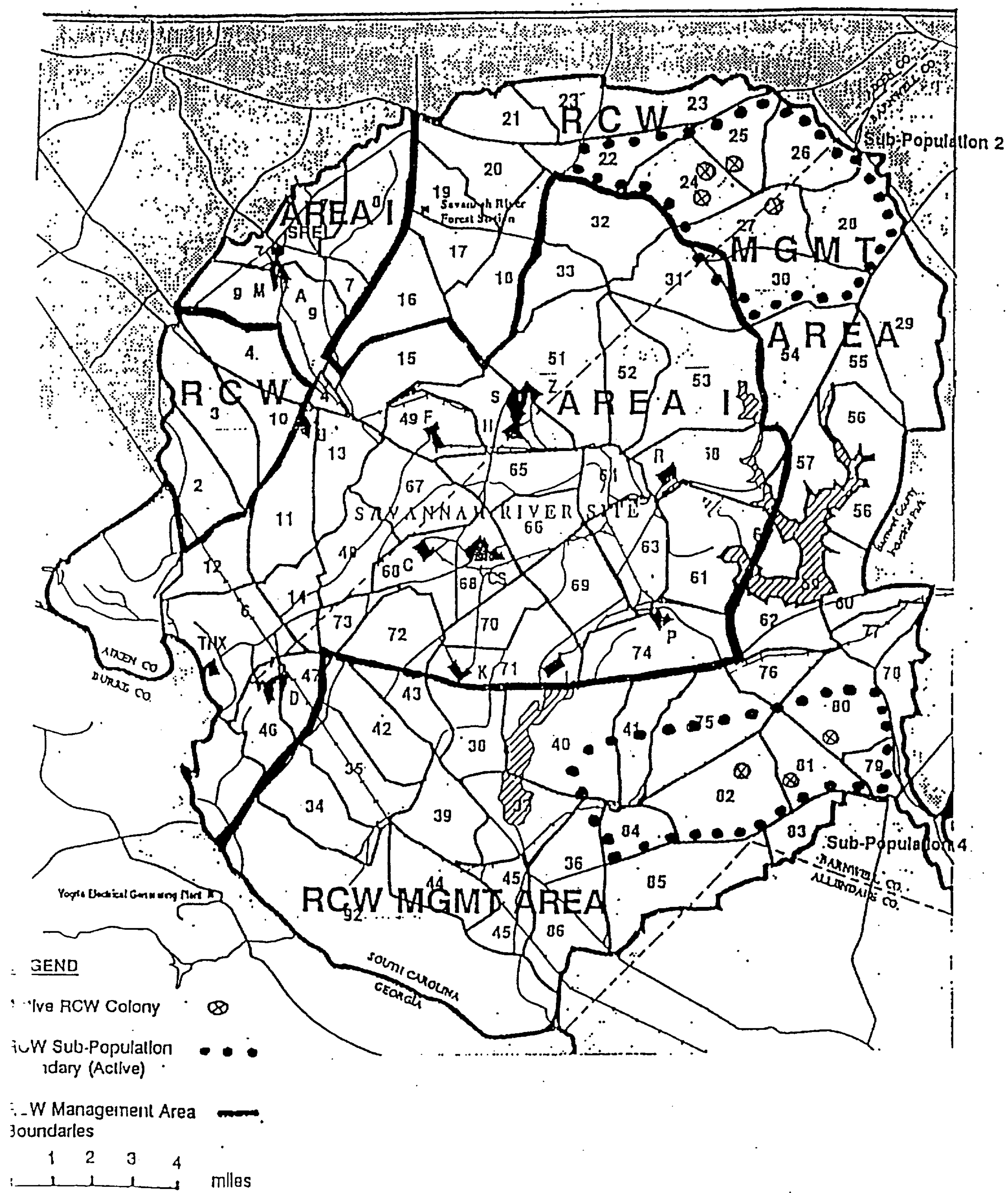


Table 1. The existing pine and pine-hardwood forest type age class distrubution for the Savannah River Site (January, 1991).

Acres by Age Classes

Age Classes	Longleaf Pine	Loblolly Pine	Slash Pine	Other Pine	Mixed Pine/Hdwd	Total
0-10	5,171	17,807	0	55	224	23,257
11-20	240	:1,055	0	57	102	11,454
21-30	7,410	1,208	1,228	0	79	9,925
31-40	14,340	19,711	24,789	0	1,043	59,883
41-50	4,776	8,829	2,357	0	1,273	17,235
51-60	3,012	3,446	275	102	927	7,762
61-70	961	1,166	0	0	550	2,677
71-80	783	241	0	0	196	1,220
81-90	371	0	0	0	0	371
91-100	110	0	0	0	0	110
Total	37,174	63,463	28,649	214	4,394	133,894

5,786 acres of pine are sparse or damaged condition.

Table 2. The Savannah River Site red-cockaded woodpecker colonies by compartment.

COMPARTMENT	COLONY	STATUS
2	12	Inactive
22	1	Inactive
24	2 18 19 27 49 (artificial)	Active Inactive Active Inactive Active
25	3	Active
26	36 37 38	Inactive Inactive Inactive
27	28 30	Active Inactive
28	35 44	Inactive Inactive
30	20	Inactive
39	8	Inactive
40	32	Inactive
42	9 10	Inactive Inactive
58	4 13 14 24	Inactive Inactive Inactive Inactive
80	16	Active
81	5 6 15 43	Active Inactive Inactive Inactive
82	39 40	Active Inactive
86	7	Inactive

TOTAL COLONY SITES - 32
TOTAL ACTIVE COLONIES - 8

Table 3. The Savannah River Site RCW colony sites by sub-population designation.

Sub-Population	Active Colonies	Inactive Colonies	Total Colonies
1	0	1	1
2	5	10	15
3	0	5	5
4	3	4	7
5	0	1	1
6	0	3	3
Totals	8	24	32

Table 4. Age class distribution for pine and pine-hardwood forest types in Management area 1 for all alternatives on the Savannah River Site (January, 1991).

Acres by Age Classes

Age Classes	Longleaf Pine	Loblolly Pine	Slash Pine	Other Pine	Mixed Pine/Hdwd	Total
0-10	577	8,031	0		73	8,681
11-20	134	4,567	0	43	66	4,810
21-30	1,237	622	505	0	0	2,364
31-40	2,259	7,700	17,004	0	357	27,320
41-50	1,365	4,144	476	0	452	6,437
51-60	1,520	1,648	55	0	513	3,736
61-70	55	693	0	0	220	968
71-80	15	217	0	0	138	370
81-90	195	0	0	0	0	195
91-100	46	0	0	0	0	46
Total	7,403	27,622	18,040	43	1,819	54,927

995 acres of pine are sparse or damaged

Table 5. Age class distribution for pine and pine-hardwood forest types in Management Area 2 for Alternative 1 on the Savannah River Site (January, 1991).

Acres by Age Classes

Age Classes	Longleaf Pine	Loblolly Pine	Slash Pine	Other Pine	Mixed Pine/Hdwd	Total
0-10	839	3,556	0	0	140	4,535
11-20	60	2,787	0	6	0	2,853
21-30	2,691	260	213	0	0	3,164
31-40	3,728	5,904	3,751	0	369	13,752
41-50	706	1,823	826	0	626	3,981
51-60	245	760	28	0	26	1,059
61-70	152	210	0	0	227	589
71-80	66	0	0	0	0	66
81-90	16	0	0	0	0	16
91-100	0	0	0	0	0	0
Total	8,503	15,300	4,818	6	1,388	30,015

571 acres of pine are sparse or damaged.

Table 6. Age class distribution for pine and pine-hardwood forest types in Management Area 2 for Alternative 2 on the Savannah River Site (January, 1991).

Acres by Age Classes

Age Classes	Longleaf Pine	Loblolly Pine	Slash Pine	Other Pine	Mixed Pine/Hdwd	Total
0-10	2,843	5,153	543	0	11	8,550
11-20	60	3,983	0	6	36	4,085
21-30	2,826	333	425	0	79	3,663
31-40	7,875	7,630	4,017	0	392	19,914
41-50	1,444	1,968	727	0	256	4,395
51-60	400	766	169	0	300	1,635
61-70	162	33	0	0	39	234
71-80	282	0	0	0	14	296
81-90	45	0	0	0	0	45
91-100	0	0	0	0	0	0
Total	15,937	19,866	5,881	6	1,127	42,817

1,458 acres of pine are sparse or damaged.

Table 7. Age class distribution for pine and pine-hardwood forest types in Management Area 3 for Alternative 1 on the Savannah River Site (January, 1991).

Acres by Age Classes

Age Classes	Longleaf Pine	Loblolly Pine	Slash Pine	Other Pine	Mixed Pine/Hdwd	Total
0-10	3,755	6,220	0	55	11	10,041
11-20	46	3,701	0	8	36	3,791
21-30	3,482	326	510	0	79	4,397
31-40	8,353	6,107	4,034	0	317	18,811
41-50	2,705	2,862	1,055	0	195	6,817
51-60	1,247	1,038	192	102	388	2,967
61-70	754	263	0	0	103	1,120
71-80	702	24	0	0	58	784
81-90	160	0	0	0	0	160
91-100	64	0	0	0	0	64
Total	21,268	20,541	5,791	165	1,187	48,952

4,220 acres of pine are sparse or damaged.

Table 8. Age class distribution for pine and pine-hardwood forest types in Management Area 3 for Alternative 2 on the Savannah River Site (January, 1991).

Acres by Age Classes

Age Classes	Longleaf Pine	Loblolly Pine	Slash Pine	Other Pine	Mixed Pine/Hdwd	Total
0-10	1,751	4,623	0	55	140	6,569
11-20	46	2,505	0	8	0	2,559
21-30	3,347	253	298	0	0	3,898
31-40	4,206	4,381	3,225	0	294	12,106
41-50	1,967	2,717	1,154	0	565	6,403
51-60	1,092	1,032	51	102	114	2,391
61-70	744	440	0	0	291	1,475
71-80	486	24	0	0	44	554
81-90	131	0	0	0	0	131
91-100	64	0	0	0	0	64
Total	13,834	15,975	4,728	165	1,448	36,150

3,333 acres of pine are sparse or damaged condition.

Table 9. Age class distribution for pine and pine-hardwood forest types in the RCW Management Area for Alternative 3 on the Savannah River Site (January, 1991).

Acres by Age Classes

Age Classes	Longleaf Pine	Loblolly Pine	Slash Pine	Other Pine	Mixed Pine/Hdwd	Total
0-10	4,594	9,776	0	55	151	14,576
11-20	106	3,488	0	14	36	6,644
21-30	6,173	586	723	0	79	7,561
31-40	12,081	12,011	7,785	0	686	32,563
41-50	3,411	4,685	1,881	0	821	10,798
51-60	1,492	1,798	220	102	414	4,026
61-70	906	473	0	0	330	1,709
71-80	768	24	0	0	58	850
81-90	176	0	0	0	0	176
91-100	64	0	0	0	0	64
Total	29,771	35,841	10,609	171	2,575	78,967

4,791 acres of pine are sparse or damaged condition.

BIOLOGICAL EVALUATION

Red-cockaded Woodpecker Management

Standards and Guidelines

Savannah River Site

June, 1991

Introduction

This is a biological evaluation to determine the effects of implementing the red-cockaded woodpecker (RCW) management standards and guidelines for the Savannah River Site on proposed, threatened, and, endangered plants and animals.

The USFS recommended to the Department of Energy (DOE) for the SRS to be included in the "Interim Standards and Guidelines" until the final EIS outlining the long-term management direction for RCW was completed in approximately 2-3 years (Letter from J. Irwin to B. Gould, 6/6/90). However, DOE made the decision not to be included in the regional guidelines (Letter from S. Wright to J. Alcock, 12/90). DOE directed the USFS to develop management guidelines for the SRS that had the flexibility to incorporate a landscape biological diversity research project.

The SRS standards and guidelines will be implemented with the objective of providing short-term protection of the existing small population and provide for the long-term expansion and recovery of the SRS population to a viable level in a management/research setting. The guidelines will address the issues concerning the lack of potential cavity trees for the short and long term, mid-story encroachment, and nesting/foraging habitat fragmentation.

This biological evaluation does not include the 30,000 acres that will be included within the landscape research project. Seperate research standards and guidelines will developed for RCW within this area. Seperate section 7 consultation with the USFWS will be conducted for the landscape research project. Approximately 60 percent of the research area will contain short rotations to experimentally isolate longleaf forest patches. The location of these short rotation experiments is not yet known. If a large part of the short rotation experiment is located within the RCW Management Area, then the overall objective of 400 colonies would be in question.

Research should identify as many areas as possible within the 56,000 acres in Management Area 1 (50 year rotation) for the short rotation portion of the experiment, to lessen conflicts with recovery objectives. If areas are selected within the RCW Management Area for the short rotation, then areas from Management Area 1 will need to be reclassified to replace the acres to maintain the 78,967 acre level of pine habitats in the RCW Management Area.

