



United States Department of Agriculture
Forest Service

Francis Marion National Forest

Draft Forest Plan Assessment

Francis Marion National Forest, Berkeley and Charleston Counties, South Carolina

Section 5.4: Threatened, endangered, proposed and candidate species

December 2013

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**Francis Marion National Forest
Draft Forest Plan Assessment
Berkeley and Charleston Counties, South Carolina**

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Section 5.4 is still under construction and needs further revisions.

5.4 Threatened, Endangered, Proposed and Candidate Species

- ✓ **The 1996 Revised Forest Plan addressed 38 Proposed, Threatened, Endangered, and Sensitive Species (PETS), including 3 mammals, 8 birds, 3 amphibians, and 4 reptiles, and suggests that management direction would provide necessary habitat conditions for them.**
- ✓ In preparing a list of conservation species of concern for this assessment, the US Fish and Wildlife Service, and the National Marine Fisheries Service, were consulted. A condensed list of threatened and endangered species from those two sources that were considered in this assessment appears in Table 5.2-1.

Table 5xxx: Threatened, endangered, proposed and candidate species considered in the 2013 assessment of the Francis Marion National Forest.

Category	Common Name	Scientific Name	Status *	Global Rank	Critical Habitat
Amphibian	Frosted Flatwoods Salamander	<i>Ambystoma cingulatum</i>	T	G2	yes
Bird	Red-cockaded woodpecker	<i>Picoides borealis</i>	E	G3	yes
Bird	Wood Stork	<i>Mycteria Americana</i>	E	G4	-
Bird	Bachman's warbler	<i>Vermivora bachmanii</i>	E	GH	-
Bird	Piping plover	<i>Charadrius melodus</i>	T	G5	-
Mammal	West Indian manatee	<i>Trichechus manatus</i>	E	-	-
Reptile	American Alligator	<i>Alligator mississippiensis</i>	T (SA)	-	-

*T – Threatened, E – Endangered, SA – Similarity of appearance.

Although other species may and have been found on or near the Forest, the frosted flatwoods salamander and red-cockaded woodpecker are the only Threatened, Endangered, or Candidate species that are known to have critical habitat on the Francis Marion National Forest.

5.4.1 Other Potential Species of Conservation Concern

In addition to T, E, or Candidate species, additional lists of species of conservation concern compiled from the 1996 Francis Marion Plan, State Comprehensive Wildlife Management Strategy, partner input, and USFWS 2012 Berkeley and Charleston county lists of rare species considered in this assessment, appears in Table 5.2.2.-1 (Potential species of Conservation Concern).

Table 5xxx. Potential Terrestrial Animal Species of Conservation Concern				
Taxa	Common Name	Scientific Name	Global Rank	State Rank
Bird	<i>Accipiter cooperii</i>	Coopers hawk	G5	S3
Bird	<i>Acris crepitans</i>	Northern cricket frog	G5	S5
Bird	<i>Aimophila aestivalis</i>	Bachman's sparrow	G3	S3
Invertebrate	<i>Amblyscirtes alternata</i>	Dusky roadside skipper	G2, G3	
Amphibian	<i>Ambystoma cingulatum</i>	Eastern Tiger Salamander	G5	S2,S3
Bird	<i>Ammodramus maritimus</i>	MacGillivray's Seaside sparrow	G4	
Bird	<i>Anas rubripes</i>	American black duck	G5	
Bird	<i>Charadrius wilsonia</i>	Wilson's plover	G5	S3
Reptile	<i>Clemmys guttata</i>	Spotted turtle	G5	S5
Bird	<i>Colinus virginianus</i>	Northern bobwhite	G5	
Reptile	<i>Corynorhinus rafinesquii</i>	Rafinesque's big-eared bat	G3,G4	S2
Mammal	<i>Condylura cristata</i>	Star-nosed mole	G5	S3
Reptile	<i>Crotalus adamanteus</i>	Eastern diamondback	G4	S3
Bird	<i>Dendroica discolor</i>	Prairie warbler	G5	
Bird	<i>Dendroica virens</i> (Wayne's)	Black-throated green warbler	G5	S4
Amphibian	<i>Desmognathus auriculatus</i>	Southern Dusky salamander	G5	
Bird	<i>Elanoides forficatus</i>	American Swallow-tailed kite	G5	S2
Bird	<i>Haliaeetus leucucephalus</i>	Bald eagle	G5	S2
Reptile	<i>Heterodon simus</i>	Southern Hognose snake	G2	
Bird	<i>Hylocichla mustelina</i>	Wood thrush	G5	S3
Bird	<i>Ictinia mississippiensis</i>	Mississippi kite	G5	S4
Bird	<i>Lanius ludovicianus</i>	Loggerhead shrike (migrant)	G4	S3
Mammal	<i>Lasiurus cinereus</i>	Hoary bat	G5	
Bird	<i>Laterallus jamaicensis</i>	Black rail		
Bird	<i>Limnothlypis swainsoni</i>	Swainson's warbler	G4	S4
Amphibian	<i>Lithobates capito</i>	Gopher frog	G3	S1
Bird	<i>Melanerpes erythrocephalus</i>	Red-headed woodpecker	G5	
Mammal	<i>Mephitis mephitis</i>	Eastern striped skunk	G5	
Mammal	<i>Microtus pennsylvanicus</i>	Meadow vole	G5	

Reptile	Micrurus fulvius	Eastern coral snake	G5	S2
Mammal	Myotis austroriparius	Southeastern myotis	G3,G4	S1
Invertebrate	Neonympha areolatus	Georgia satyr	G3, G4	
Mammal	Neotoma floridana floridana	Eastern woodrat	G5	S3
Reptile	Nerodia floridana	Florida green water snake	G5	S2
Reptile	Ophisaurus compressus	Island glass lizard	G3, G4	S1
Bird	Passerina ciris ciris	Painted bunting	G5	S1
Reptile	Pituophis m. melanoleucus	Northern pine snake	G4	S3
Bird	Plegadis falcinellus	Glossy ibis	G5	
Amphibian	Pseudobranchius striatus	Dwarf siren	G5	S2
Mammal	Sciurus niger	Eastern fox squirrel	G5	
Bird	Sitta pusilla	Brown-headed nuthatch	G5	
Reptile	Seminatrix pygaea	Black swamp snake	G5	
Bird	Tyto alba	Barn owl	G5	S4
Mammal	Ursa americanus	Black bear	G5	S3
Invertebrate	Zale perculata	Okefenokee Zale moth	G2	

5.4.2 Findings of analysis of At Risk Species

- ✓ The Fish and Wildlife Service (FWS) oversees the enforcement of the Endangered Species Act (ESA), and is responsible for working with the Forest Service to provide habitat on for Threatened, Endangered and Proposed Species (TES) on national forest lands.
- ✓ In 2003, the Fish and Wildlife Service updated the Red-cockaded Woodpecker (RCW) recovery plan. The size and health of the population indicates that the RCW might not need the specific pine tree size and age requirements for its foraging as indicated in the RCW Recovery Plan. The biggest difference between the FM forest plan and the 2003 RCW recovery was that the FM forest plan had more intensive monitoring requirements.

Since 2007, the Francis Marion National Forest's RCW population has exceeded the recovery goal of 350 PBG's as described in the Recovery Plan for the Red-cockaded Woodpecker (*Picoides borealis*) Second Revision (RCW Recovery Plan).

Over a third of the RCW clusters on the FMNF have foraging at or below the managed stability standard, yet the population continues to grow naturally. Although so many clusters on the FMNF do not meet the recovery standard or

managed stability standard, the bird is thriving within the areas that are burned on a two-three year interval (referred to as the Core Burn Area on the FMNF, See Figure 3 in Appendix for a map depicting the core burn area).

- ✓ The 1996 Francis Marion forest plan addresses management of habitat for RCW, RCW populations have grown, and new information is available.
 - Due to aggressive habitat management and installation of over 2,800 artificial cavities, the RCW population has rebounded to approximately 439 active clusters as of January 1, 2013 (Table 2 & Figure 1).
 - The long-term objective for RCW in the 1996 Forest Plan is 450 active clusters (p.2-2 in the Francis Marion forest Plan). However, RCW management will continue to be needed for many years to come (e.g., artificial cavity installation and replacement, mechanical midstory control and annual monitoring).

- ✓ The 1996 forest plan does not address critical habitat for Frosted Flatwoods Salamander. Critical habitat (1,176 ac on the FMNF) was designated for the Frosted Flatwoods Salamander during 2008. In terms of the Frosted Flatwoods Salamander, only 8 adults and approximately 12 larvae have been captured on the Francis Marion in the past 20 years. (Harrison, 2004, 2005, Palis 2009). Nineteen wetlands were surveyed during 2010, and *Ambystoma cingulatum* was documented on the forest for the first time since 2003. Six larvae were collected from a previously undocumented breeding wetland during March 2010.