SRS Proposed, Endangered, and Threatened (PET) Species

The PET species on the SRS are the red-cockaded woodpecker, southern bald eagle, wood stork, and the shortnose sturgeon. The American alligator is threatened due to similarity in appearance to the American Crocodile.

Red-cockaded Woodpecker (RCW)

Presently the SRS RCW population contains 32 colony sites. Of these colony sites, 8 are active. As of 6/91, 6 colony sites are breeding and producing young. The 32 colonies are divided into 6 demographic sub-populations. The active colonies are located in 2 of these sub-populations. One of these active sub-populations(sub-population 2) is located in the northeastern section of the SRS and the other sub-population (sub-population 4) is located in the southeastern section (Figure 1.)

Nesting habitat requirements center around the birds need for older, living southern pines to excavate cavities for nesting and roosting. The average age for cavity trees in the SRS population is 74 years (47-127) for loblolly pine and 110 years (55-260) for longleaf pine. The average age for cavity starts (from data in the 1985 FSH 2609.23R) is 74 and 77 years for loblolly and 95 years for longleaf pine.

Another important component for nesting habitat is that the pine forest involved contain open mid-story free from encroachment of dense hardwood and pine saplings greater than 10 - 15 feet in height. The optimum nesting habitat would be in an older (100+ years) longleaf pine/wiregrass or bluestem forest community with sufficient foraging habitat to support a colony.

Foraging habitat is presently defined as pine or pine/hardwood forest greater than 30 years old, within 1/2 mile of colony sites or suitable nesting habitat. These pine and pine/hardwood forest should contain a minimum of 6350 pine stems 10 inches or greater in DBH and 8500 square feet of basal area that is not isolated from the colony or suitable nesting habitat.

Southern Bald Eagle

Presently there are two eagle nests located on the SRS. One of these nests is currently active and has fledged young during the spring of 1990 and 1991.

Both nests are located in isolated areas of the SRS. Both nests are within one mile of large reservoirs (L-Lake and Par Pond) on the site. One nest is located in a bald cypress in a Carolina bay and the active nest is located in a large loblolly pine on the edge of a large beaver pond. The eagles feed primarily in the large reservoirs.

Eagle management zones have been put in place within a 1 mile radius of the nests.

Wood Stork

Presently there are no nesting wood stork colonies on the SRS. Wood storks primarily use wetland (bays and swamps) and the edges of aquatic habitats (reservoirs) on the SRS for foraging after the breeding season during the summer. These storks come to the site from the nearest breeding site at the Birdsville colony in Georgia.

Shortnose Sturgeon

This species has been found (no recent sitings) in the Savannah River adjacent to the SRS.

Alternative Descriptions

Based on direction given to the SRFS by the Department of Energy and interaction with the Southeastern Forest Experiment Station (SEFES), three alternatives were developed to address new management direction for the SRS RCW Population with the purpose of providing habitat to support an effective population size of 250 colonies.

Several standards and guidelines (S&G) are common to all alternatives within the RCW Management Area. These S&G involve (1) the management of foraging habitat, (2) the minimum amount of foraging habitat to be provided for each colony site and recruitment site, (3) colony site management, (4) recruitment site management, (5) the retention of relicts and potential cavity trees throughout the RCW Management Area, (6) monitoring, (7) size of regeneration harvest cuts, and (8) the retention of the oldest available longleaf and loblolly pine forests, with regeneration coming from the younger dominate age classes, with the emphasis on converting slash pine stands to longleaf pine.

Alternatives 1-2

Alternatives 1 - 2 divide the RCW management area into 2 areas (Area 2 and 3) with different regeneration harvest strategies. Area 2 has a maximum average regeneration harvest level of 12.5 percent of the area regulated pine acres for a 10 year period (equates to an 80 year pine rotation). Area 3 has a maximum average harvest level of 8.5 percent of the area regulated pine acres (equates to a 120 year pine rotation).

The differences between the alternatives is the location, size, and configuration of areas 2 and 3 within the RCW management area.

Alternative 1 contains 30,015 pine acres in area 2 and 48,952 pine acres in area 3. Area 3 is continuous in the southeastern, eastern, and northeastern sections of the RCW Management Area and encompasses the active sub-populations 2 and 4.

Alternative 2 contains 42,817 pine acres in area 2 and 36,150 pine acres in area 3. Area 3 is divided into 2 sections, with one section being located in the northeastern section and the other section is located in the southwestern section of the RCW Management Area. Area 3 encompasses active sub-population 2 and area 2 contains active sub-population 4.

Alternative 3

Alternative 3 treats the RCW Management Area uniformly across the 78,967 acres of pine forest. Longleaf pine management types will be managed on a 120 year rotation and loblolly pine management types will be managed on an 80 year rotation. The assumption is that a minimum of 50% of the existing loblolly forest type will be converted to longleaf. This would than equate to a maximum regeneration harvest level for a 10 year period of 9.5% of the area regulated pine forest types. Five out of the six sub-populations will be contained within this management strategy, which includes the 2 active sub-populations 2 and 4.

Evaluation of Effects

The effects of the different alternatives on the following issues will be discussed.

Age Class Distribution (Availability of Nesting Habitat)

Short-term (0-20 years)

In all alternatives, the emphasis will be to convert existing slash pine to longleaf pine during the next two decades. Harvest cuts will not adversely effect existing potential nesting habitat. Levels of harvest throughout the next two decades will be determined more by nesting and foraging habitat requirements, than by the maximum allowable levels. The older age classes (50+ years) in the longleaf and loblolly will be maintained at current levels and above.

Artificial cavities will be placed in suitable nesting habitat as well as younger stands, at a rate of 3 to 4 per 10 acres of habitat, within 3 miles of all active colonies for all alternatives in an effort to further assist in the expansion of the existing population.

Long-term (20 plus years)

In alternatives 1 - 2, a portion of the RCW Management Area is placed in area 2 (80 year rotation) and a portion in area 3 (120 year rotation).

Projected age class distributions after 5 decades for alternative 1 are shown in Table 1. It is projected that in 50 years, 32 percent of the RCW Management Area will contain suitable nesting habitat.

Projected age class distributions after 5 decades for alternative 2 are shown in Table 2. It is projected that in 50 years, 28 percent of the RCW Management Area will contain suitable nesting habitat.

While, equilibrium projects were not made, it is assumed that the percentages of acreage in suitable nesting habitat shown in alternatives 1 - 2 after 5 decades will be close to those in the long-term equilibrium age class distributions.

The distribution of suitable nesting habitat will be limited by the configuration of areas 2 and 3 in alternatives 1 - 2. Area 2 in these alternatives will contain suitable nesting habitat in the recruitment areas and in stands that contain scattered relicts and potential cavity trees. The ability of the RCW to expand into area 2 over the long-term may be limited due to the smaller percentage of nesting habitat that will be provided in recruitment stands only. A continual flow of nesting habitat over time will not occur in area 2. Expansion potential in area 3 should be good for the RCW, with a continual flow of nesting habitat occurring over time in this area.

In Alternative 3 the RCW Management Area is uniformly treated, with longleaf pine managed on a 120 year rotation and loblolly pine on an 80 year rotation.

Projected age class distributions after 5 decades for alternative 3 are shown in Table 3. It is projected that in 50 years, 35 percent of the RCW Management Area will contain suitable nesting habitat. It is assumed that this alternative past 50 years will potentially contain around 40 percent of the area in suitable nesting habitat.

The distribution of suitable nesting habitat will be uniform throughout the RCW Management Area in Alternative 3, being provided by both recruitment areas and a percentage of the area regulated acres. Younger forest stands will contain relicts and potential cavity trees in addition to the older aged stands.

Alternative 3 will have around 40 percent of the pine acreage potentially available for nesting and should provide good RCW expansion potential throughout the RCW Management Area. A continual flow of nesting habitat should occur over time throughout the entire RCW Management Area.

Mid-story Encroachment

An aggressive program of mid-story control in colony sites, recruitment stands, and suitable habitat not included in recruitment stands is identified for all alternatives. The priority will be to treat and maintain nesting habitat free of mid-story within 3 miles of active colony sites. A mix of growing season and winter prescribe burns will be conducted to maintain suitable RCW habitat on the large scale. These treatments will not adversely effect the RCW and will actually benefit the species.

Nesting Habitat Isolation (Colony Isolation)

Colony isolation and potential nesting habitat isolation pertains to the relationship of these sites to adjacent foraging habitat or other nesting habitat.

Short-Term (0-20 years)

During the next 2 decades, nesting habitat isolation should not occur for any alternative due to the priority on conversion of slash pine to longleaf pine, the oldest longleaf and loblolly pine stands will be retained, and harvest cuts will not occur if colony or recruitment isolation could result from the cut.

Long-Term (20 plus years)

The same results should hold true for the long-term period as the short-term. However, the potential for isolation is greatest in area 2 for alternatives 1 - 2. Isolation should not be a problem in these areas if before harvest cuts are planned the question is asked, "Will colony/recruitment isolation occur as a result of this harvest cut?". The answer should always be "No", which is in keeping with the S&G for harvest cuts. As stated previously, the level of harvest will be determined by habitat requirements of the RCW, not by attaining a predetermined regeneration harvest level.

Foraging Habitat Fragmentation

Short and Long-Term

Prior to any regeneration harvest occurring, a determination that foraging habitat will not be fragmented or isolated from colony sites or potential nest sites will be made. Foraging habitat fragmentation should not occur in any of the alternatives.

Determination of Effects

Other PET Species

The alternatives described will not adversely effect the Southern Bald Eagle, Wood Stork, or Shortnose Sturgeon on the SRS.

Red-cockaded Woodpecker

The alternatives described will provide different degrees of benefit and expansion potential to the RCW. Alternative 3 provides the best potential for the short-term protection and long-term expansion of the RCW to viable levels, because this alternative (1) provides for a continual flow and distribution of nesting habitat, and (2) provides the highest acreage levels containing potential cavity trees across the entire RCW Management Area. Alternative 3 is least likely to fragment or isolate nesting and foraging habitat. Alternative 2 provides the least potential for the short-term protection and long-term expansion of the RCW to viable levels. This is because (1) one active sub-population is included in Area 2 (80 year rotation) and (2) the fewest acres are in the Area 3 (120 year rotation), which limits the distribution of nesting habitat and a continual flow of habitat through time and provides the fewest acres containing potential suitable cavity trees of the three alternatives. Alternative 1 has all active sub-populations within Area 3 and contain acreage in Area 3 (longer rotation) below alternative 3 and above alternatives 2. Alternatives 1 would rank between alternative 2 and alternative 3 with regards to short-term and long-terms affects on RCW.

Alternatives 1 - 2 both divide a portion of the RCW Management Area into an 80 year rotation (without regard to tree species) at differing levels. Expansion potential into these areas have the potential to be hampered over the long-term due to harvesting at levels that will not provide good distribution and an even flow of nesting habitat over time. However, there are standards and guidelines that apply to the 80 year rotation areas (Area 2) that will not permit regeneration harvest to proceed if certain criteria pertaining to foraging habitat requirements, foraging fragmentation, and colony isolation are not met. There are S&Gs that provide for the retention of all relicts, retention of the oldest available longleaf and loblolly pine stands, the overall priority for retaining longleaf pine, the limit on regeneration harvest size, identifying the highest population density objective of 1 colony per 200 acres of pine forest, artificial cavities, high level of monitoring (SEFES), aggressive augmentation, and nesting habitat improvement (recruitment potential) in all potential nesting habitat, even in areas not identified has recruitment areas. Without these types of S&G, the determination that Alternatives 1 - 2 would likely adversely effect RCW would have to be made. However, the S&G's are in place for all alternatives and management areas.

Alternatives 1 thru 3 are not likely to adversely affect the RCW. This determination does not take into account the effects of the 30,000 acre landscape research program that is under development. If alternatives 1 thru 3 is selected, concurrence by the USDI, Fish and Wildlife Service will be requested. Any site-specific variation, during program implementation, from the alternative that is selected, will require USFWS consultation.

GLEN D. GAINES
WF&B Staff Officer

Figure 1. Subpopulation and colony locations for the Savannah River Site red-cockaded woodpecker population.