- ✓ Prescribed burning is the most important, cost-effective management tool to maintain critical habitat for Federally listed species, such as the RCW and Frosted Flatwoods Salamander. The Francis Marion RCW population is expanding in some areas of the forest, especially in areas that are consistently burned on a 2-3 year return interval. Areas that have been consistently burned on a 2-3 return interval are commonly lumped together and referred to as the Core Burn Area (Figure 3). There are some areas on the FMNF where clusters are becoming inactive or reduced to Single Bird Groups (SBG's). These clusters tend to be concentrated in the wildland/urban interface (WUI) and/or areas where minimal forest management has allowed undesirable midstory succession to occur (Figure 4).

- ✓ The federally endangered (*Trichechus manatus*) West Indian Manatee has been documented in the waters of Berkeley and Charleston, but the Francis Marion NF does not occur in the area covered by the 2001 recovery plan (USFWS 2001). The West Indian manatee lives in freshwater, brackish and marine habitats. Submerged, emergent, and floating vegetation are their preferred food. During the winter, cold temperatures keep the population concentrated in peninsular Florida and many manatees rely on the warm water from natural springs and

power plant outfalls. During the summer they expand their range and on rare occasions are seen as far north as Rhode Island on the Atlantic coast and as far west as Texas on the Gulf coast.

- ✓ The Federally listed *Mycteria americana* Wood stork has been documented on the FMNF, but it is not addressed in the 1996 Francis Marion Forest Plan. From the 1960s to the mid-1980s, the wood stork nesting population declined in southern Florida and increased in northern Florida, Georgia, and South Carolina. Prior to 1970, a majority (70 percent) of the population nested south of Lake Okeechobee and declined from 8,500 pairs in 1961 to fewer than 500 pairs in the late 1980s and early 1990s. During the same period, nesting in Georgia increased from 4 to 1,501 pairs and nesting in South Carolina increased from 11 to 829 pairs (US FWS 2007). This extended the breeding range north along the coastal plain of Georgia and South Carolina. Overall, surveys between 1983 and 1995 documented a population in the Southeast U.S. ranging between 4,073 and 7,853 pairs.
- ✓ In 2007, the American Bald Eagle was de-listed as a federally endangered species, but it is still protected by the Bald and Golden Eagle Protection Area. The species was listed as a Forest Sensitive species after it was delisted. As such, it has been included as a Potential Species of Conservation Concern.
- ✓ The 1996 Forest Plan direction includes standards to protect American Swallow-tailed kite, but new information is available on this species. There are concerns about the impact of prescribed burning on the species during the nesting season. The use of aerially ignited prescribed burns during the swallow-tailed kite nesting season is a biological concern. This concern is mainly tied to the intensity of burning that sometimes takes place in prime swallow-tailed kite nesting habitat (e.g., ecotones and floodplains of streams). Swallow-tailed kite numbers on the Francis Marion National Forest have remained fairly constant since Hurricane Hugo. However, preliminary nesting data since 2004 indicates that nesting success may be of concern on the FMNF.
- ✓ Carolina Gopher Frog (*Lithobates capito*) is one of the the rarest amphibians on the FMNF. The Carolina gopher frog is currently a state endangered species in South Carolina with a natural heritage rank of S1 (NatureServe 2005). The USFWS has been petition to list it under the Endangered Species Act.
- ✓ Some potential species of conservation concern are included, although they have not have had a recorded occurrence on the FMNF in the last 10 to 15 years. The status of Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) and southeastern myotis (*Myotis austroriparius*), are unknown due to the fact that these species are extremely difficult to monitor.
- ✓ In terms of habitat concern, the Wando Area is likely the number one area on the FMNF, as it supports some of the highest densities of Potential Species of

Conservation Concern on the FMNF. Increased urbanization and human population growth are significant concerns within the planning area, especially in terms of the negative impacts they pose to at risk species and forest management. In terms of habitat concern, the Wando Area is likely the number one area on the FMNF to be concerned about during the next 10-15 years, as it supports some of the highest densities of proposed, endangered and forest sensitive (PETS) species on the FMNF. The Wando Area supports one of the last remaining Frosted Flatwoods Salamander populations in South Carolina, and some of the highest concentrations of Carolina Gopher Frog breeding wetlands in the state. In fact, all known *A. cingulatum* occurrences on the FMNF only occur in the Wando Area.

- ✓ Hurricanes will always be a potential threat to the RCW on the FMNF. Since 1700, there appear to have been about 18 hurricanes that probably affected the FMNF (Langley and Marter 1973, Calhoun 1983, USACE 1986, Neumann et al. 1987, Hooper 1990). These data suggest the FMNF is subjected to hurricane-force winds about once every 16 years. The RCW now exists in habitat islands spread out along the Atlantic and Gulf Coast states. As such, hurricanes are a menace to the species. Although the RCW population has rebounded to historically high numbers, the Francis Marion National Forest will have to continue aggressive habitat management and monitoring for many years to come. As long as there are no catastrophic events, it is anticipated that the artificial cavity program will continue to be needed until there are vast amounts cavity-size pines in suitable habitat for the RCW. This may take as long as 40 years due to Hurricane Hugo's destruction. There are some areas on the FMNF where red-cockaded woodpecker clusters are becoming inactive or reduced to SBG's. These clusters tend to be concentrated in the wildland/urban interface (WUI) and/or areas where minimal forest management has allowed undesirable midstory succession to occur.
- ✓ Roads can have significant adverse ecological and biological effects on amphibians and reptiles, as well as numerous other faunal groups. Some heavily traveled paved roads on the FMNF cause significant amphibian and reptile mortality (i.e., Highway 17, Highway 41, Highway 402, Highway 45, and Steed Creek Rd). As the human population continues to increase in the counties of Berkeley, Charleston and Dorchester, wildlife road mortality is expected to continue to increase as more vehicles are on the roads. Road impacts on wildlife need to be assessed on the FMNF in order to identify potential mitigation measures.
- ✓ Many isolated wetlands on the Francis Marion have been negatively impacted by past land practices and are in need of restoration. These wetlands provide some of the best and only available breeding habitat for species such as the Frosted Flatwoods Salamander and Carolina Gopher Frog.

- ✓ Personal communications with Julian Harrison in 2006 and 2007, who had more intimate knowledge of the FMNF herpetofauna than any other human being at that time living, indicated that one of the biggest changes to Frosted Flatwoods Salamander and Carolina Gopher Frog breeding wetlands on the FMNF since the 1950's was hardwood shrub and tree encroachment both within the wetland ecotones and the wetlands themselves. Changes in vegetation like this can significantly degrade breeding wetlands for species such as *A. cingulatum* and *L. capito*

5.4.3 Summary of important changes that have occurred since 1996:

1. **An expanding red-cockaded woodpecker population with active management, primarily through prescribed burning and thinning.**
2. **Delisting of the American Bald Eagle.**
3. **Change in status of the American alligator.**
4. **Identification of critical habitat for the Frosted flatwoods salamander.**
5. **Management emphasis shifting to incorporate restoring hydrologic regimes on the Forest.**
6. **Rapid urban development of the Mt Pleasant Wando area, and Hwy 17 corridor since 1996.**

Red-cockaded Woodpecker (*Picoides borealis*) **Status: endangered**

Of all plant and animal species known to occur on the FMNF, no other species has a greater influence on Forest Service management than the red-cockaded woodpecker (RCW). The FMNF supports the third largest population of the federally endangered RCW in the United States, and is one of 13 designated core recovery populations. Prior to Hurricane Hugo in 1989, the RCW population exceeded 475 groups and was one of the only known naturally expanding populations. In one night, Hurricane Hugo killed an estimated 63% of the RCW population, destroyed 87% of the cavity trees and 59% of the foraging habitat across the Francis Marion National Forest (Hooper et al. 1990 & Hooper et al. 1991). Approximately 50% of the clusters were believed to have lost all of their cavity trees due to the hurricane. In 1990, there were only approximately 205 clusters with at least one



active cavity tree present (Hooper 1990). The breeding population had been reduced to approximately 242 potential breeding groups (Figure 2). By 1995, the population increased to approximately 361 potential breeding groups (PBG's), which was largely due to the installation of over 1,000 artificial cavities, continued prescribed burning operations, and mechanical habitat improvements (Table 2 & Figure 2). Beginning in 1996, the population began a decline that continued through 1999, culminating in an estimated 314 potential breeding groups. This decline was attributed to lack of suitable cavities and increased midstory vegetation conditions in many areas of the FMNF.