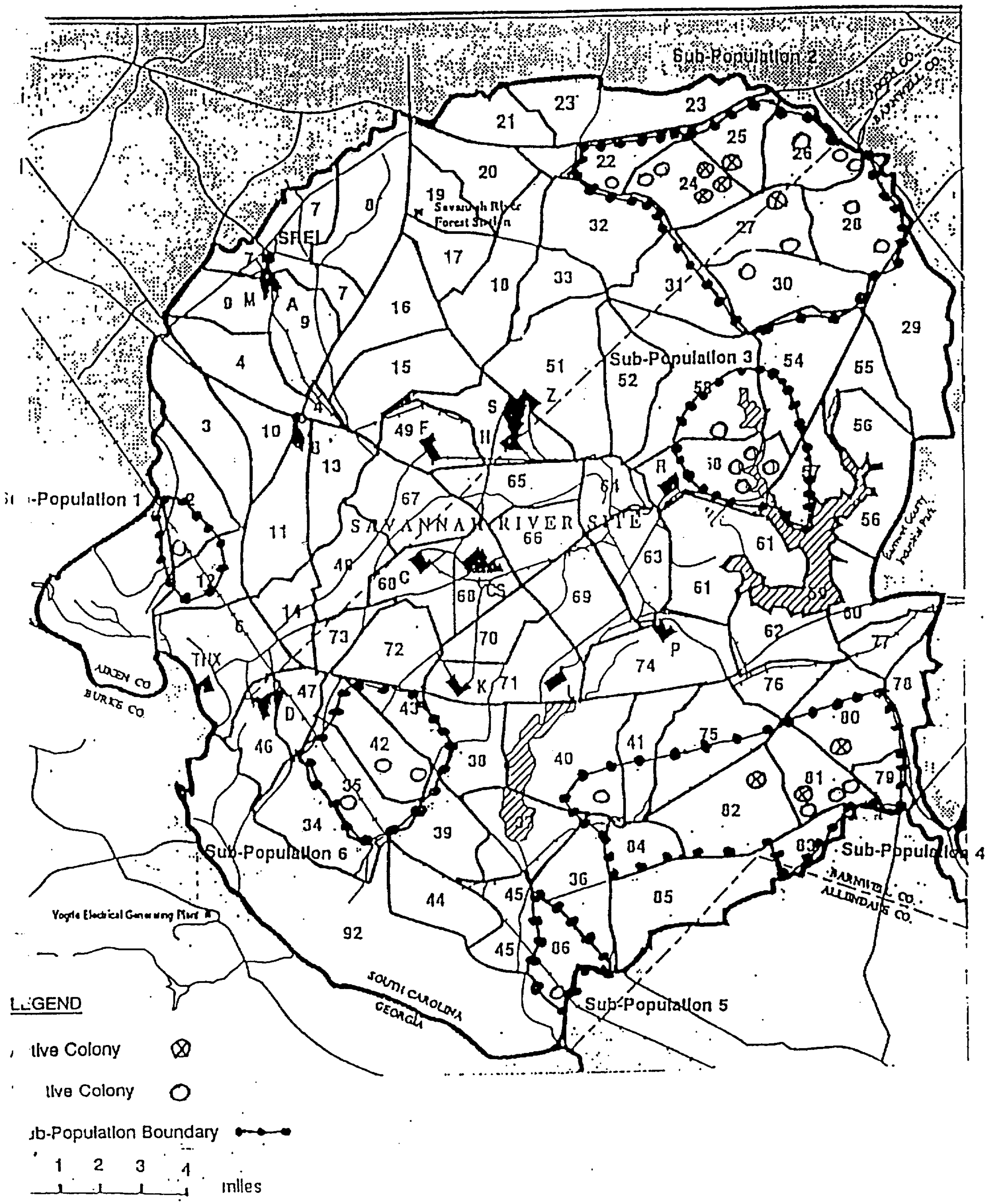


Table 1. The projected pine and pine-hardwood forest type age class distribution in the RCW Management Area (areas 2 and 3 combined) for Alternative 1 after 50 years for the Savannah River Site (January, 1991).

Acres by Age Classes

Age Classes	Longleaf Pine	Loblolly Pine	Slash Pine	Other Pine	Mixed Pine/Hdwd	Total
0-10	5,184	1,727	0	0	0	6,911
11-20	5,184	1,727	0	0	0	6,911
21-30	5,184	1,727	0	0	0	6,911
31-40	6,108	803	0	0	0	6,911
41-50	6,911	0	0	55	151	7,117
51-60	4,594	9,003	0	14	36	13,647
61-70	106	394	0	0	79	579
71-80	6,173	0	0	0	686	6,859
81-90	10,414	0	0	0	821	11,235
91-100	982	0	0	102	414	1,498
101-110	0	0	0	0	330	330
111-120	0	0	0	0	58	58
Total	50,840	15,381	0	171	2,575	68,967

10,000 acres recruitment/research (uneven-aged management)

Estimated Suitable Nesting Habitat - 22,520 acres

-Assumptions for 50 year simulation:

Regeneration harvest at the maximum average levels

10,000 acres of uneven-aged management for recruitment/research

50% of loblolly off-site

Conversion priority during the first 2 decades was slash to longleaf and during decades 3 thru 5 the priority was converting loblolly to longleaf.

Table 2. The projected pine and pine-hardwood forest type age class distribution in the RCW Management Area (areas 2 and 3 combined) for Alternative 2 after 50 years for the Savannah River Site (January, 1991).

Acres by Age Classes

Age Classes	Longleaf Pine	Loblolly Pine	Slash Pine	Other Pine	Mixed Pine/Hdwd	Total
0-10	5,406	1,952	0	0	0	7,358
11-20	6,084	1,274	0	0	0	7,358
21-30	5,519	1,839	0	0	0	7,358
31-40	6,384	1,027	0	0	0	7,411
41-50	7,358	0	0	55	151	7,564
51-60	4,594	9,776	0	14	36	14,420
61-70	106	2,382	0	0	79	2,567
71-80	6,173	0	0	0	686	6,859
81-90	5,355	0	0	0	821	6,176
91-100	992	0	0	102	414	1,508
101-110	0	0	0	0	330	330
111-120	0	0	0	0	58	58
Total	47,971	18,250	0	171	2,575	68,967

10,000 acres recruitment/research (uneven-aged management)

Estimated Suitable Nesting Habitat - 25,073 acres

-Assumptions for 50 year simulation:

Regeneration harvest at the maximum average levels

10,000 acres of uneven-aged management for recruitment/research

50% of loblolly off-site

Conversion priority during the first 2 decades was slash to longleaf and during decades 3 thru 5 the priority was converting loblolly to longleaf.

Table 3. The projected pine and pine-hardwood forest type age class distribution in the RCW Management Area (areas 2 and 3 combined) for Alternative 3 after 50 years for the Savannah River Site (January, 1991).

Acres by Age Classes

Age Classes	Longleaf Pine	Loblolly Pine	Slash Pine	Other Pine	Mixed Pine/Hdwd	Total
0-10	4,397	2,155	0	0	0	6,552
11-20	4,397	2,155	0	0	0	6,552
21-30	4,397	2,155	0	0	0	6,552
31-40	4,397	2,155	0	0	0	6,552
41-50	4,397	2,155	0	55	151	6,758
51-60	4,594	9,776	0	14	36	14,420
61-70	106	1,414	0	0	79	1,599
71-80	6,173	0	0	0	686	6,859
81-90	11,398	0	0	0	821	12,219
91-100	0	0	0	102	414	516
101-110	0	0	0	0	330	330
111-120	0	0	0	0	58	58
Total	47,869	18,250	0	171	2,575	68,967

10,000 acres recruitment/research (uneven-aged management)

Estimated Suitable Nesting Habitat - 27,571 acres

-Assumptions for 50 year simulation:

Regeneration harvest at the maximum average levels

10,000 acres of uneven-aged management for recruitment/research

50% of loblolly off-site

Conversion priority during the first 2 decades was slash to longleaf and during decades 3 thru 5 the priority was converting loblolly to longleaf.

Appendix C:
Comparison of 1991 and 1999 SRS RCW Management Plans

	SUMMARY OF 1991 RCW MANAGEMENT PLAN	
	MANAGEMENT AREA 1	**MANAGEMENT AREA 2**
Parameters		
Total acres	83,168	115,179
RCW acres	Na	~80,000 (CISC database)
Population objective	0 groups	400 groups (1 group per 200 acres)
Incidental take	no	no
Facilities and Development Flexibility	none	none
Management Activities		
Rotation length	50 years for pine species	80 years for loblolly pine; 120 for longleaf pine
Regeneration size	10-80 acres for harvest cuts; average 40 acres	10-40 acres for harvest cuts; average <25 acres
Pine thinning	Maintain 60-80 ft^2 basal area per acre	Maintain 60-80 ft^2 basal area per acre
Prescribed fire	Non-growing season fires 1 to 2 times per 10 years	Prescribed fires 2 times per 10 years with a burning target of 4,000 to 6,000 acres. Burns will be conducted during non-growing season with every 3rd burn (12-15 years) conducted during the growing season.
Relict trees in harvest cuts and thinnings	Na*	Retain a minimum of 6 relict and/or potential cavity trees per acre, except in stand conversion cuts. All >1 acre clumps of longleaf pine containing >40 ft^2 basal area will be retained as inclusions.
Pine thinning in clusters	Na*	Thin to spacing of 20-25 ft and maintain over-story pine BA of at least 60 ft^2
Hardwood removal in clusters	Na*	Remove mid-story hardwoods on an entire stand basis and on a minimum of 10 acres
Foraging habitat	Na*	6,350 stems >10 inches DBH and 8,500 ft^2 of pine basal area >30 years of age. Insure regeneration and intermediate thinnings do not reduce RCW foraging below this minimum.
Fragmentation/ isolation of active clusters	Na*	"Ensure that regeneration practices do not result in RCW cluster isolation or foraging habitat fragmentation." The Bluebook defines non-contiguous as >330 ft.

	SUMMARY OF 1991 RCW MANAGEMENT PLAN	
	MANAGEMENT AREA 1 (Facilities)	MANAGEMENT AREA 2 (RCW)
Management Activities		
Monitoring	Na*	Band, identify, and track each individual's location and status. All active clusters sites, inactive cluster sites, and recruitment stands within 3 miles of an active cluster will be monitored annually. Monitoring will include cluster composition, group status, and roost checks. Cavity competition will be monitored in active clusters and recruitment clusters.
Replacement stands	Na*	As close as possible to active cluster but <½ mile and >10 acres in size.
Recruitment clusters	Na*	Within ½ to 3/4 mile from clusters and >10 acres
Regeneration	Standard even-aged management (i.e., clearcutting)	Priority for regeneration will be the conversion of off-site slash pine. No regeneration harvest will reduce foraging habitat within ½ mile of active clusters or recruitment stands to below federal guidelines. Regeneration practices will not result in RCW cluster isolation or foraging habitat fragmentation. Both even-aged (clearcutting, seedtree, and shelterwood) and unevened-aged methods may be used to regenerate forested stands.

Na* = not applicable unless RCW group becomes established by natural dispersal. If this were to occur, management activities outlined for Management Area 2 would apply.

	SUMMARY OF 1999 RCW MANAGEMENT PLAN		
	OTHER-USE AREA	SUPPLEMENTAL RCW HMA	RCW HMA
Parameters			
Total acres	64,111	48,167	86,069
RCW acres	Na	30,892 (ecosystem classification)	65,288 (ecosystem classification)
Population objective	0 groups	103 groups (1 group per 300 acres)	315 groups (1 group per 200 acres)
Incidental take	yes	yes	no
Facilities and Development Flexibility	yes	yes	yes
Management Activities in Forage Habitat			
Rotation length	50 years for pine species	50 years for pine species	100 years for loblolly pine; 120 years for longleaf pine
Regeneration size	10-80 acres for harvest cuts; average 40 acres	10-80 acres for harvest cuts; average 40 acres	10-40 acres for harvest cuts; average <25 acres
Regeneration	Standard even-aged management (i.e., clear cutting)	Forage habitat surrounding each supplemental RCW cluster will have regeneration harvests by even-aged management. Regeneration cuts will be between 10-80 acres and average 40 acres. During regeneration, an attempt will be made to retain adequate forage and to avoid RCW cluster isolation or forage habitat fragmentation.	Priority for regeneration will be the conversion of off-site species, primarily slash pine. No regeneration harvest will reduce foraging habitat within ½ mile of clusters or in recruitment clusters within 1.5 miles of active clusters to below federal guidelines. No pine stands within 1/4 mile of an active cluster will be regenerated by clear cutting. This includes regeneration cutting to restore desirable species. Only thinning to enhance RCW habitat, irregular shelterwood or irregular seedtree harvests, or uneven-aged management will occur, if other applicable guidelines, including foraging habitat, are met. In seedtree and shelterwood harvest cuts, at least 20-30 ft^2 of pine BA will be retained, inclusive of at least 6 longleaf pine trees per acre, where available. Seedtree and shelterwood areas will be considered as foraging habitat. Residuals trees will not be harvested.

Prescribed fire	Non-growing season fires 1 to 2 times per 10 years	Prescribed burning will be conducted in pine stands 1-2 times during each 10-year planning period. Growing season burns will be emphasized in habitats that were naturally maintained by growing-season fires (i.e., longleaf pine). **However, burn when you can!**	Prescribed burning will be conducted in pine stands 2-3 times during each 10-year planning period. Growing season burns will be emphasized in habitats that were naturally maintained by growing-season fires (i.e., longleaf pine). **However, burn when you can!**
Relict trees in harvest cuts and thinnings	Na	Na	All relict trees will be retained in regeneration harvest cuts. Where relicts are limited, a minimum of 6 relict and/or potential RCW cavity trees per acre will be retained. All >1 acre clumps of longleaf pine containing >40 ft^2 basal area will be retained as inclusions.

	SUMMARY OF 1999 RCW MANAGEMENT PLAN		
	OTHER-USE AREA	**SUPPLEMENTAL RCW HMA**	**RCW HMA**
Management Activities in Clusters			
Pine thinning in clusters	Na	Thin to spacing of 20-25 ft and maintain overstory pine BA of at least 50 ft^2. The order of priority for retaining trees during thinnings will be (1) relict trees; (2) potential cavity trees; (3) trees ≥10 inch DBH that are not potential cavity trees; and (4) trees <10 inch DBH. No more than 10 ft^2 of total over-story BA will be in hardwood species. All snags (pine and hardwood) will be left standing unless they pose a safety risk.	Thin to spacing of 20-25 ft and maintain over-story pine BA of at least 50 ft^2. The order of priority for retaining trees during thinnings will be (1) relict trees; (2) potential cavity trees; (3) trees ≥10 inch DBH that are not potential cavity trees; and (4) trees <10 inch DBH. No more than 10 ft^2 of total over-story BA will be in hardwood species. All snags (pine and hardwood) will be left standing unless they pose a safety risk.
Hardwood removal in clusters	Na	Midstory removal and control will occur over the entire stand. All hardwood mid-story trees within a 50-foot radius of active and inactive cavity trees will be removed. An average of 3 selected mid-story hardwoods per acre may be retained throughout the remainder of the stand. Pine midstory will also be controlled to remove physical barriers to cavity trees, potential cavity trees, and the line of sight between them. No more than 5 within-canopy hardwoods per acre will be retained in active clusters, recruitment clusters, or replacement clusters.	Midstory removal and control will occur over the entire stand. All hardwood mid-story trees within a 50-foot radius of active and inactive cavity trees will be removed. An average of 3 selected mid-story hardwoods per acre may be retained throughout the remainder of the stand. Pine midstory will also be controlled to remove physical barriers to cavity trees, potential cavity trees, and the lire of sight between them. No more than 5 within-canopy hardwoods per acre will be retained in active clusters, recruitment clusters, or replacement clusters.

Foraging habitat	Na	Bluebook requirements for forage availability represent only a target in the Supplemental RCW HMA, but a goal that Management should strive to meet to ensure the success of supplemental recruitment clusters (SRCs).	Forage habitat must be within ½ mile of the geometric center of the cavity tree cluster. Forage will include only pine and pine-hardwood stands. Forage will contain at least 6,350 pine stems ≥10 inch DBH and ≥30 years of age. Forage will be continuous and contiguous with the cluster. Forage requirements may be reduced by 1/3 below "Bluebook" for (1) off-site conversion of pine species; (2) where pine stocking is >100 BA; (3) for SPB control and prevention, and (4) to establish new recruitment stands, and 5) in general, for ecological restoration.
Fragmentation/ isolation	Na	During regeneration an attempt will be made to avoid RCW cluster isolation and foraging habitat fragmentation.	No regeneration harvest will result in the isolation of an active RCW cluster of fragmentation of its forage habitat. No specific criteria will be identified to control habitat fragmentation or cluster isolation. However, the harvest restrictions within 1/4 miles of a cluster, the BA required in shelterwood cuts, the retention of relicts and inclusions in other regeneration areas, and the reduced regeneration harvest cut size, are intended to minimize potential habitat fragmentation and reduce the amount of unsuitable habitat among active clusters.
Monitoring	Na	Band, identify, and track each individual's location and status. All active clusters sites, inactive cluster sites, and recruitment stands will be monitored annually. Monitoring will include cluster composition, group status, and roost checks. Cavity competition will be monitored in active clusters and recruitment clusters.	Band, identify, and track each individual's location and status. All active clusters sites, inactive cluster sites, and recruitment stands will be monitored annually. Monitoring will include cluster composition, group status, and roost checks. Cavity competition will be monitored in active clusters and recruitment clusters.

Recruitment clusters	Na	Recruitment clusters will be established on a compartmental basis at a density of 1 cluster per 300 acres in all suitable habitat. Clusters will be approximately 10 acres in size. Clusters will be located 1/4 to ½ mile from active and inactive clusters, with their initial spatial arrangement in close proximity to the boundary between the RCW HMA and Supplemental RCW HMA.	Recruitment clusters will be selected on a compartment basis at a density of 1 cluster per 200 acres. All recruitment clusters will be at least 10 acres in size. The oldest available stands containing a minimum pine basal area (50 ft^2) will be selected for recruitment clusters, with first priority being within 3 miles of active clusters. Recruitment clusters will be located no closer than 1/4 mile from active clusters, inactive clusters serving as recruitment clusters, and other recruitment clusters. The number of recruitment clusters created annually will be based on an anticipated 10% growth in the number of existing groups.
Replacement stands	Na	Replacement stands will be selected for all active clusters. They will be located as close as possible and no more than ½ mile from the cluster. They will be >10 acres and preferably 20 to 30 years younger than the nearby cavity trees.	Replacement stands will be selected for all active clusters. They will be located as close as possible and no more than ½ mile from the cluster. They will be >10 acres and preferably 20 to 30 years younger than the nearby cavity trees.
Prescribed fire	Na	Prescribed burning will be conducted at least once every 4 years in active clusters. Growing season fires will be emphasized in longleaf pine habitats. However, habitat goals may require burning whenever conditions permit. After midstory is controlled and the native herbaceous vegetation is re-established, a combination of growing-season and non-growing-season fires may be used to prevent and control mid-story encroachment, especially in clusters where loblolly pine is dominant.	Prescribed burning will be conducted at least once every 4 years in active clusters. Growing season fires will be emphasized in longleaf pine habitats. However, habitat goals may require burning whenever conditions permit. After midstory is controlled and the native herbaceous vegetation is re-established, a combination of growing-season and non-growing-season fires may be used to prevent and control mid-story encroachment, especially in clusters where loblolly pine is dominant.

Appendix D:

RCW Augmentation Guidelines

Red-cockaded Woodpecker Augmentation
Guidelines

These guidelines include the critical steps for augmenting single bird colonies and translocating pairs to create new active colonies, as well as worked needed in the donor colonies. Included are tips learned during numerous augmentations.

AUGMENTING SINGLE BIRD COLONIES

Identify Single Bird Colonies

* Confirm single status by morning roost check (it is easy to miss a second bird in the evening, when some birds come in silently)

* Capture single birds to determine sex, and band with USFWS and color bands.

* Continue periodic monitoring (morning roost checks) as augmentation time approaches. Birds begin shuffling around in the fall, young begin dispersing, etc., and singles often pick up a mate on their own.

* Continue looking for single bird colonies through February. A dispersing bird may take up residence in an inactive colony or recruitment stand, or a bird may lose its mate. If donor birds are available, we can continue augmenting through February.

Preparation of Recipient Colony

* Install inserts if needed, in order to provide 4 suitable cavities. Install restrictors on suitable natural cavities. If no suitable cavity is available within 50 feet of the single bird's tree, install an insert. It is important to release the new bird near the resident to ensure that they meet.

* If the colony has not yet been midstoried, finish all midstory work prior to augmention. Some additional work may need to be done if the midstory has regrown to the point that it is difficult to get ladders in to the trees.

* Monumentation - make sure cavity trees and inserts are well-marked, and that the colony is easily located.

* If necessary, flag a route from the road into the tree the new bird will be put in. A colony looks a lot different by flashlight at 10pm than it does during the day!!

* 1-2 days before augmentation is planned, do a final roost check to make sure the bird is still single.

Augmentation Day

* Examine the cavity intended for the new bird. Make sure it is dry, not enlarged, etc. Remove any flying squirrels, wasps, etc., and cover with a screen (hardware cloth, 1/2" mesh) to keep squirrels out. Do not stuff a rag in it, as a rag can wick water into the cavity if it rains. This can be done a couple of days before augmentation.

* Put the single bird to bed the night of the augmentation. This is a last confirmation that the bird is single, and also insures that we know where it is roosting. If it has changed cavities, we might need to put the new bird in a different tree. Keep in mind that the new bird should be put into a tree within 50 feet of the resident.

* When the new bird arrives, it should be quickly and quietly put into its intended cavity. Use carpet tacks to tack the screen over the entrance to keep the new bird in the cavity. Don't tack the screen on so tightly that it is hard to pull off in the morning. If you put one tack at each corner, and put them in at an angle, they will hold the screen against the tree without you having to pound the tacks all the way in. Drop the string to the ground and have someone hold it away from the tree while the climber descends. Be careful not to accidently catch the string with the ladder and pull the screen off.

* Keep noise to a minimum to avoid flushing the resident bird.

Release Day

* Be at the colony well before you expect the single bird to emerge. Single birds have odd schedules, and might be skittish from the noise of the augmentation the night before. I recommend being there about daylight.

* The new bird will likely be ready to emerge before the resident, and will probably be tapping on the screen. Do not release the new bird until the resident emerges (do not flush resident - let it come out on its own).

* When resident emerges, pull screen off to release new bird. They nearly always come right out. If it doesn't emerge, tap or scratch on tree to flush it. NOTE: When pulling screen, pull slowly and steadily, and look down, so that the tacks don't hit you in the face.

* Have ladders present, so that if the string breaks you can quickly climb and pull the screen off the new bird's cavity. Use strong string (nylon is good), and check it before each augmentation to make sure it's in good condition. Don't tack the screen on so tight you can't pull it off easily!

* Have a cassette player with a tape of RCW calls handy. If the birds don't meet up you can hopefully use the tape to call the resident bird back to the new bird.

* Observe the birds for a while to see if they "hit it off". If the male follows the female, and both are twittering excitedly and hitching up the trunk together, chances are things are going well.

* Roost the birds that night to see if the new bird returns.

* Continue monitoring periodically. Even if the augmentations appears unsuccessful, the new bird might return weeks later, so don't give up. Do not be quick to re-augment a single bird - give the first bird time to settle down and return.

CREATION OF NEW COLONIES

Selection of Recipient Site

* Some general considerations: We want to avoid scattering isolated pairs over a large areas. When moving pairs of birds we need to form clusters of clans which are close enough to each other (within 1/2 mile) so that there is movement between clans. For example, if there are 1 or 2 clans which are isolated from the remainder of a population, moving several more pairs to inactive colony sites or recruitment stands within 1/2 mile of these clans will form a more stable subpopulation less vulnerable to sudden extinction. If it is possible to place the new pairs so that they link the isolated clans to the rest of the population, or link two isolated clans, so much the better.

Preparation of Recipient Site

* Site condition: Sites selected to receive birds (generally these are inactive colony sites or recruitment stands) should have been midstoried and should otherwise be suitable for the birds. Complete all midstory work prior to moving birds to the site.

* If at least 4 good-quality natural cavities are not available, inserts should be installed. Keep in mind that the birds should be placed in trees within 50 feet of each other.

* Monumentation - If necessary, flag the route in to the trees in which birds will be placed.

* A few days prior to moving the birds in, do a final inspection of the site and all cavity trees and inserts to make sure birds have not moved in on their own.

* Inspect the 2 cavities which will receive the new birds, remove squirrels, wasps, etc., and cover with screen.

Moving the Birds

* Follow the same procedures as for moving one bird. At release time, wait until both birds are tapping at their screens, and then pull both screens off. Monitor the birds as in regular augmentations.

* Continue follow-up monitoring even if neither bird returns to roost in the colony site the first night following release. Birds may return days or weeks after being moved, so keep checking. Also check nearby colony sites. If you locate one of the birds in this manner, it may be treated as a single bird and augmented.

DONOR POPULATION RESPONSIBILITIES

Preparation of Donor Colonies

* Donor colonies should contain adequate suitable cavities for all adult members of the clan, but should also have 2-3 cavities suitable for occupancy by fledglings. Birds roosting in the open have higher mortality than do birds using cavities. To save as many fledglings as possible inserts should be installed to remedy a cavity shortage. This is especially important in colonies with very few trees, where even adults are short of cavities.

* September-November is the time when many active cavity trees are lost to SPB, and this is also the time when we are in the colonies trapping fledglings. The loss of cavity trees to SPB can create a severe shortage of cavities, requiring timely installation of inserts. Even if a fledgling manages to survive while roosting in the open, it does our augmentation program no good if we can't catch it.

Banding fledglings

* Monitor fledglings closely to determine when they begin roosting in cavities. This will probably be in late July or August. When they start using cavities begin intensive banding, with as many crews as possible.

* Keep records of total number of birds in each colony, and which trees the fledglings are using. They often will be using the same tree when time to move them.

* Band as many fledglings as possible, until it is no longer possible to reliably distinguish them from the adults. The size of our augmentation program will be determined by the number of fledglings we have to work with. We can expect a 50% loss due to mortality and dispersal between the time the birds are banded and the time we finish augmentation.