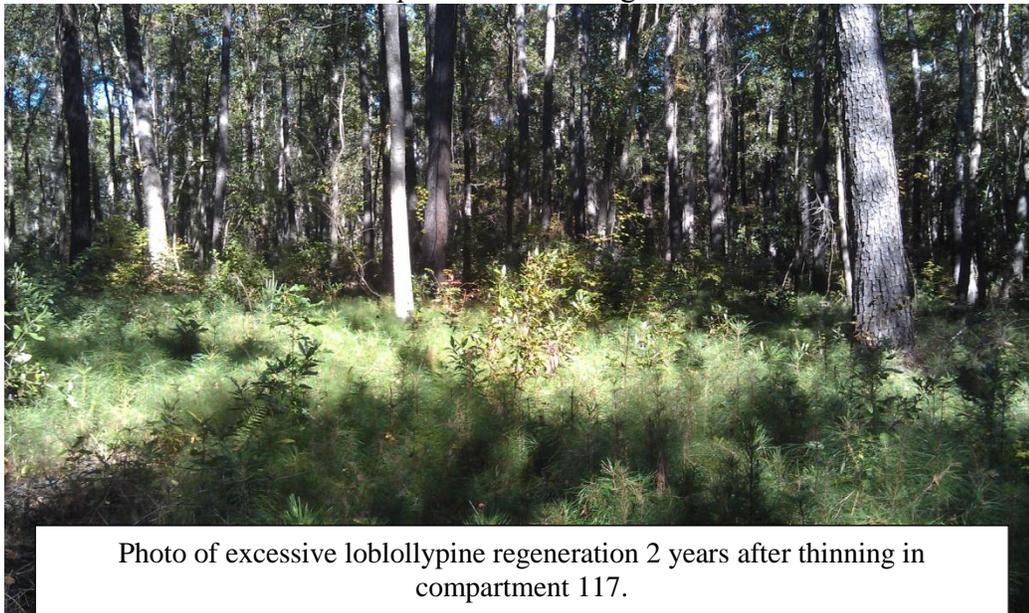
Due to aggressive habitat management and installation of over 2,800 artificial cavities, the RCW population has rebounded to approximately 439 active clusters as of January 1, 2013 (Table 2 & Figure 1). The long-term objective in the 1996 Francis Marion Forest Plan is 450 active clusters (p.2-2). At present, we are not far from meeting this objective. In fact, it is highly likely that the FMNF has already exceeded 450 active clusters, but we just haven't documented all of the budded clusters that exist on the forest. Currently, there are a total of 496 managed clusters on the FMNF, of which 426 are PBG's, 13 are single bird groups (SBG's) and 57 are inactive (Table 2 & Figure 2).

A cluster, as defined in the Recovery Plan, is "the minimum convex polygon containing all of a group's cavity trees *and* the 61 m (200 ft) buffer surrounding that polygon. The minimum cluster area size is 4.05 ha (10 ac)." Based on this definition, the 496 managed clusters on the FMNF occupy approximately 7,473 acres. The average half mile foraging partition on the FMNF is approximately 289 acres. The half mile foraging partitions of all known clusters encompass approximately 143,489 acres. As such, the FMNF currently manages RCW habitat on approximately 23,489 more acres than were identified as the Habitat Management Area (HMA) in the 1996 Forest Plan. Since 2007, the Francis Marion National Forest's RCW population has exceeded the recovery goal of 350 PBG's as described in the Recovery Plan for the Red-cockaded Woodpecker (*Picoides borealis*) Second Revision (RCW Recovery Plan). Despite the fact that the majority clusters on the forest have foraging habitat that does not meet the recovery standard, the Francis Marion National Forest (FMNF) supports one of the most robust populations in the United States. Based on intensive monitoring conducted during 2009, the average group size on the FMNF is greater than 3 birds/group, and reproductive success averages approximately 2.3 fledglings per successful nest.

The Francis Marion RCW population is expanding in some areas of the forest, especially in areas that are consistently burned on a 2-3 year return interval. Areas that have been consistently burned on a 2-3 return interval are commonly lumped together and referred to as the Core Burn Area (Figure 3). The FMNF population is truly a testament to the resiliency of the species. Over a third of the RCW clusters on the FMNF have foraging at or below the managed stability standard, yet the population continues to grow naturally. Although so many clusters on the FMNF do not meet the recovery standard or managed stability standard, the bird is thriving within the Core Burn Area. There are some areas on the FMNF where clusters are becoming inactive or reduced to SBG's. These clusters tend to be concentrated in the wildland/urban interface (WUI) and/or areas where minimal forest management has allowed undesirable midstory succession to

occur (Figure 4). As one might expect, the highest densities of RCW clusters are found within the Core Burn Area (Figure 5).

However, there are some exceptions to this trend. The southwest portion of the forest, which is commonly referred to as the Wando Area, supports some of the highest densities of RCW's and other PETS species on the FMNF. In fact, this portion of the Forest likely supports one of the last remaining Frosted Flatwoods Salamander populations in South Carolina, and some of the highest concentrations of Carolina Gopher Frog breeding wetlands in the state. Unfortunately, the Wando Area has numerous wildland urban interface issues, which have severely limited the Forest Service's ability to burn this area frequently. Fire and mechanical treatments have been effectively used to greatly improve habitat conditions for species such as the Frosted Flatwoods Salamander and Carolina Gopher Frog in some portions of the Wando Area (i.e., compartments 115 & 116). However, some compartments, such as compartment 114 between Highway 41 and Cainhoy Rd, have not been burned in over 20 years. In addition to the issues associated with fire exclusion and suppression, there are over 11,000 acres of densely stocked pine and mixed pine hardwood stands in the Wando Area. These dense stands are typically characterized by high fuel loads and suppressed understories. Silvicultural thinning treatments have been used to improve habitat conditions in densely stocked pine stands. Unfortunately, mechanical treatments only provide short term habitat benefits lasting 2-3 years. If thinning is not followed with repeated prescribed burning operations every 2-3 years, undesirable midstory conditions quickly deteriorate stand conditions. The following picture is a classic example of the pine and hardwood regeneration that can result shortly after a traditional thinning treatment if it is not followed with prescribed burning.



In terms of habitat concern, the Wando Area is likely the number one area on the FMNF to be concerned about during the next 10-15 years. Virtually all of the PETS species found within the Wando Area are dependent upon fire maintained ecosystems. Due to the fact that it has been so difficult for the Forest Service to adequately burn the Wando Area since the last 1996 Forest Plan Revision, conditions are only expected to

deteriorate in the future. This is especially true as urbanization continues to increase along the Highway 41 corridor. Already, large private landholdings along the Highway 41 corridor have been approved for high density housing. Figure 5 depicts the estimated urban area of Berkeley, Charleston and Dorchester counties in 2005. Based on The Strom Thurmond Institute's 2005 estimates, the total urban area is expected to increase from 398 square miles in 2005 to 868 square miles in 2030 (Figure 6). As such the urbanized area of Charleston, Berkeley and Dorchester counties may more than double in land area between now and 2030.

In terms of forest management designed to benefit the RCW and other species of the longleaf ecosystem, the FMNF needs to dramatically increase longleaf pine restoration treatments. As of 2013, we estimate the potential range for longleaf on the FMNF at almost 145,000 acres, including 54,000 acres in upland longleaf, and 90,735 acres in wet pine savanna and flatwoods (55% of the forest). The 1996 Forest Plan, estimated the range of longleaf pine on the FMNF to be between 37,000 and 75,000 acres. The goal for longleaf pine ecosystem expansion was 21% of the forest. Based on 2013 inventory data, we currently have 49,102 acres (19% of the forest) in the longleaf and mixed longleaf stands. Loblolly pine or loblolly pine/hardwood dominate 104,376 acres on the forest (40.5%), including 25,673 acres (48%) of all upland longleaf sites and 50,760 acres (56%) of wet pine savanna and flatwoods sites. If the acres in longleaf and loblolly pine are accurate, the percentage of longleaf forest on the FMNF has actually decreased by approximately 12 percent since acquisition in 1936. After the FMNF was acquired in 1936, A.A. Grumbine estimated the dominant forest types as follows:

Forest Description:

The following table shows the acreage and percentage of area by types for stands 1 MBM and over per acre, and stands under 1 MBM per acre (acquired and approved).

Acreage by Types and Conditions

Type ¹	Stands 1 MBM/A & above	Stands under 1 MBM/A	Total	Percent
Longleaf	24,527	51,205	75,732	31
Loblolly	24,813	53,356	78,169	32
Pine Hardwood	12,048	9,036	21,084	9
Bottom Hardwood	9,810	12,335	21,945	9
Hardwood Swamp	4,877	1,865	6,742	3
Pond	13,339	19,937	33,276	13
Bay		4,733	4,733	2
Total Forest	89,214	152,467	241,681	99
Non-Forest		2,151	2,151	1
Total (Acquired and Approved)	89,214	154,618	243,832	100

Loblolly sites² range from 50 to 110, with an average site index of 75. Longleaf sites range from 50 to 90, with an average index of 60. 88% of the hardwoods are in sites I and II.