* When a juvenile male is captured, it is important to determine if there is also a helper male in the clan. A juvenile male should be moved only if there will be a helper left in the colony. If clan size is not already known, it may be necessary to continue trapping clan members until 2 adult males are captured.

Selecting Donor Birds

* Avoid stripping all of a particular age/sex class from a given area. That is, do not remove all of the known juvenile females from one area. Some must be left to replace adult females lost to natural causes. Spread out the colonies from which you take birds. Keep this in mind when banding fledglings - band over a wide area.

* Before removing a juvenile male, double check to make sure there is still a helper present.

* When you capture a bird for augmentation, double check the USFWS band number. Birds, especially juvenile females, begin moving around in the fall. Make sure you are not taking a juvenile female which might have just dispersed and replaced a breeding female that had died.

* When selecting a male and female to be moved to a new colony site, select birds from widely separated colonies to lessen the chance that they are related.

* When planning an augmentation, do some roost checks of potential donor colonies. As mentioned, juvenile females are especially likely to begin dispersing by November. Have several donor birds located as back-ups, in case you are unable to capture one, or it has disappeared.

Transporting Birds

* Transport birds in cages which are well-ventilated, but are covered. Most species of birds tend to remain calmer in the dark.

* Transport birds one to a cage. Birds will peck at each other if placed together in a cage.

* The obvious precautions apply here - keep the bird in the front of the truck with you, not in the back; avoid bouncing the cage about, etc.

MATERIALS NEEDED FOR AUGMENTATION

* 1/2" mesh hardware cloth - need a piece about 5" x 7" (one piece for each bird).

* Nylon cord - need a piece long enough to reach the ground (one piece for each screen).

* Carpet tacks - get a couple of boxes, since you can never find the tacks in the woods to reuse them. 1/2" long tacks are adequate.

* Cages - need one cage per bird. Recommend each district have a couple of cages, and donor district should have about 4.

* Mirror, light, battery, etc. - to inspect cavities for flying squirrels.

* "Squirrel grabber" - a mechanic's pick-up tool, used to pull squirrels from cavities.

* Capture equipment (nets, poles, etc.)

Dawn K. Carrie
Wildlife Biologist
San Jacinto Ranger District
Sam Houston NF, Texas
June 1992

Appendix E:

South Carolina Safe Harbor Agreement

Dear Land Steward:

Thank you for your interest in the Safe Harbor Program for Red-cockaded Woodpeckers in South Carolina. Enclosed is some information explaining the program in more detail, and a copy of the Safe Harbor Agreement. This program is permitted by the US Fish and Wildlife Service.

In a nutshell, Safe Harbor for the Red-cockaded Woodpecker (RCW) is a voluntary agreement between a landowner and the South Carolina Department of Natural Resources (SCDNR). After determining the "baseline" (the current number of RCW groups and associated foraging habitat found on the property), the landowner agrees to continue certain management practices favorable for RCW's (typically those that attracted them in the first place), such as prescribed burning, thinning, longer rotations, growing longleaf pine, etc. In return, the landowner will only be responsible for the baseline number. Any RCW's that move onto the property or increase within the property above the baseline can legally be "taken," that is landowners can harvest timber, build roads, clear land, and conduct other development projects within the habitat of the "excess" woodpeckers. The only requirements are that: 1) SCDNR or its official representatives be allowed to move or relocate the RCW's, with a 60-day notice, before the habitat is altered; 2) RCW's may not be shot, captured, or otherwise directly "taken;" and 3) nests with eggs or young cannot be taken unless authorized by DNR.

Landowners can also shift their baseline responsibilities within the property. That is, if a RCW group occupies an area desired for timber harvest or development, the landowner can proceed with the project, provided another group is established to take its place at another location on the property.

Landowners can also sign a Safe Harbor Agreement for a baseline of "0" RCW's if none currently reside on the property, but based on its location and current management practices, the possibility exists that the birds could eventually move in. The only requirement is that the landowner continue to practice at least one management activity beneficial for RCW's, such as burning or growing longleaf pine.

Any non-federal landowner, including local governments, private landowners and buisnesses, can sign up for a Safe Harbor Agreement. The agreement can be as long as desired (generally in the range of 30 to 99 years), can be transferrable if the property is sold, and can be terminated with a 60 day written notice. If the agreement is terminated, RCW management would continue as before under the US Fish and Wildlife Service's "Landowner Guidelines"

(1992). Landowners could still legally "take" any RCW's above the baseline at the time the agreement was in effect, provided SCDNR, or its agents, were given an opportunity to relocate the birds.

The first step in the Safe Harbor process is to determine the baseline nunber of RCW's that occur on the property and provide a map or plat of the property to SCDNR, showing precise locations of all RCW cavity trees. This requires a qualified consultant or personnel familiar with their biology. A GPS (Global Positioning System) unit is usually needed for accurate mapping of RCW cavity trees. The landowner agrees to allow SCDNR or its authorized representatives, including the US Fish and Wildlife Service, access to the property for verification of the baseline as well as periodic monitoring of the terms and conditions of the Safe Harbor Agreement.

Thank you again for your interest and please contact us at Sandhills Research and Education Center, PO Box 23205, Columbia, SC, 29224, Telephone, 803-419-9645, Fax, 803-736-4418, if you have additional questions or would like to proceed with a Safe Harbor Agreement.

Sincerely,

John Cely
Wildlife Diversity Section

QUESTIONS AND ANSWERS ABOUT THE SOUTH CAROLINA SAFE HARBOR AGREEMENT FOR THE ENDANGERED RED-COCKADED WOODPECKER

Q. What is South Carolina's Safe Harbor Agreement for the Red-cockaded Woodpecker?

A. The South Carolina Safe Harbor Agreement for Red-cockaded Woodpeckers is a program, developed under the federal Endangered Species Act, to benefit the conservation of the endangered Red-cockaded Woodpecker through voluntary habitat improvements by private landowners.

Q. Why is this agreement important?

A. Safe Harbor is designed to encourage private landowners to undertake actions that will benefit an endangered species, the Red-cockaded Woodpecker. The program removes a regulatory impediment that has caused some landowners to fear that if they do anything that might attract an endangered species to their property, their use of that property could be restricted in the future.

Q. Is the agreement voluntary?

A. Yes, it is entirely voluntary. Only those landowners who wish to participate will do so. The agreement can be terminated with a 60-day written notice.

Q. What happens if the agreement is terminated?

A. Red-cockaded Woodpecker management would continue as before under the US Fish and Wildlife Service's "Landowner Guidelines (1992). Landowners could still legally "take" any Red-cockaded Woodpeckers above the baseline at the time the agreement was in effect, provided the South Carolina Department of Natural Resources (SCDNR), or its agents, were given an opportunity to relocate the birds.

Q. How will the Red-cockaded Woodpecker benefit from Safe Harbor?

A. The Red-cockaded Woodpecker has been in a long-term decline throughout its range in the Southeastern states. This decline has been most pronounced on privately-owned land, where few landowners have undertaken the sort of actions that would help the bird. Encouraging voluntary, beneficial action by private landowners will help the bird by slowing, stopping, or reversing its decline, maintaining the contiguity of its habitat, and buffering against the possibility of major storms or other catastrophes destroying populations on public lands. In the unlikely event that all participating landowners eventually drop out of the program, the result would be to return to conditions that would have existed in the absence of the program.

Q. Who is eligible to participate in the agreement?

A. Any landowner within South Carolina where Red-cockaded Woodpeckers are known to occur is eligible to participate in the program, if his or her land could provide suitable nesting or foraging habitat for the

Woodpecker habitat restoration or enhancement activities by relieving a landowner who enters into a cooperative agreement with SCDNR from any additional responsibility under the federal Endangered Species Act, beyond that which exists at the time a landowner enters into the agreement, i.e., to provide a "safe harbor." While participating landowners will be required to protect any Red-cockaded Woodpeckers using the property at the time the agreement is signed (their baseline responsibilities), they are under no obligation to protect any additional Red-cockaded Woodpeckers that may be attracted to the land. Participating landowners will enter into a cooperative agreement with the SCDNR and receive a "Certificate of Inclusion" under a permit that authorizes the future removal, alteration, or elimination of any habitat except that designated for baseline groups. Thus, as long as a landowner carries out the agreed upon habitat improvements and maintains his or her baseline habitat responsibilities, they may develop, harvest trees upon, or make any other lawful use of the property, even if such use incidentally results in the loss of Red-cockaded Woodpeckers or their habitat. The participating landowner will only be required to notify the SCDNR, and give it, its representatives, or the US Fish and Wildlife Service a 60 day notice to relocate any woodpeckers expected to be adversely affected by such actions.

Q. Can landowners sign up for Safe Harbor if they currently have no Red-cockaded Woodpeckers on their property but feel birds may move in at a later date?

A. Yes, landowners can sign up for a baseline of "0", assuming that their current management practices benefit the Red-cockaded Woodpecker and the property is reasonably expected to attract them. The landowner's obligation will be to agree to continue at least one enhancement activity such as prescribed burning.

Q. Will the type of action that this program encourage have other benefits besides helping the Red-cockaded Woodpecker?

A. Yes. The land management practices that this program encourages should maintain significant plant and animal species that are associated with the longleaf pine ecosystem and other open pine forests. Game species such as quail will be among the expected beneficiaries. In addition, hardwood control will make it possible for landowners to realize some revenue from harvesting pinestraw. Pinestraw raking is a multi-million dollar industry in South Carolina and has the potential to illustrate that forest management is economically compatible with the needs of the Red-cockaded Woodpecker.

Q. How will the provisions of the agreement be monitored?

A. The landowner agrees to provide SCDNR or its official representatives, or the US Fish and Wildlife Service, access to the property for periodic monitoring as well as to capture, band, or relocate any Red-cockaded Woodpeckers in excess of the baseline.

Q. How long will it take to become a participant in the program?

A. The length of time to complete a cooperative agreement with SCDNR and to receive a Certificate of Inclusion in the program will vary depending on the availability of pertinent information. A potential participant can expect a maximum of 60-90 days to complete the process. If all the pertinent information is available, it

Red-Cockaded Woodpecker Safe Harbor Agreement

The South Carolina Department of Natural Resources (Administrator) and ____________________ (Cooperator) have entered into this Cooperative Agreement (Agreement) in order to maintain and enhance habitat for the red-cockaded woodpecker (RCW) on lands owned by the Cooperator.

The Cooperator agrees to undertake, for the duration of this Agreement, activities and procedures for the benefit of the RCW on the Cooperator's property delineated on the map labeled Exhibit A.

In consideration of the foregoing, the United States Fish and Wildlife Service (Service) has issued to the Administrator an Incidental Take Permit pursuant to the provisions of Section 10(a)(1)(B) of the Endangered Species Act of 1973, as amended; and the Administrator has issued to the Cooperator a Certificate of Inclusion under the Permit. Upon issuance, this Certificate authorizes the Cooperator and the Cooperator's successors or assigns to carry out any activity subject to the constraints of federal, state, and local laws on the Cooperator's property delineated in Exhibit A that will or may result in the incidental taking[1] of RCWs or their habitat above the established baseline responsibilities at the time this Agreement is executed, subject to the following: (1) The Cooperator agrees to maintain the baseline responsibilities/constraints specified in the Agreement; (2) The Cooperator agrees to provide for habitat enhancement activities also specified in the Agreement; (3) The Cooperator will give the Administrator reasonable notice prior to commencing any activities that may result in the taking of RCWs; and (4) The Cooperator will provide the Administrator the opportunity to translocate RCWs.

A. Responsibilities/Constraints for Baseline RCW Groups

The baseline responsibilities/constraints of the Cooperator are to provide all the overstory necessary to maintain the cavity trees and the foraging area for all groups of RCWs as discovered by a baseline RCW survey of the Cooperator's property. Baseline responsibilities may include providing foraging areas for known RCW groups on neighboring lands as described in Section E and set forth in Appendix B. If no RCW groups are discovered during the baseline RCW survey and there are no known RCW groups on neighboring lands, there are no baseline responsibilities/constraints.

Specifically the baseline responsibilities/constraints, as derived from the Service's proposed RCW guidelines for private lands[2], are to:

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[1] An incidental take is the "take" of any federally listed wildlife species that is incidental to, but not the purpose of, otherwise lawful activities (see definition of "take") [ESA section 10(a)(1)(B)]. For example, deliberately shooting or wounding a listed species would not be considered an incidental take, conversely, the destruction of endangered species habitat for development generally would be construed as incidental and would be authorized by an incidental take permit.

[2] The Administrator will not require the Cooperator to abide by more strict habitat requirements for baseline groups of RCWs should the Service revise the guidelines for managing RCWs on private lands. Should the habitat requirements be reduced, this agreement will be modified to reflect the new guidelines.

1. Mark all active and inactive baseline cavity trees and start trees.
2. Manage active baseline clusters as follows:
   a. Each cluster will be managed as a timber stand comprising at least 10 contiguous acres.
   b. Overstory stocking in a cluster will be maintained between 50 and 80 ft^2 of basal area per acre if the trees are currently present or when they become available.
   c. Cluster boundaries will be at least 200 feet from a cavity tree.
   d. Hardwood basal area in a cluster will be maintained below 20 ft^2 of basal area per acre.
   e. Twenty to 25 feet should be maintained between trees within the cluster.
   f. Midstory vegetation will be maintained in an "open" condition by prescribed burning, precommercial thinning, or other means.[7]
   g. Cavity trees will be protected from fire[8] during prescribed burning.
3. Maintain foraging habitat of 3000 ft^2 of basal area in pine trees on 60 to 300 acres (including the cluster stand) for each active baseline cluster as follows:
   a. Overstory stocking for foraging habitat will be maintained between 10 and 80 ft^2 of basal area per acre.
   b. Hardwood basal area in foraging habitat will be maintained below 20 ft^2 of basal area per acre.
   c. Midstory vegetation will be maintained in an "open" condition by prescribed burning, precommercial thinning, or other means.[9]
4. Allow the Administrator to translocate juvenile birds off the property.

C. Other Enhancement Activities.

1. On one or more mutually agreeable areas, the Cooperator agrees to enhance habitat for RCWs by allowing or providing for one or more of the following activities:

   a. Installing artificial RCW cavities in baseline and/or recruitment clusters.
   b. Providing additional midstory control with prescribed burning.
   c. Providing additional hardwood midstory control with herbicides or machinery.
   d. Allowing translocation of juvenile RCWs to unoccupied clusters or recruitment clusters.
   e. Implementing forest management practices that enhance habitat for existing baseline groups or provide habitat for additional groups of RCWs (thinning, longer rotations, regeneration that favors pine species).
   f. Providing or allowing other activities beneficial to RCWs.

See Appendix A for specific activities that the Cooperator agrees to undertake.

2. In addition the Cooperator agrees to make a reasonable effort to ascertain if new RCW groups

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[7]Prescribed burning and other activities to reduce brush and understory competition will be required no more frequently than once every three years.

[8]Precautions should be taken to minimize the risk of igniting cavity trees, examples include: raking litter away from the base of cavity trees, limiting burning to high moisture conditions, or back-firing away from cavity trees.

[9]See footnote 7.

more than one landowner's property ...it is impossible to have one set of 'rules' for all possible scenarios." Accordingly, the map labeled Exhibit A identifies known RCW groups not on the Cooperator's property for which the Cooperator agrees to provide habitat as part of the baseline responsibilities. Appendix B sets forth the Cooperator's responsibilities with respect to providing foraging habitat for such RCW groups.

F. Successors in Interest

Successors and assigns will incur the responsibilities and benefits of this Agreement until the date of termination unless canceled in writing as specified in the Life of the Agreement (Section L). The Cooperator will inform the Administrators in the event all, or part of, the Cooperator's property delineated on the map labeled Exhibit A is transferred to another owner.

G. RCW Surveys

A baseline survey will be made immediately (within 6 months) prior to the Agreement to inventory all existing RCW groups to establish baseline responsibilities. The survey will only include RCWs, unless other species are specifically requested to be surveyed by the Cooperator. The Cooperator can have additional species surveyed and incorporated into the Agreement at anytime. Surveys (baseline or supplemental) can be done by either the Administrator (or the Administrator's contractor) or a firm mutually agreeable to both the Cooperator and the Administrator at the Cooperator's discretion. If the Administrator (or the Administrator's contractor) does a survey, it will bear all costs. If a mutually agreeable firm does a survey, the Cooperator will bear all costs. The results of the baseline survey done by a mutually agreeable firm shall be the property of the Cooperator and shall be used only at the Cooperator's discretion. However, no agreement will be signed until the baseline survey is reviewed and approved by the Administrator. Supplemental surveys as specified in "Other Voluntary Enhancement Activities" (Section C) that are required prior to activities that may result in an incidental take must be submitted to the Administrator at least 30 days prior to commencing such activities. Supplemental RCW surveys conducted by the Administrator (or the Administrator's contractor) must be completed within 45 days of a written request for a supplemental RCW survey by the Cooperator. Supplemental surveys are not required for any activity for one year after the baseline survey, unless artificial recruitment clusters have been established in the area that will be affected by the activity.

H. Geographic Scope

This Agreement will extend only to those lands of the Cooperator delineated on the map labeled Exhibit A.

I. Access to the Property

The Cooperator shall grant access to the Administrator at least annually to verify that the

M. Life of Agreement

The Cooperator agrees to conduct the activities and manage the property as indicated in Section B for a period of __ years (the time frame of the agreement is variable subject to mutual agreement by the Administrator and the Cooperator) from the date of signing by both parties. The Cooperator, or the Cooperator's successors or assigns, may terminate the Agreement at any time with 60 days written notification to the Administrator. The Administrator may terminate the Agreement with 60 days written notification to the Cooperator, or the Cooperator's successors or assigns, if it deems adequate progress has not been made in meeting baseline responsibilities and accomplishing the voluntary maintenance and enhancement activities in the Agreement. In the event that the Agreement is terminated, the Cooperator or the Cooperator's successors or assigns shall retain the Incidental Take Permit for non-baseline RCW clusters established during the time the Agreement was in force[15], provided that the Administrators are permitted to relocate RCW's as provided for in Section C. This Agreement can be renewed, extended, or modified at any time subject to both the Cooperator's and the Administrator's approval.

South Carolina Department of Natural Resources

__________________, Cooperator

By________________________________

Date ________________________

By________________________________

Date ________________________

Attest___________________________

[15] Precedent, established in similar agreements, generally limits the Cooperator's right to an Incidental Take Permit to 99 years from the signing of the Agreement.

Appendix B

Baseline Responsibilities for Foraging Habitat for Clusters on Neighboring Lands

Appendix F:

Effectiveness of Flying Squirrel Excluder Devices on RCW Cavities

Effectiveness of Flying Squirrel Excluder Devices on Red-cockaded Woodpecker Cavities

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Abstract: I tested the effectiveness of squirrel excluder devices (SQEDs) in deterring southern flying squirrels (*Glaucomys volans*) from using artificial red-cockaded woodpecker (*Picoides borealis*) cavities by placing them on approximately one-half of the cavities in 14 inactive recruitment clusters on the Savannah River Site, South Carolina. SQEDs consisted of 2 pieces of 35.5-cm wide aluminum flashing placed 7.6 cm above and below the cavity entrance. Cavities with ($N = 37$) and without ($N = 35$) SQEDs were checked once per month from February 1995 to January 1996; all flying squirrels found in cavities were removed and destroyed. Cavities with and without SQEDs did not differ in cavity height ($P = 0.70$), distance to first branch ≥1 m in length ($P = 0.09$), distance to the nearest tree ($P = 0.29$), number of trees within 8 m ($P = 0.82$), or previous use by flying squirrels ($P = 0.67$). Flying squirrels used cavities without SQEDs throughout the year and occupied 5.7% to 38.2% of the cavities/month. In contrast, only 1 flying squirrel was found in a cavity with a SQED; thus, SQEDs effectively impeded flying squirrels from using red-cockaded woodpecker cavities and should be considered a tool in red-cockaded woodpecker management where flying squirrels are a potential threat to population stability or expansion.

Proc. Annu. Conf. Southeast Assoc. Fish and Wildl. Agencies 50:303-311

The endangered red-cockaded woodpecker (RCW) is highly dependent on the cavities it excavates in living pines (*Pinus* spp.) for survival and reproduction (Ligon 1970). Each bird roosts in an exclusive cavity year round and nesting usually occurs in the cavity of the breeding male. The lack of sufficient cavities is a major limiting factor in both population maintenance (Ligon 1970) and expansion (Copeyon et al. 1991, Heppell et al. 1994). Limited availability of cavities results from long excavation times (Hooper et al. 1980, Conner and Rudolph 1995), limited numbers of trees with sufficient heartwood and red-heart fungus (*Phellinus pini*) decay for cavity excavation (Hooper 1988), cavity tree mortality (Conner et al. 1991), and use of cavities by other species (Dennis 1971, Jackson 1978). Many species of vertebrates use RCW cavities, including southern flying squirrels, other woodpecker species, several cavity-nesting passerines, and snakes (Dennis 1971, Jackson 1978, Harlow and Lennartz 1983, Rudolph et al. 1990*a*, Kappes 1993, Loeb 1993).

Southern flying squirrels are the most prevalent non-target users of RCW cavities in South Carolina (Dennis 1971, Harlow and Lennartz 1983), Georgia (Loeb 1993), and Texas (Rudolph et al. 1990*a*), and the second most prevalent user of RCW cavities in Mississippi (Jackson 1978) and Florida (Kappes 1993). Use of cavities by flying squirrels has been associated with nest loss of RCWs (Lennartz and Heckel 1987, LaBranche and Walters 1994) and inter-cluster movements of individuals (Jackson 1990). Although nest loss and inter-cluster movement may have few consequences in large populations, their effects in small populations are unknown. Management of several small populations of RCWs includes removal of flying squirrels from RCW cavities (e.g., DeFazio et al. 1987, Gaines et al. 1995, Montague et al. 1995, Richardson and Stockie 1995). Although no experimental tests have been conducted, it is hypothesized that squirrel removal is an important management activity contributing to the stabilization and growth of small populations (Gaines et al. 1995, Montague et al. 1995, Richardson and Stockie 1995); however, removal of squirrels from cavities is time consuming and expensive (E. LeMaster, pers. commun.).

In 1991, Montague et al. (1995) developed a squirrel excluder device (SQED) to prevent use of RCW cavities by flying squirrels on the Ouachita National Forest, Arkansas. They wrapped aluminum flashing around the bole of the tree above and below the cavity so that a squirrel could only enter the cavity if it glided or jumped to the exposed bark between the strips of flashing. SQEDs were placed on cavities that were being used by flying squirrels and the flying squirrels and nest material were removed. In 8 of 10 cases, flying squirrels eventually abandoned the cavities and the cavities were subsequently re-occupied by RCWs. These results suggest that SQEDs might be an effective and cost efficient device for preventing RCW cavity usurpation by flying squirrels; however, Montague et al. (1995) did not include non-SQED trees (controls) in their field trials, so their results are difficult to evaluate.

My objective was to experimentally test the effectiveness of SQEDs in deterring southern flying squirrels from using RCW cavities. I compared use of cavities with and without SQEDs by southern flying squirrels in inactive recruitment stands (i.e., sites that are managed for RCWs in hopes that they will occupy the area) with artificial cavity inserts. No attempt was made to evaluate the acceptance of SQEDs by RCWs.

This project was supported by the Department of Energy, Savannah River Site, and the USDA Forest Service, Savannah River Forest Station. I thank P. Johnson and D. Ussery for their assistance in squirrel removal. G. Chapman and T. Ridley assisted in SQED installation and data collection. R. N. Conner, J. W. Edwards, E. LeMaster, W. G. Montague and J. C. Neal reviewed earlier drafts of this manuscript. T. Ridley drafted the figure.

Methods

The study was conducted on the Department of Energy's Savannah River Site (SRS) in Aiken, Barnwell, and Allendale counties, South Carolina. Approximately

78,000 ha in size, the site is located in the Upper Coastal Plain physiographic region. Soils are generally well-drained, sandy, and of low fertility (Batson et al. 1985). When the Department of Energy acquired the site in 1950, much of the accessible land was logged; thus, most of the site is young (≤ 50 years) forest managed by the USDA Forest Service, Savannah River Forest Station. Approximately 15,000 ha are in hardwoods, 4,000 ha are in mixed pine-hardwoods, and 50,000 ha are in pines (Workman and McLeod 1990).

Intensive research and management of the SRS population of RCWs has occurred since 1985, when the population was at 4 individuals (Gaines et al. 1995). Since then, the population has grown to 65 to 70 individuals in 21 clusters. Management activities include hardwood midstory control in all cluster sites and recruitment stands, population monitoring, translocation of birds from other populations, translocation of birds within the population, installation of artificial cavity inserts, and flying squirrel removal. Artificial cavity inserts were placed in existing clusters, both active and inactive, and in recruitment stands. Twenty-four recruitment clusters were established between August 1991 and January 1995; eight are now active (i.e., occupied by ≥1 RCW).

Fourteen inactive recruitment clusters were included in the study. Each cluster was provisioned with 3 to 8 artificial cavity inserts between August 1991 and May 1994. Insert cavities were placed at either 3.4 to 4.3 m or 6.1 to 7.3 m in height. Cavities in 9 of the clusters were checked monthly and all flying squirrels removed from the time of installation to the onset of the study. The presence of other vertebrate species was recorded. In 5 clusters, cavities were screened closed and not checked for 2 to 4 months prior to the study, but were checked during the months prior to screening. Screens were removed when SQEDs were installed. In most clusters, SQEDs were placed on one-half the trees with artificial cavity inserts; the remaining trees with inserts served as controls. Trees to receive SQEDs were selected randomly; however, some of the trees could not be used because a branch or knob prevented placement of the SQED. In these cases, the SQED was placed on a control tree and the intended SQED tree became a control.