With regards to the RCW, prescribed burning is likely the single most important silvicultural treatment utilized on the FMNF. Since 1997, the FMNF has burned approximately 12,995 ha (32,000 ac) annually, and the forest will likely burn close to 42,000 acres during 2013. Between 2005 and 2012, 36% of our upland longleaf and

15% of our wet pine savanna and flatwoods ecosystems were burned at a desirable frequency (at least 3 or more times - 2.6 year burning rotation), and 8% of our upland longleaf and 11% of our wet pine savanna and flatwoods ecosystems were burned 3 times, including at least one growing season burn.

Since Hurricane Hugo, most timber harvesting has consisted of biomass removal and small timber thinning. The FMNF typically masticates approximately 150 acres and selectively thins approximately 1,215-1,619 ha (3-4,000 ac) annually in order to improve habitat for the RCW and other threatened and endangered species. Mastication treatments tend to be concentrated in RCW clusters where hardwood midstory is encroaching upon the cativity trees. During 2010, approximately 263 ha (650 ac) were masticated on the FMNF, which significantly improving RCW habitat in numerous RCW clusters.

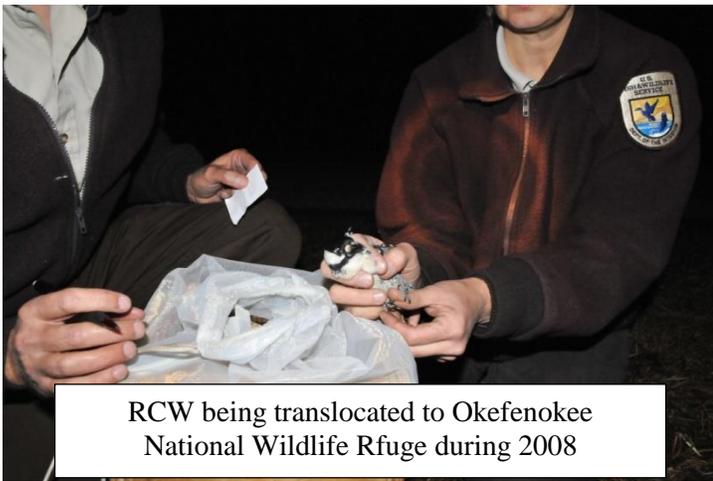
There have been approximately 50,000 acres of stands regenerated on the FMNF since 1989, with over 80% of the regeneration occurring between 1989-1991 (Figure 7). Of the 50,000 +/- acres, only 12-13,000 acres were restored to longleaf pine (25%), while over 31,000 acres (62%) of loblolly pine and loblolly pine mixtures were regenerated on the FMNF since 1989 (Figure 8). As of 2013, these stands are at most 23 years of age, and represent some of the worst ecological conditions found on the FMNF. Most post-Hugo pine stands (loblolly and longleaf) are densely stocked, possess closed canopies, and do not offer good quality foraging habitat for the RCW. Based on LIDAR analysis, approximately 33.7% of our longleaf pine ecosystems appear to have open canopies (i.e., less than 60% canopy cover), 8.5% are in savanna condition (i.e., less than 26% canopy cover) and 25% are in woodland condition (i.e., 26-60% canopy cover). As such, most of our older longleaf stands appear to be in desirable condition. As previously mentioned, many of the longleaf stands that were regenerated after Hurricane Hugo currently offer poor habitat for species such as the RCW.

The FMNF only recently began trying to restore longleaf pine in post-Hugo loblolly stands (i.e., the 2011 Hellhole Environmental Analysis). The Hellhole Environmental Analysis (Hellhole EA) seeks to restore longleaf on approximately 580 acres of densely stocked loblolly pine stands. Prior to the Hellhole EA, most of these post-Hugo loblolly stands received traditional silvicultural thinnings. These traditional silvicultural thinnings did a wonderful job opening up the canopy and generally improving habitat conditions for species such as the RCW, especially within the Core Burn Area. Unfortunately, these treatments have not contributed to longleaf restoration, and instead, many of these traditional thinning treatments have allowed offsite loblolly to persist in many areas that should have been restored to longleaf pine.

As described earlier, thinning is only a short term habitat enhancement for the RCW if it is not properly maintained with prescribed burning. In terms of RCW habitat, the benefits from thinning typically only last 2-3 years on the FMNF if the thinnings aren't maintained with an adequate fire return interval (personal observations). Mechanical tree thinnings tend to be costly, especially if the material is unmerchantable. In many cases, the Forest Service has had to rely on costly mastication treatments to restore and maintain RCW habitat, especially in the WUI. These mastication treatments have cost

the Forest Service anywhere from \$200-\$600/acre, while traditional pre-commercial thinning (AKA biomass thinning) has cost the Forest Service upwards of \$150/acre. Fire can be used as a means to thin over stocked pine stands at a fraction of the cost (economic and/or ecologic) of traditional mechanical silvicultural methods (Wade 1993). The results of Wade 1993 indicate that low-intensity (< 346 KWIm) backing fires can produce a thinning from below where groundline diameter (GRD) range in overstocked loblolly pine stands is wide enough to allow differential survival and where the trees targeted for removal have GRD's less than 3.8 cm (1.50 in.). Thinning by fire occurs regularly inside the core burn area, and has been extremely useful in opening up closed canopy pine stands. Unfortunately, most of the prescribed burning on the FMNF takes place during the dormant season between February and April. Burning during this time period rarely gets hot enough to thin longleaf pine, especially as they increase in height and diameter. As a result, exceptionally dense longleaf understory and midstory is developing across certain areas of the FMNF, especially in longleaf pine stands along the Halfway Creek Road corridor stretching from the Southampton Rd/Halfway Creek Rd intersection to the Halfway Creek Rd/Highway 45 intersection.

The Honey Hill Environmental Analysis (Honey Hill EA), completed in 2009, was actually the first large longleaf restoration proposed on the FMNF since the early 1990's. The Honey Hill EA seeks to restore longleaf pine across approximately 780 acres, which are concentrated east of Highway 45. Longleaf restoration treatments such as those



RCW being translocated to Okefenokee National Wildlife Refuge during 2008

proposed in the Honey Hill and Hellhole EA's should prove beneficial for numerous species that are dependent upon the longleaf pine ecosystem. The FMNF should focus all future silvicultural activities on restoration and enhancement of natural ecological systems, especially with regards to the longleaf pine ecosystem. By focusing efforts on restoration and enhancement, native

species dependent upon specific ecological systems and conditions will benefit, including species such as the RCW.

Beginning in 2008, the FMNF facilitated a translocation and monitoring project which lasted until 2010. This project was conducted in cooperation with the University of Georgia, Southeast Regional Partnership for Planning and Sustainability (SERPPAS), USFS, and the Southern Range Translocation Cooperative (SRTC). Funding provided by SERPPAS funded a fulltime RCW biologist, whose sole responsibility was to ensure success of the translocation project on the FMNF. In association with this project, approximately 101-102 RCW clusters were monitored each year from 2008-2010, and nestlings were banded in approximately 94 clusters annually. Following a severe winter in 2009/2010, the 2010 translocation clusters had slightly smaller group and brood sizes, with a higher percentage of females fledging than in previous years (i.e., 57% vs. 52% in

2009). During 2009, only one of the translocation clusters did not have at least one helper. However, in 2010 at least 7 clusters did not have a helper. Several groups initiated nests earlier than in previous seasons with the earliest banding dates being 3-4 days earlier than in the past years. Also, the peak banding dates were not as clearly defined as in previous breeding seasons with the daily number of nests scheduled to band being spaced more evenly throughout May rather than most banding taking place the third week of May. A total of 186 RCW nestlings were banded in 101 nesting attempts from 102 groups that were monitored during 2010. For the 102 groups monitored, an average group size of 3.27 (N=50) was estimated. Within these 102 RCW groups, 7 initial nest attempts failed, 9 groups did not attempt a nest and 5 groups had clutches that did not hatch. The nestlings of 3 re-nests were successfully banded while 4 groups had nests that failed during the second attempt. Of all nestlings, 184 reached 21 days old and these were assumed to have fledged. For groups that fledged young, an average of 2.1 nestlings fledged/nest (n=88). For fledglings that were able to be sexed, 57.1 % were females (n=101) and 42.9% (n=76) were males). During pre-fledge nest checks, 32 nests had either a lone nestling of known sex or all nestlings were the same sex. These clusters were not re-visited for post-fledge checks during 2010. The remaining clusters were re-visited post-fledge to assign a sex to the band combination of the banded birds.