Each SQED consisted of 2 pieces of 35.5-cm wide aluminum flashing wrapped around the bole of the tree and fastened with felt-paper nails. The flashing was placed approximately 7.6 cm above and below the cavity entrance (Fig. 1). The top 5 cm were folded at a 90° angle to the tree to prevent resin from flowing down the SQED and providing a travel route for squirrels (Montague et al. 1995).

Thirty-eight SQEDs were installed in January 1995 and cavities in all clusters were checked monthly from February 1995 to January 1996. The number of cavities checked each month varied slightly. The SQED was removed from 1 tree because a bird was translocated to it in March 1995. A tree fell against another cavity with a SQED and it could not be checked for 3 months, April to June. Finally, a non-SQED tree died in June and was no longer safe to climb. Most flying squirrels found in cavities were removed and destroyed by cervical dislocation. This method of euthanasia for southern flying squirrels was approved by the Clemson University Animal Research Committee (#93-053). A small number of flying squirrels escaped before

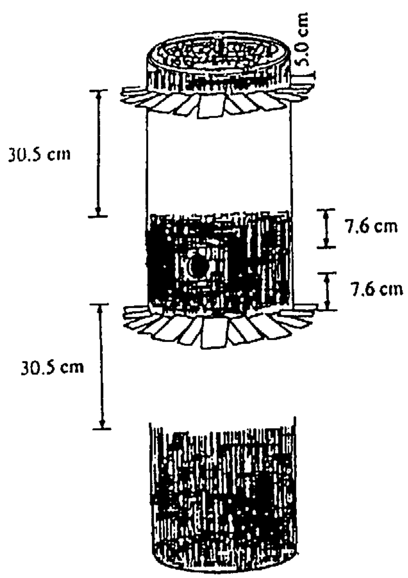

Figure 1. Diagrammatic sketch of a squirrel excluder device (SQED) and its position relative to the RCW cavity entrance.

they could be captured. The presence of other species in cavities was recorded, but the animals were not removed.

To establish that tree and cavity characteristics were similar between SQED and non-SQED trees and that any difference in cavity use was due to the presence or absence of SQED's, I measured cavity height, distance from the cavity to the first branch, live or dead, ≥1 m in length above the cavity, distance to the nearest tree, live or dead, ≥4 cm diameter breast height (dbh), and number of trees ≥4 cm dbh within 8 m. Log-likelihood *G*-tests were used to compare use of SQED and non-SQED cavities by flying squirrels and *t*-tests were used to compare characteristics of SQED and non-SQED trees and cavities.

Results

Characteristics of trees and cavities with and without SQEDs were similar (Table 1). Cavity height ($t = 0.39$, df = 70, $P = 0.70$), distance to first branch ($t = 1.73$, df = 70, $P = 0.09$), number of trees within 8 m ($t = 0.23$, df = 70, $P = 0.82$), and distance to the nearest tree ($t = 1.07$, df = 70, $P = 0.29$) did not differ between trees with and without SQEDs. Cavities with and without SQEDs had similar histories of flying squirrel use prior to the study, with flying squirrels using cavities in similar proportions ($G = 0.18$, df = 1, $P = 0.67$). Further, the time since cavities were last used by flying squirrels was not different between cavities with and without SQEDs ($t = 0.73$, df = 45, $P = 0.47$).

Table 1. Characteristics of RCW trees and artificial cavities with and without SQEDs on the Savannah River Site, South Carolina. Means +1 SE are presented.

Tree or cavity characteristic	Trees with SQEDs (*N* = 37)	Trees without SQEDs (*N* = 35)
Cavity height (m)	4.4 ± 0.22	4.5 ± 0.24
Distance to 1st branch (m)	3.9 ± 0.50	2.8 ± 0.45
N trees within 8 m	2.6 ± 0.46	2.8 ± 0.47
Distance to nearest tree (m)	6.1 ± 0.49	5.4 ± 0.40
N (%) previously used by flying squirrels	25 (67.6%)	22 (62.9%)
N (%) previously used by used by other species	4 (11.4%)	4 (10.8%)
N months since use by flying squirrels	6.4 ± 1.3	5.1 ± 1.0

Use of artificial cavities with and without SQEDs by flying squirrels differed significantly over the year ($G = 106.2$, df = 1, $P = < 0.001$). Only 1 flying squirrel used a cavity with a SQED during the entire study. In contrast, flying squirrels used cavities without SQEDs throughout the year (Table 2). Use of cavities without SQEDs by flying squirrels varied seasonally. Highest use occurred in spring and late fall to early winter, and lowest use occurred in late winter and late summer. The numbers of flying squirrels/cavity ranged from 1 to 5 with the largest groups occurring in November and January. At least one non-SQED cavity was used by a flying squirrel in every RCW recruitment cluster.

Other species used cavities, although in much lower numbers than flying squirrels. Rat snakes (*Elaphe* spp.) were found in 3 cavities, 2 with SQEDs and 1 without. One red-bellied woodpecker (*Melanerpes carolinus*) was confirmed roosting in a

Table 2. Southern flying squirrel (SFS) use of artificial cavities with and without SQEDs in inactive RCW recruitment clusters on the Savannah River Site, South Carolina, February 1995 to January 1996.

	Cavities with SQEDs			Cavities without SQEDs		
Month	*N* cavities inspected	*N* (%) cavities with SFS	*N* SFS using cavities	*N* cavities inspected	*N* (%) cavities with SFS	*N* SFS using cavities
Feb	38	0 (0.0)	0	34	4 (11.8)	5
Mar	37	0 (0.0)	0	35	2 (5.7)	3
Apr	36	0 (0.0)	0	35	7 (20.0)	12
May	36	0 (0.0)	0	35	8 (22.9)	14
Jun	36	1 (2.8)	1	34	5 (14.7)	10
Jul	37	0 (0.0)	0	34	6 (17.6)	8
Aug	37	0 (0.0)	0	34	3 (8.8)	5
Sep	37	0 (0.0)	0	34	2 (5.9)	2
Oct	37	0 (0.0)	0	34	4 (11.8)	8
Nov	37	0 (0.0)	0	34	13 (38.2)	26
Dec	37	0 (0.0)	0	34	8 (23.5)	13
Jan	37	0 (0.0)	0	34	12 (35.3)	27
Combined	442	1 (0.2)	1	411	74 (18.0)	133

cavity without a SQED. Several additional cavities, both with and without SQEDs, were suspected of being used for roosting by red-bellied woodpeckers.

Discussion

The SQEDs were extremely effective in deterring southern flying squirrels from using inactive artificial RCW cavities. Only 1 cavity with a SQED was used during the entire year, while cavities without SQEDs were used throughout the year. The cavity with a SQED that was used by a flying squirrel was similar to the other cavities, both with and without SQEDs. One characteristic that may have made this cavity more susceptible to use by flying squirrels than other cavities with SQEDs was the distance to the first branch ≥1 m in length. The branch was only 1.5 m above the cavity, well below the average for both SQED and non-SQED cavities. A branch just above the SQED may allow a squirrel to jump to the exposed bark between the upper and lower pieces of flashing; thus, SQEDs placed on trees with branches close to the cavity entrance may be less effective than those on trees with no branches near the cavity. Although it did not happen in this study, I hypothesize that a similar occurrence is possible if another tree is close to the cavity tree.

The SQEDs did not appear to be effective in preventing use of cavities by snakes. Although only 2 snakes used cavities with SQEDs, this is relatively high compared to previous cavity use by snakes in active and inactive clusters on SRS. From 1985 to 1994, there were only 6 instances of cavity use by snakes in 10,347 cavity checks (D. Lotter, unpubl. data); however, all the trees examined in the present study were inactive and had little or no fresh resin present. Fresh, sticky resin is effective in reducing use of cavities by snakes (Jackson 1974, Rudolph et al. 1990*b*). The distance to the first branch above the cavity was only 0.6 m for the 2 cavities with SQEDs used by snakes. Distances to the nearest trees were 7.8 m and 13.2 m, respectively; therefore, it is unlikely that snakes reached the branches from other trees and approached the cavity from above. Snakes are capable of climbing across 30 cm wide pieces of flashing (J. Neal, pers. commun.) and the 2 snakes recorded may have climbed over the SQEDs. Alternatively, because irregularities in the shape of some trees often result in small spaces between the SQED and the bark, the snakes may have accessed the cavities by climbing behind the SQEDs. If snakes are a problem in a particular RCW population, snake excluders and traps might be considered (Richardson and Stockie 1995, Withgott et al. 1995).

All clusters remained inactive while the SQEDs were on the trees. Most of the clusters were inactive for 2 to 3 years prior to the onset of the study, indicating that the SQEDs were not the reason RCWs failed to occupy the sites. In Arkansas, RCWs readily re-occupy cavities with SQEDs, indicating that the birds will accept them (Montague 1995, Montague et al. 1995); however, in Arkansas many of the SQEDs were placed on recently active cavities (Montague et al. 1995). Perhaps RCWs use cavities with novel objects more readily if they have already used the cavities. The hypothesis requires further study. In this study nesting material left by flying squirrels or other species was not removed from cavities. Although cleaning cavities has not been necessary for reoccupation by RCWs at SRS (DeFazio et al. 1987) or in the Piedmont of Georgia (pers. obs.), other investigators (Montague et al. 1995) have suggested that cavities should be cleaned to increase the likelihood of reoccupation by RCWs.

Management Implications

I showed that SQEDs are an effective method for keeping flying squirrels from using RCW cavities, and may be an alternative to continuous removal programs. Regardless, cavities should be monitored to ensure that SQEDs are not damaged or covered in sap and will remain an effective barrier to flying squirrels, particularly cavities with limbs or other trees short distances away. If flying squirrels continue to use cavities with SQEDs due to a branch close to the cavity, branch removal is recommended. Similarly, a nearby tree that improves flying squirrel accessibility should be removed if it does not contain a RCW cavity or is not a potential cavity tree.

SQEDs will only become an important management tool if they are accepted by RCWs. Few data are available on the response of RCWs to SQEDs, the effect of SQEDs on resin well production, and the effect of SQEDs on resin flow around the cavity. In Texas, some RCWs abandon cavities when SQEDs are placed on them (R. Conner, pers. commun.). In contrast, at least 14 cavities with SQEDs have been used for roosting by RCWs in Arkansas (Montague 1995); however, in the Arkansas population, SQEDs were only placed on inactive cavities within active clusters. Until more is known about the response of RCWs to SQEDs, it may be advisable to place SQEDs only on inactive cavities in active clusters, particularly those that have recently been abandoned due to occupation by flying squirrels. This will provide alternate cavities for RCWs that may be displaced from the cavities by flying squirrels or other species, as well as provide clean, unoccupied cavities for fledglings to use. Use of SQEDs in inactive recruitment clusters may be as important as use in active clusters. Occupation of cavities by flying squirrels in recruitment clusters limits the number of available cavities and may prevent red-cockaded woodpeckers from settling in the new site. Montague (1995) suggested that SQEDs may provide a visual attraction for RCWs and assist them in locating vacant cavity tree clusters; thus, SQEDs may be an important tool in population expansion as well as population stabilization.