Based on allocations determined at the 2010 SRTC meeting, six pairs of sub-adults were translocated to U.S. Army Garrison Fort Jackson (Richland County, SC) on 6 & 21 October 2010, two pairs were translocated to Savannah River Site on 21 October 2010, and two pairs went to the U.S. Air Force's Poinsett Electronic Combat Range (Sumter County, SC) on 1 November 2010. This translocation project has not only saved the government money in terms of RCW monitoring, but has also identified 20-30 new budded and pioneered clusters. These budded clusters would not have been found during our typical annual monitoring activities.

The FMNF translocated 49 RCWs between 2008 and 2009. During the 2009 translocation project, four pairs of sub-adults were translocated to Ocala National Forest, five pairs went to the Talladega National Forest and five pairs went to Joseph E. Jones Ecological Research Center at Ichauway. During 2008, a total of 245 nestlings were banded for an average # of chicks per banded nest of 2.4 (compared to 1.8 on the Osceola NF), reflecting the size and "maturity" of the FMNF vs. the Osceola NF. During 2008 post-fledge checks, the RCW biologist found and sexed 229 fledglings. Sixteen (16) of the 245 nestlings were not found, and presumed dead as a result of nest failure. Based on allocations determined at the 2008 Southern Range Translocation Cooperative (SRTC) meeting, four pairs of sub-adults were translocated to U.S. Army Garrison Fort Jackson, three pairs went to the Okefenokee National Wildlife Refuge and three pairs were translocated to Military Ocean Terminal Sunny Point in NC. Of the 20 birds translocated in 2008, 60% were successful, which exceeded the regional (SRTC) 2008 success rate of 53% (McDearman 2011). In 2009, the FMNF birds experienced a lower-than-average success rate of 46%; the STRC average success rate for 2009 was 51% (McDearman 2011). Yearly variation is normal and both years were within reasonable range of the SRTC overall average.

Additional data that was gleaned from the translocation project pertained to genetics. Based on buccal swabs obtained from the FMNF and three small recipient RCW



Buccal swab sample being obtained from sub-adult RCW

populations (i.e., Joseph W. Jones Ecological Research Center at Ichauway, Silver Lake Wildlife Management Area and Enon/Sehoy Plantations), Alstad 2010 was able to analyze genetic diversity of these populations based on multi-locus microsatellite genotypes and mitochondrial haplotypes in an AMOVA framework. On

the FMNF, one nestling was randomly chosen and swabbed per nest from 55 randomly selected nests, during April and May of 2008 and 2009 (Alstad 2010). Researchers were also able to obtain buccal swabs from 20 sub-adults being translocated from Francis Marion to recipient populations. The results of Alstad 2010 suggested that range-wide translocations can mitigate some of the detrimental effects associated with population fragmentation. However, his results also showed that there are still sufficient reasons to be concerned about the genetic health of small isolated RCW populations (Alstad 2010). A low rate of gene flow due to significant geographic isolation, lack of translocations, and subsequent random drift may have affected linkage disequilibrium in the Francis Marion RCW population (Alstad 2010). Due to the shear destruction of Hurricane Hugo, the Francis Marion RCW population likely experienced a genetic bottleneck when Hurricane Hugo struck in 1989 (Alstad 2010). Alstad 2010 detected significant inbreeding (FIS) in all of the RCW populations that were examined. The FMNF had a moderate level of inbreeding (FIS = 0.29 for one individual per cluster sampled). While this could be an artifact of the Hurricane Hugo bottleneck, other mechanisms may also influence measures of inbreeding in this population (Alstad 2010). Compared to most other RCW populations, the FMNF still exhibits a high degree of genetic diversity, especially when considering what the FMNF population went through after Hurricane Hugo.

Although systematic surveying of suitable habitat is not possible at this time, pioneer clusters are regularly located by Forest Service employees during the course of their normal field activities, as well as with annual monitoring activities. Beginning in 2006, the FMNF monitored at least 33% of the RCW population annually so that the entire population was monitored after 3 years. However, due to funding constraints, no monitoring was conducted during 2011, and the Forest began monitoring 20% of the population during 2012. The 20% annual sample was randomly selected using Hawth Tools in ArcGIS, so that the entire population will be monitored after 5 years. The

population growth rate has somewhat slowed since 2010, but growth is expected to continue as habitat enhancement/maintenance practices are consistently implemented. Artificial recruitment clusters have been routinely installed on the FMNF where possible. However, one of the biggest obstacles to establishing new recruitment clusters is locating large enough cavity trees within suitable habitat. Where there is suitable habitat, cluster density is so high that it is virtually impossible to find suitable locations for recruitment clusters. As such, the FMNF hasn't established any new recruitment clusters since 2008. The population is naturally expanding on its own. As such, our focus since 2006 has been to provide each cluster with at least 4 suitable cavities, and to provision clusters with replacement inserts and restrictor plates as needed.

Hurricanes will always be a potential threat to the RCW on the FMNF. Since 1700, there appear to have been about 18 hurricanes that probably affected the FMNF (Langley and Marter 1973, Calhoun 1983, USACE 1986, Neumann et al. 1987, Hooper 1990). These data suggest the FMNF is subjected to hurricane-force winds about once every 16 years. This estimate may be inflated because it is impossible to get specific information about the early hurricanes. However, the mean elapsed time between hurricanes is fairly stable across centuries (1700's- 16.7; 1800's- 14.3; and the 1900's- 17.8). Clearly, not all these hurricanes had the same effect as Hugo, but cavity trees are at risk relatively frequently. Knowledge and experience gained from managing the catastrophic damage of Hurricane Hugo has well equipped the FMNF in the areas of hurricane preparedness and response.

Hooper 1990's discussion related to RCW's and hurricanes is the most logical, yet most impractical too: "The best biological answer is appealing but impractical: revert back to pre-Columbian conditions. In that era, hurricanes no doubt destroyed large areas of red-cockaded woodpecker habitat and killed large numbers of the birds but had relatively little impact on the species as a whole. Now with the bird existing in habitat islands, hurricanes are a menace to the species. The next best answer is to have as many geographically large populations as possible. An extensive population is desirable because a single hurricane is less likely to destroy the entire population beyond the point that it can recover. Cooperative management agreements with owners of private land adjacent to public land with red-cockaded woodpeckers may be the most practical way to increase the geographic extent of a population."

Although the RCW population has rebounded to historically high numbers, the Francis Marion National Forest will have to continue aggressive habitat management and monitoring for many years to come. As long as there are no catastrophic events, it is anticipated that the artificial cavity program will continue to be needed until there are vast amounts cavity-size pines in suitable habitat for the RCW. This may take as long as 40 years due to Hurricane Hugo's destruction. The artificial cavity program typically consists of installing approximately 150 structures per year. These structures mainly consist of replacement inserts and restrictor plates. However, new inserts, drilled cavities, and drilled starts are installed each year, especially in clusters with less than 5-6 suitable cavities. Monitoring 20% of the RCW population each year so that the entire population has been monitored after 5 years is significantly less than what the FMNF

historically monitored. However, this level of monitoring is sufficient to gauge the health and viability of the RCW population.

Due to the uncertainties that exist with the RCW population on the Francis Marion National Forest, and trends that have occurred when suboptimal conditions existed in past years, monitoring will continue to be needed for many years to come. Ideally, the FMNF will continue to serve as a source for future translocation projects. Due to its size and health, the Francis Marion RCW population will be critical for augmenting existing small populations, as well as efforts to reintroduce the species into new habitats. Future translocation projects will not only benefit the species throughout its range, but will also allow us to glean detailed population information such as that generated from the 2008-2010 translocation projects.

Frosted Flatwoods Salamander (*Ambystoma cingulatum*)

Status: Federally threatened



2 year old *A. cingulatum* collected as a larva on FMNF in 2010

The Frosted Flatwoods Salamander is a federally threatened mole salamander which breeds within seasonally flooded isolated wetlands (SFIW's) within fire-maintained pine woodlands and savannas. This salamander burrows near water or moves about under debris on the forest floor. It is carnivorous and an opportunistic feeder, primarily eating earthworms and arthropods. The species needs shallow winter ponds to

breed, and does not do well in ponds that contain fish. The timing and frequency of rainfall is critical to the successful reproduction and recruitment of flatwoods salamander (Final Rule for Listing, 1999). Surviving populations are currently threatened by habitat loss and degradation from agriculture, urbanization, and various silvicultural practices (Final Rule for Listing, 1999). The Flatwoods Salamander is extremely rare in South Carolina, and the FMNF is home to one of only four known populations in the entire state.

Most known, historic and potential Frosted Flatwoods Salamander breeding wetlands on the Forest (as identified by Harrison in monitoring report dated 2004) occur within the Wando Area of the FMNF. As one will read Conservation measures for the species are included in the final

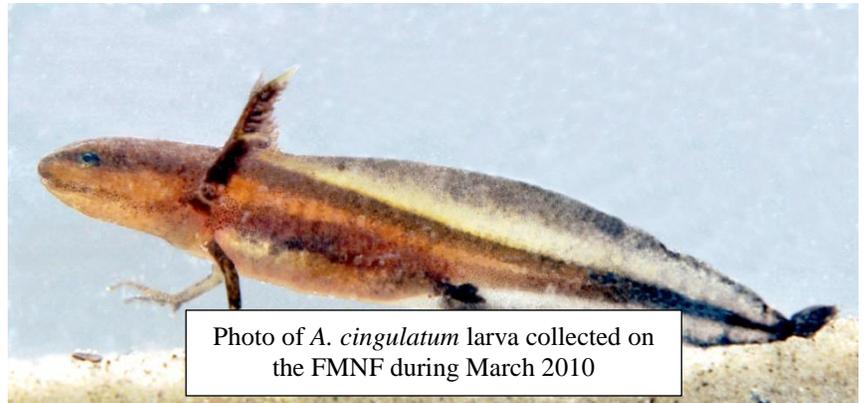


Photo of *A. cingulatum* larva collected on the FMNF during March 2010

rule for listing (Federal Register Vol.64, No.62:15703), and address management activities within a 450m radius of known flatwoods salamander breeding ponds. Only 8 adults and approximately 12 larvae have been captured on the Francis Marion in the past 20 years. (Harrison, 2004, Harrison 2005, Palis 2009, internal USFS records). Initial observations of flatwoods salamanders on the Francis Marion National Forest were made by Julian Harrison in the early 1950s through 1970 (Harrison 2003). Subsequent observations were made during flatwoods salamander surveys by Moulis and Seyle 1987 and Moulis and Williamson 1998. More recent observations of flatwoods salamanders on FMNF were made fortuitously. John Fauth captured four adults in October 1995 and a single larva in 2003 (Harrison 2003), William Resetarits encountered an adult on Hoover Road in June 1997 (internal Forest Service documentation) and a larva was captured in Hoover Pond in 2002 (Harrison 2003). The first observations of flatwoods salamanders on FMNF were made by Bennett (1995), 2000 (Humphries 2000), 2001 (Harrison 2001, Waldron 2001), 2003 (Harrison 2003), 2009 (Palis 2009), and 2010 (Palis and Klaus).

Photo of *A. cingulatum* larva collected on the FMNF during March 2010

The majority of sampling on the Forest is conducted via dip-netting and deployment of minnow traps for larval salamanders. Since 2006, the FMNF has only been able to conduct surveys for this species during 2009 and 2010 due to drought conditions. During 2010, John Palis and Joyce Marie Klaus conducted surveys on the FMNF. Nineteen wetlands were surveyed, and *Ambystoma cingulatum* was documented on the forest for the first time since 2003. Six larvae were collected from a previously undocumented breeding wetland during March 2010. Three larvae were taken to Riverbanks Zoo in Columbia, SC, where Scott Pfaff (Curator of Herpetology) successfully raised them to metamorphosis. At the time of collection, the larvae were too small to collect tail tissue, so the zoo reared them until they were big enough to collect tissue. DNA analysis was performed, and results indicate that individuals from the FMNF do not represent a distinct species, and are closely related to other populations of the Frosted Flatwoods Salamander. This was the first genetic material available from SC.

The August 13, 2008 Federal Register (Volume 73, Number 157) designated critical habitat for *A. cingulatum*. Critical habitat on the Francis Marion was given the unique identifier of Unit FFS-6. The Federal Register stated the following for Unit FFS-6: “Unit FFS-6 occupied at the time of listing, encompasses 1,300 ac (526 ha) on Federal and private land in Berkeley County, South Carolina. This unit is bisected by State Highway 41 approximately 10 mi (16 km) south of the town of Huger. Within this unit, 1,176 ac (476 ha) are in the Francis Marion National Forest and 124 ac (50 ha) are on private land. Land within this subunit owned by the U.S. Forest Service is protected from agricultural and urban development; however, threats remain to frosted flatwoods salamander habitat that may require special management of the PCEs. These threats include the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, and potential hydrologic changes resulting from adjacent highways and roads that could alter the ecological functioning of the breeding pond and surrounding terrestrial habitat. Special management of the PCEs may also be required for the threats posed by agricultural and urban development on the lands in private ownership. All lands proposed for designation contain all PCEs and support multiple frosted flatwoods salamander life processes.”

In terms of the species’ natural history requirements, the August 13, 2008 Federal Register provides the following useful information:

“Food, Water, Air, Light, or Other Nutritional or Physiological Requirements

Post-larval frosted and reticulated flatwoods salamanders eat small invertebrates that share their fossorial habit. Records exist of earthworms that have been found in the stomachs of dissected adult salamanders (Goin 1950, p. 314). Larval flatwoods salamanders most likely prey on a variety of aquatic invertebrates and perhaps small vertebrates such as other amphibian larvae (Palis and Means 2005, p. 608). Data from a recent study of larval food habits found that freshwater crustaceans dominated stomach contents of preserved, wild-caught individuals from Florida and South Carolina (Whiles *et al.* 2004, p. 208). This indicates a preference for freshwater crustaceans or perhaps is an indication that these invertebrates are the most abundant or most easily captured prey in breeding ponds.

Within the pine uplands, a diverse and abundant herbaceous layer consisting of native species is important to maintain the prey base for adult frosted and reticulated flatwoods salamanders. Wetland water quality is important to maintain the aquatic invertebrate fauna eaten by larval salamanders. An unpolluted wetland with water free of predaceous fish, sediment, pesticides, and the chemicals associated with road runoff, is important to maintain the aquatic invertebrate fauna eaten by larval salamanders.

Cover or Shelter

At wetland sites, developing larval frosted and reticulated flatwoods salamanders hide in submerged herbaceous vegetation during the day (Palis and Means 2005, p. 608) as protection from predators. Thus, an abundant herbaceous community in these ponds is important for cover. Generally, flatwoods salamander breeding pond and upland habitats are separated by an ecotone (area of transitional habitat) through which salamanders must move during pre- and post-breeding events (Palis 1997, p. 58). The graminaceous (grass-like) ecotone represents a distinct habitat type and is important for maintaining connectivity between aquatic and terrestrial habitats. When the ecotone provides cover and appropriate microclimatic conditions, survival of migratory salamanders is enhanced. Studies of migratory success in post-metamorphic salamanders have demonstrated the importance of high levels of survival of these individuals to population maintenance and persistence (Rothermel 2004, pp. 1544-1545). Post-larval and adult frosted and reticulated flatwoods salamanders occupy upland flatwoods sites where they live underground in crayfish burrows, root channels, or burrows of their own making (Goin 1950, p. 311; Neill 1951, p. 765; Mount 1975, pp. 98-99; Ashton and Ashton 2005, pp. 63, 65, 68-71). The occurrence of these belowground habitats is dependent upon protection of the soil structure within flatwoods salamander terrestrial sites.”

As published in Federal Register Volume 74 Number 26, the USFWS finalized the listing under the Endangered Species Act of 1973 of the currently threatened flatwoods salamander (*Ambystoma cingulatum*) into two distinct species: Frosted Flatwoods Salamander (*Ambystoma cingulatum*) and Reticulated Flatwoods Salamander (*Ambystoma bishopi*). The USFWS made a determination of endangered status for the Reticulated Flatwoods Salamander, and retained threatened status for the Frosted Flatwoods Salamander (Federal Register 2009). Designated critical habitat for the Frosted Flatwoods Salamander and the Reticulated Flatwoods Salamander were further finalized in Federal Register Volume 74 Number 26.

Due to its potential for maintaining and increasing the number of metapopulations, the Francis Marion National Forest is likely the most important habitat for the Frosted Flatwoods Salamander in all of South Carolina. As with numerous other endangered and threatened species, public lands are critical for ensuring species viability. Twenty-two (88 percent) of the known Frosted Flatwoods Salamander populations occur primarily on public land (Federal Register 2009). Sixteen of the populations (64 percent of total populations of the species) on public land represent metapopulations supported by more than one breeding site (Federal Register 2009). Unfortunately, all known current and historic Frosted Flatwoods Salamander breeding wetlands are found in the Wando Area

of the FMNF. As previously mentioned in this document, the Wando Area is one of the most rapidly urbanizing areas on the Francis Marion National Forest, and supports some of the highest densities of proposed, endangered, threatened, and previously identified forest sensitive species on the forest. In terms of habitat concern, the Wando Area is likely the number one area on the FMNF to be concerned about during the next 10-15 years. Virtually all of the PETS species found within the Wando Area are dependent upon fire maintained ecosystems. Due to the fact that it has been so difficult for the Forest Service to adequately burn the Wando Area since the last 1996 Forest Plan Revision, conditions are only expected to deteriorate in the future if adequate fire return intervals are not maintained in this area.