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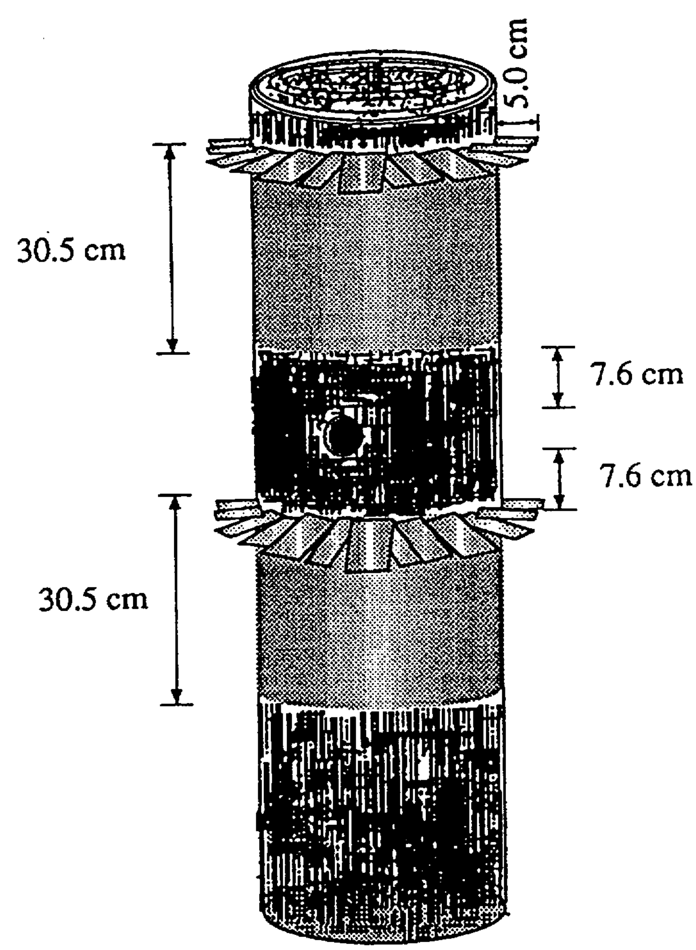
5.0 cm
30.5 cm
7.6 cm
7.6 cm
30.5 cm

Imm Ecosystem Classification - August 18, 1997

RCW HMAs

RCW HMA	Forage Only?	Pine/ Pine-Hdwd?	Setaside?	R-O-W?	Acres		
Industrial Use Area	N				12012.765		
Industrial Use Area	N		Y		1287.8066		
Industrial Use Area	N	Y			21602.683		
Industrial Use Area	N	Y	Y		822.11315	*Pine/PH in*	
				Total Pine/PH:	**22424.796**	*Setasides:*	**822.11315**
RCW HMA	N				10631.892		
RCW HMA	N		Y		6491.7221		
RCW HMA	Y				430.81538		
RCW HMA	Y		Y		0.101671		
RCW HMA	N	Y			61843.497		
RCW HMA	Y	Y			2967.0655		
RCW HMA	N	Y	Y		3109.6568		
RCW HMA	Y	Y	Y		27.750846	*Pine/PH in*	
				Total Pine/PH:	**67947.971**	*Setasides:*	**3137.4076**
Special-Use Area	N				22117.156		
Special-Use Area	N		Y		92.153904		
Special-Use Area	N	Y			2047.7023		
Special-Use Area	N	Y	Y		35.309169	*Pine/PH in*	
				Total Pine/PH:	**2083.0115**	*Setasides:*	**35.309169**
Supplemental RCW HMA	N				10149.891		
Supplemental RCW HMA	N		Y		1497.9723		
Supplemental RCW HMA	Y				457.16394		
Supplemental RCW HMA	Y		Y		107.49381		
Supplemental RCW HMA	N	Y			29600.701		
Supplemental RCW HMA	Y	Y			1816.8317		
Supplemental RCW HMA	N	Y	Y		491.13997		
Supplemental RCW HMA	Y	Y	Y		81.54635	*Pine/PH in*	
				Total Pine/PH:	**31990.219**	*Setasides:*	**572.68632**
Areas in R-O-W or Facilities:							
Industrial Use Area	N			Y	2171.2676		
Industrial Use Area	N		Y	Y	9.98022		
Industrial Use Area	N	Y		Y	1902.0935		
Industrial Use Area	N	Y	Y	Y	61.553272		
RCW HMA	N			Y	226.73146		
RCW HMA	N		Y	Y	33.899927		
RCW HMA	Y			Y	18.953221		
RCW HMA	N	Y		Y	686.03251		
RCW HMA	N	Y	Y	Y	11.321073		
RCW HMA	Y	Y		Y	144.08050		
Special-Use Area	N			Y	82.624105		
Special-Use Area	N	Y		Y	18.068876		
Supplemental RCW HMA	N			Y	1548.6938		
Supplemental RCW HMA	N		Y	Y	17.930648		
Supplemental RCW HMA	Y			Y	30.347419		
Supplemental RCW HMA	N	Y		Y	1697.8813		
Supplemental RCW HMA	N	Y	Y	Y	3.289199		
Supplemental RCW HMA	Y	Y		Y	131.16459		

Frost Ecosystem Classification - August 18, 1997

RCW HMAs

RCW HMA	Forage Only?	Pine/ Pine-Hdwd?	Setaside?	R-O-W?	Acres		
Industrial Use Area	N				14072.718		
Industrial Use Area	N		Y		1413.5216		
Industrial Use Area	N	Y			19542.739		
Industrial Use Area	N	Y	Y		696.40403	*Pine/PH in*	
				Total Pine/PH:	**20239.143**	*Setasides:*	**696.40403**
RCW HMA	N				14211.012		
RCW HMA	Y				507.42358		
RCW HMA	N		Y		7350.1537		
RCW HMA	Y		Y		0.101671		
RCW HMA	N	Y			58264.371		
RCW HMA	Y	Y			2890.4573		
RCW HMA	N	Y	Y		2251.2284		
RCW HMA	Y	Y	Y		27.750846	*Pine/PH in*	
				Total Pine/PH:	**63433.808**	*Setasides:*	**2278.9793**
Special-Use Area	N				22506.183		
Special-Use Area	N		Y		99.361828		
Special-Use Area	N	Y			1658.6736		
Special-Use Area	N	Y	Y		28.101245	*Pine/PH in*	
				Total Pine/PH:	**1686.7749**	*Setasides:*	**28.101245**
Supplemental RCW HMA	N				14078.182		
Supplemental RCW HMA	Y				531.76883		
Supplemental RCW HMA	N		Y		1597.8151		
Supplemental RCW HMA	Y		Y		107.49381		
Supplemental RCW HMA	N	Y			25672.427		
Supplemental RCW HMA	Y	Y			1742.2277		
Supplemental RCW HMA	N	Y	Y		391.29488		
Supplemental RCW HMA	Y	Y	Y		81.54635	*Pine/PH in*	
				Total Pine/PH:	**27887.496**	*Setasides:*	**472.84123**
Areas in R-O-W or Facilities:							
Industrial Use Area	N			Y	2306.5349		
Industrial Use Area	N		Y	Y	13.464279		
Industrial Use Area	N	Y		Y	1766.8199		
Industrial Use Area	N	Y	Y	Y	58.069214		
RCW HMA	N			Y	256.06334		
RCW HMA	Y			Y	20.859202		
RCW HMA	N		Y	Y	35.523788		
RCW HMA	N	Y		Y	656.70016		
RCW HMA	Y	Y		Y	142.17451		
RCW HMA	N	Y	Y	Y	9.697212		
Special-Use Area	N			Y	88.025288		
Special-Use Area	N	Y		Y	12.667666		
Supplemental RCW HMA	N			Y	1672.6214		
Supplemental RCW HMA	Y			Y	33.207329		
Supplemental RCW HMA	N		Y	Y	17.959412		
Supplemental RCW HMA	N	Y		Y	1573.9383		
Supplemental RCW HMA	Y	Y		Y	128.30380		
Supplemental RCW HMA	N	Y	Y	Y	3.260435		

Stand and CISC data - August 18, 1997							
RCW HMAs							
RCW HMA	**Forage Only?**	**Pine/ Pine-Hdwd?**	**Setaside?**	**R-O-W?**	**Acres**		
Industrial Use Area	N				9764.9925		
Industrial Use Area	N		Y		1338.9689		
Industrial Use Area	N	Y			23850.326		
Industrial Use Area	N	Y	Y		770.94429	*Pine/PH in*	
				Total Pine/PH:	**24621.271**	*Setasides:*	**770.94429**
RCW HMA	N				11591.247		
RCW HMA	N		Y		6817.7113		
RCW HMA	Y				420.20363		
RCW HMA	Y		Y		0.359822		
RCW HMA	N	Y			60884.171		
RCW HMA	Y	Y			2977.6231		
RCW HMA	N	Y	Y		2783.6736		
RCW HMA	Y	Y	Y		27.492695	*Pine/PH in*	
				Total Pine/PH:	**66672.960**	*Setasides:*	**2811.1663**
Special-Use Area	N				19292.228		
Special-Use Area	N		Y		95.776278		
Special-Use Area	N	Y			4872.5672		
Special-Use Area	N	Y	Y		31.692381	*Pine/PH in*	
				Total Pine/PH:	**4904.2596**	*Setasides:*	**31.692381**
Supplemental RCW HMA	N				9220.7257		
Supplemental RCW HMA	N		Y		1626.9087		
Supplemental RCW HMA	Y				403.62537		
Supplemental RCW HMA	Y		Y		111.61748		
Supplemental RCW HMA	N	Y			30529.667		
Supplemental RCW HMA	Y	Y			1870.3546		
Supplemental RCW HMA	N	Y	Y		362.20060		
Supplemental RCW HMA	Y	Y	Y		77.432674	*Pine/PH in*	
				Total Pine/PH:	**32839.654**	*Setasides:*	**439.63328**
Areas in R-O-W or Facilities:							
Industrial Use Area	N			Y	3059.9525		
Industrial Use Area	N		Y	Y	56.413113		
Industrial Use Area	N	Y		Y	1013.5474		
Industrial Use Area	N	Y	Y	Y	15.130441		
RCW HMA	N			Y	590.20356		
RCW HMA	N		Y	Y	40.788504		
RCW HMA	Y			Y	53.373281		
RCW HMA	N	Y		Y	322.52619		
RCW HMA	N	Y	Y	Y	4.416353		
RCW HMA	Y	Y		Y	109.70113		
Special-Use Area	N			Y	94.590931		
Special-Use Area	N	Y		Y	6.088105		
Supplemental RCW HMA	N			Y	2401.8271		
Supplemental RCW HMA	N		Y	Y	21.109654		
Supplemental RCW HMA	Y			Y	142.81999		
Supplemental RCW HMA	N	Y		Y	844.96407		
Supplemental RCW HMA	N	Y	Y	Y	0.106022		
Supplemental RCW HMA	Y	Y		Y	18.699374		

Jones Ecosystem Classification - August 18, 1997

RCW HMAs

RCW HMA	Forage Only?	Pine/ Pine-Hdwd?	Setaside?	R-O-W?	Acres		
Industrial Use Area	N				8803.3764		
Industrial Use Area	N		Y		914.59787		
Industrial Use Area	N	Y			24812.075		
Industrial Use Area	N	Y	Y		1195.3269	*Pine/PH in*	
				Total Pine/PH:	**26007.402**	*Setasides:*	**1195.3269**
RCW HMA	N				7342.6711		
RCW HMA	Y				347.58364		
RCW HMA	N		Y		4711.1047		
RCW HMA	Y		Y		0.101671		
RCW HMA	N	Y			65132.627		
RCW HMA	Y	Y			3050.3023		
RCW HMA	N	Y	Y		4890.2522		
RCW HMA	Y	Y	Y		27.753225	*Pine/PH in*	
				Total Pine/PH:	**73100.935**	*Setasides:*	**4918.0054**
Special-Use Area	N				19964.216		
Special-Use Area	N		Y		87.832882		
Special-Use Area	N	Y			4200.5611		
Special-Use Area	N	Y	Y		39.630139	*Pine/PH in*	
				Total Pine/PH:	**4240.1912**	*Setasides:*	**39.630139**
Supplemental RCW HMA	N				7020.8332		
Supplemental RCW HMA	N		Y		1222.9239		
Supplemental RCW HMA	Y				212.24367		
Supplemental RCW HMA	Y		Y		100.43501		
Supplemental RCW HMA	N	Y			32729.737		
Supplemental RCW HMA	Y	Y			2061.7515		
Supplemental RCW HMA	N	Y	Y		766.18094		
Supplemental RCW HMA	Y	Y	Y		88.605151	*Pine/PH in*	
				Total Pine/PH:	**35646.274**	*Setasides:*	**854.78609**
Areas in R-O-W or Facilities:							
Industrial Use Area	N			Y	2049.3885		
Industrial Use Area	N		Y	Y	9.299123		
Industrial Use Area	N	Y		Y	2023.9871		
Industrial Use Area	N	Y	Y	Y	62.234363		
RCW HMA	N			Y	191.15531		
RCW HMA	N		Y	Y	25.145477		
RCW HMA	Y			Y	17.123077		
RCW HMA	N	Y		Y	721.63476		
RCW HMA	N	Y	Y	Y	20.064185		
RCW HMA	Y	Y		Y	145.90764		
Special-Use Area	N			Y	61.82814		
Special-Use Area	N	Y		Y	38.862559		
Supplemental RCW HMA	N			Y	1430.4351		
Supplemental RCW HMA	N		Y	Y	11.237529		
Supplemental RCW HMA	Y			Y	19.73551		
Supplemental RCW HMA	N	Y		Y	1816.1728		
Supplemental RCW HMA	N	Y	Y	Y	9.982368		
Supplemental RCW HMA	Y	Y		Y	141.77650		

Used to define Pine/Pine-Hardwood

Frost:

Xeric Longleaf and Longleaf-Turkey Oak
Dry-Mesic and Mesic Longleaf Pine Savanna
Longleaf Pine-Pyrophytic Woodland Complex

Imm:

Longleaf Pine
Longleaf Pine - Scrub Oak
Pine Hardwood
Yellow Pine

Jones:

Xeric
Subxeric
Submesic
Mesic

Stands:

Forest Types - 2 - 39

SRI Natural Resource Vision Components

The following were developed as a result of a meeting held 8/7 with SRI staff:

*Conduct natural resource management compatible with prime mission.

*Restoration of habitats and T&E species.

*Manage population levels to achieve a balance of native communities within an industrial setting.

*Generate revenues from forest products.

*Survey and monitor natural resources.

*Conduct large scale manipulative research.

*Education and demonstration of technologies.

*Maintain and increase public benefits and increased public use.