Fire and mechanical treatments have been effectively used to greatly improve habitat conditions for species such as the Frosted Flatwoods Salamander and Carolina Gopher Frog in some portions of the Wando Area (i.e., compartments 115 & 116). However, some compartments, such as compartments 113 and 114 between Highway 41 and Cainhoy Rd, have not been burned in over 20 years. When fire is suppressed and excluded from fire dependent ecosystems, undesirable habitat conditions and rates of forest succession occur. In addition to the issues associated with fire exclusion and suppression, there are over 11,000 acres of densely stocked pine and mixed pine hardwood stands in the Wando Area. These dense stands are typically characterized by high fuel loads and suppressed understories, and offer marginal habitat for species such as the Frosted Flatwoods Salamander. Silvicultural thinning treatments have been used to improve habitat conditions in densely stocked pine stands all across the FMNF. Unfortunately, mechanical treatments only provide short term habitat benefits lasting 2-3 years, especially if the residual basal areas are fairly high (e.g. residual basal area of pine > 50 ft²/ac). If thinning is not followed with repeated prescribed burning operations every 2-3 years, undesirable midstory conditions quickly deteriorate stand conditions. Numerous thinned loblolly pine stands along Halfway Creed Rd in compartments 115, 116 and 117 provide credence to this assertion, as the habitat benefits from the thinning only lasted 2-3 years due to the lack of prescribed burning. The hardwood and loblolly pine midstory is exceptionally dense in these recently thinned pine stands, and is upwards of 6-8 feet tall in places. From a biological and ecological standpoint, it would have likely been more beneficial to remove all of the loblolly pine in these young stands than to only thin them. The following picture is another picture taken in compartment 117 during 2012, and depicts the undesirable loblolly regeneration that resulted two years after thinning without prescribed fire. If an adequate fire return interval isn't maintained in a stand such as this, habitat conditions will continue to deteriorate, and it will be virtually useless to a species such as the Frosted Flatwoods Salamander, red-

cockaded woodpecker and Carolina Gopher Frog.



Numerous isolated wetlands have been severely altered by previous land management practices on the FMNF. Some of the best examples of Frosted Flatwoods Salamander breeding wetlands on the FMNF are bordered by the Tuxbury Horse Trail in compartments 114, 115 and 116. Much of the Tuxbury Trail runs along a former tram bed that was used to transport lumber in the early to mid 1900's. This tram bed is impacting numerous isolated wetlands in the Wando Area, including potential Frosted Flatwoods Salamander and Carolina Gopher Frog breeding wetlands. This tram is impacting the hydrology of numerous isolated wetlands due to the fact that it is ditched on both sides and was intentionally built up to traverse through wetlands. Unfortunately, there are no culverts or bridges on this horse trail/tram. As such, this artificial land feature serves as a barrier to sheet flow and is impacting the hydrology of adjacent wetlands. Additionally, the ditches on either side of the tram drain adjacent wetlands and serve as vectors for undesirable aquatic organisms such as fish. Restorative activities need to be implemented in areas such as compartments 114, 115 and 116 so as to improve habitat conditions for the Frosted Flatwoods salamander and other isolated wetland dependent organisms. Due to the potential threats that exist in the Wando Area, the FMNF needs to examine opportunities for translocation and reintroduction of species such as the Frosted Flatwoods Salamander and Carolina Gopher Frog in the future. Because all known *A. cingulatum* breeding wetlands on the FMNF only occur in the Wando Area, it is conceivable that this species could become extirpated on the FMNF if habitat conditions continue to degrade in this area. As indicated throughout this portion of the assessment, the habitat conditions with the Wando Area have, and are expected to continue to degrade if appropriate land management practices are not implemented (e.g., adequate fire frequency).

Translocation and reintroduction of *A. cingulatum* to other suitable habitats on the FMNF would increase the number of metapopulations on the FMNF, and could offset the potential impacts of continued habitat deterioration in the Wando Area. There are numerous habitats within the core burn area that could support the Frosted Flatwoods Salamander and Carolina Gopher Frog. It is highly likely that the Frosted Flatwoods Salamander and Carolina Gopher Frog once occurred across the entire FMNF, especially along the Cainhoy Ridge and Bethera Ridge. However, due to their highly specialized habitat requirements and environmental sensitivity, past destructive land practices likely lead to the demise of virtually all metapopulations on the FMNF.

Carolina Gopher Frog (*Lithobates capito capito*)

Status: Forest Sensitive, state endangered, petitioned for federal listing and positive 90 day finding

The Carolina gopher frog is a member of the family Lithobatidae, the true frogs. Its closest relatives include the bullfrog, leopard frog and bronze frog. This species can reach sizes of 6 to 9 cm (2.4 to 3.5 inches). It has the body shape of a typical frog, but is a little plumper than other frogs with proportionately shorter legs. Gopher frogs are typically light to dark brown with heavy blotching and numerous warts (Conant and Collins 1991; Martof et al. 1980). In fact, while it is a true frog, the



Photo of *L. capito* captured in April 2009

Carolina Gopher Frog does somewhat resemble a toad in appearance, due to the presence of the warts. This trait, as with the toad, is evidence of a more terrestrial lifestyle. Similar to the Frosted Flatwoods Salamander, the Carolina Gopher Frog spends the majority of its adult life cycle in terrestrial habitats as fossorial species, inhabiting crayfish holes, root channels, stump holes, rodent burrows, and other subterranean cavities. Although the Frosted Flatwoods Salamander typically migrates to its breeding wetlands during autumn and early winter rains (Anderson and Williamson 1976), the Carolina Gopher Frog migrates to its breeding wetlands in late winter and early spring (Braswell 1993). However, under the right environmental conditions, the Carolina Gopher may breed throughout all of the spring months. The Carolina Gopher Frog was documented from several breeding wetlands on the FMNF and adjacent

properties on 23 February and 30 April 2013. The aquatic larva of these species may spend several months in a breeding wetland before metamorphosis occurs. Newly metamorphosed individuals move away from breeding wetlands into the surrounding uplands, and only return to these wetlands when they become reproductively mature adults (Petranka 1998).

Prescribed fire is critically important for proper Carolina Gopher Frog habitat maintenance and enhancement. This includes both their non-breeding terrestrial habitat as well as their breeding wetlands. Fire should never be prevented from burning up to and within Carolina Gopher Frog breeding wetlands on the FMNF. Unfortunately, this was not always the case on the Francis Marion, and firebreaks were actually constructed around some wetland habitats in order to prevent fire from entering into them.

Evidence of these firebreaks can still be found on the FMNF today, but luckily, this destructive practice is no longer used. Gopher frogs appear to have an affinity for fire maintained habitats. In a radio telemetry study conducted on the Ocala National Forest in Florida, researchers reported that dispersing juveniles actually selected fire-maintained habitat that was associated with an open canopy, few hardwood trees, small amounts of leaf litter, and large amounts of wiregrass (Roznik and Johnson 2009). Timing of prescribed fire may be critical for minimizing direct mortality of individuals. Timing prescribed fire to occur when individuals are less likely to be moving during a breeding period or post-metamorphosis migration will minimize effects to the species. The FMNF has never identified formal guidance on the timing of prescribed burning for *A. cingulatum* or *L. capito*. Guidance on the timing of prescribed burns where these two species are known to occur should be a priority. The following burn matrix was developed on the DeSoto National Forest, where the Mississippi Gopher Frog (*Lithobates sevosus*) is known to occur. This burn matrix could prove useful on the FMNF as well.

Example burn matrix from Desoto NF, which could be modified for use within *A. cingulatum* and *L. capito* habitat on the FMNF.

Forest Service burn conditions**	Burn Uplands	Burn Pond Basin
Use existing standards		
Frog Parameters		
Adult frogs not in pond (Jan – Mar)	yes	no
Adult frogs in pond	no	no
Adult frogs not in pond (Apr – Sep)	yes	yes
Burning Oct-Dec	no	no
Most (> 75%) adult frogs left pond (>7 days since last movement at drift fence)	yes	no
Tadpoles present and after April 1 st	no	no

The Carolina Gopher Frog has been documented from 13 isolated wetlands on the FMNF since 1997 (internal Forest Service records). Since 2006, it has been

observed acoustically or visually from 8 isolated wetlands on the FMNF, including a previously undocumented breeding wetland along Halfway Creek Rd that was discovered during 2013.

One of the largest Carolina Gopher Frog (*Lithobates capito*) breeding events in the past 10 years was documented on the FMNF during April 2009. Hundreds of individuals were documented in known breeding wetlands. Dipnetting for larval Carolina Gopher Frogs was conducted by USFS and Department of Natural Resources (DNR) personnel on June 2, 2009. Carolina Gopher Frog tadpoles and questionable tadpoles were collected and sent to the Riverbanks Zoo in Columbia, SC. These tadpoles were successively raised at the Riverbanks Zoo, and the zoo now has 3 subadult Carolina Gopher Frogs. The frogs will be kept in captivity at the zoo in order to study the species' feeding habits and lifespan. Genetic material will be collected and analyzed for comparison with other *Lithobates capito* populations. Breeding was also confirmed on the FMNF during 2010 and 2013.

Beginning in 2007, Mark Danaher installed 3 North American Amphibian Monitoring Program (NAAMP) frog routes on the FMNF. These NAAMP routes are run three times per year and are designed to monitor anuran populations. The primary goal of these frog routes is to assess frog and toad population trends using a calling survey technique. Overall, frog and toad trends on the FMNF appear to be stable, but long-term monitoring is needed to account for temporal variation and the complex life histories of our native amphibians. Species such as the Carolina Gopher Frog and Frosted Flatwoods Salamander are in a critical state, and are highly susceptible to local extirpation without proper protection and habitat management. These NAAMP routes provide the Forest Service with an efficient means of documented and monitoring trends of anurans. Had it not been for one of the NAAMP routes, a newly discovered Carolina Gopher Frog breeding wetland would not have been found in 2013. The FMNF and other protected lands in SC provide critical refuges for isolated wetlands, which are critical habitats for species such as *L. capito* and *A. cingulatum*. These palustrine wetlands are critical for ensuring the continued viability of pond breeding amphibians, especially rare and declining species such as *L. capito*, *A. cingulatum* and the dwarf siren (*Pseudobranchius striatus*). Some of the highest densities of isolated wetlands on the FMNF occur along the Cainhoy Ridge and Bethera Ridge formation, and are primarily depressional-type wetlands. As such, these geologic formations also offer some of the best opportunities to increase metapopulations of species such as the Carolina Gopher Frog.

Many isolated wetlands on the FMNF have and continue to be impacted by roads, ditches, past silvicultural practices, utility right-of-ways, former tram beds, illegal vehicular



activities, and non-native invasive species such as the wild pig (*Sus scrofa*). In some instances, the lack of appropriate management practices (i.e., fire suppression and exclusion) has significantly degraded known breeding wetlands for the Carolina Gopher Frog and Frosted Flatwoods Salamander. Research by Burke and Gibbons (1995) and Semlitsch (1997) have indicated that terrestrial buffers should be left around wetlands to protect the semi-aquatic organisms that utilize them, although no scientific study has explicitly shown that forested buffers are a necessity for isolated wetland herpetofaunal viability (Russell et al. 2002b). The FMNF has never required terrestrial buffers around isolated wetlands during logging activities unless there were isolated wetland dependent PETS species within the project area. Personal communication with Julian Harrison, who had more intimate knowledge of the FMNF herpetofauna than any other human being, indicated that one of the biggest changes to *A. cingulatum* and *L. capito* breeding wetlands on the FMNF was hardwood shrub and tree encroachment, both within the wetland ecotones and the wetlands themselves. Changes in vegetation like this can significantly degrade breeding wetlands for species such as *A. cingulatum* and *L. capito*. Both of these species require open herbaceous dominated wetlands and adjacent uplands for their survival.

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Roads can have significant adverse ecological and biological effects on amphibians and reptiles, as well as numerous other faunal groups. Some heavily traveled paved roads on the FMNF cause significant amphibian and reptile mortality (i.e., Highway 17, Highway 41, Highway 402, Highway 45, and Steed Creek Rd). As the human population continues to increase in the counties of Berkeley, Charleston and Dorchester, wildlife road mortality is expected to continue to increase as more vehicles are on the roads. Road impacts on wildlife need to be assessed on the FMNF in order to identify potential mitigation measures. Roads contribute to habitat fragmentation by isolating blocks of remaining contiguous habitat. They may disrupt migration routes and dispersal of individuals to and from breeding sites. Roads and road construction can negatively impact hydrology of wetlands and destruction of breeding ponds. In addition, vehicles may also cause the death of amphibians when they are attempting to cross roads (Means 1996). Road construction resulted in the destruction of a historic reticulated flatwoods

salamander breeding pond in Escambia County, Florida (Palis 1997b). Rare species such as the Carolina Gopher Frog have been killed by vehicle traffic on Highway 41 in the Wando Area. The Francis Marion has no mitigation measures in place on the forest to mitigate the negative impacts of roads on wildlife (e.g., travel corridors).

Rana viruses in the family Iridoviridae and the amphibian chytrid fungus (*Batrachochytrium dendrobatidis*) may be other potential threats to amphibians on the FMNF, although the susceptibility of the *A. cingulatum* and *L. capito* to these diseases is unknown. Rana viruses have been responsible for mass die-offs of tiger salamanders throughout western North America and spotted salamanders (*A. maculatum*) in Maine (Daszak et al. 1999 & USFWS 2009). Chytrid fungus has been discovered and associated with mass mortality in tiger salamanders in southern Arizona and California, and the Santa Cruz long-toed salamander (*A. macrodactylum croceum*) (Vredenburg and Summers 2001, Davidson et al. 2003, Padgett-Flohr and Longcore 2005, USFWS 2009). There are just too many unknowns associated with the introduction of rana viruses. Had there been proactive mitigation measures in place prior to the mass die-offs of bats from white-nose syndrome, some colonies might have been saved. There have been no documented occurrences of rana viruses or chytrid fungus on the FMNF to date, but these viruses and fungus are a huge concern should they ever be introduced. Precautionary measures should be taken to minimize the chances of introducing these lethal viruses and fungus.

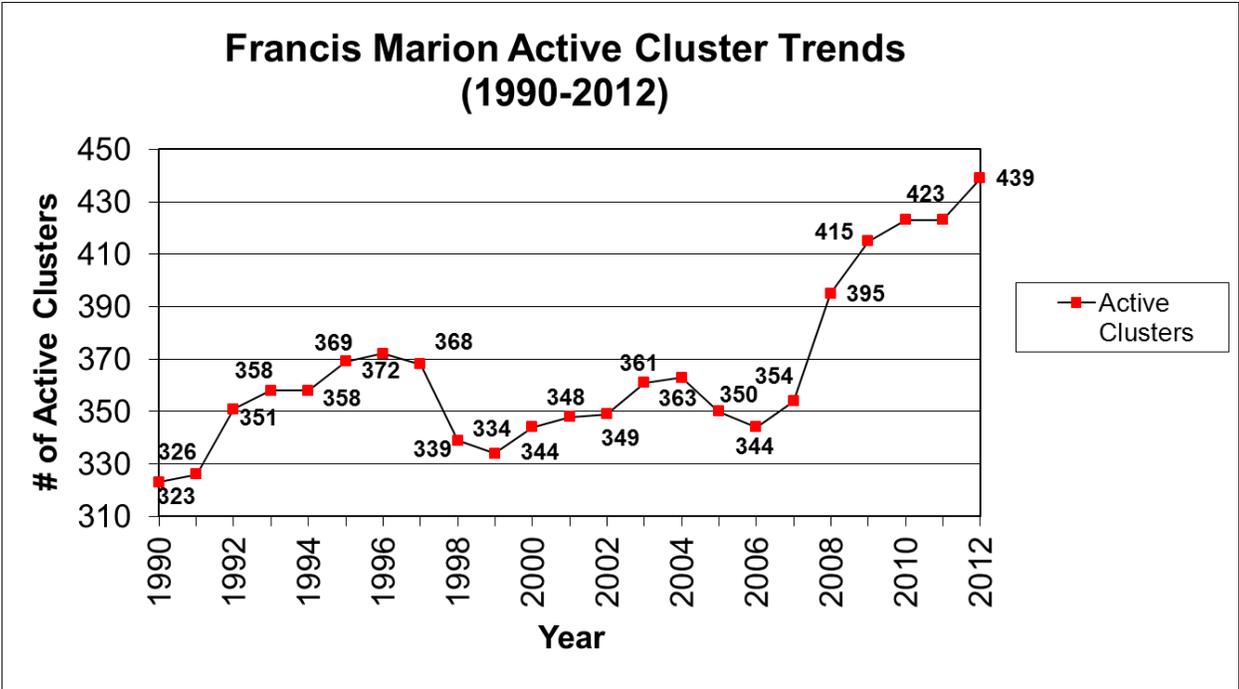


Figure 1. Active RCW cluster trends on FMNF since 1990.

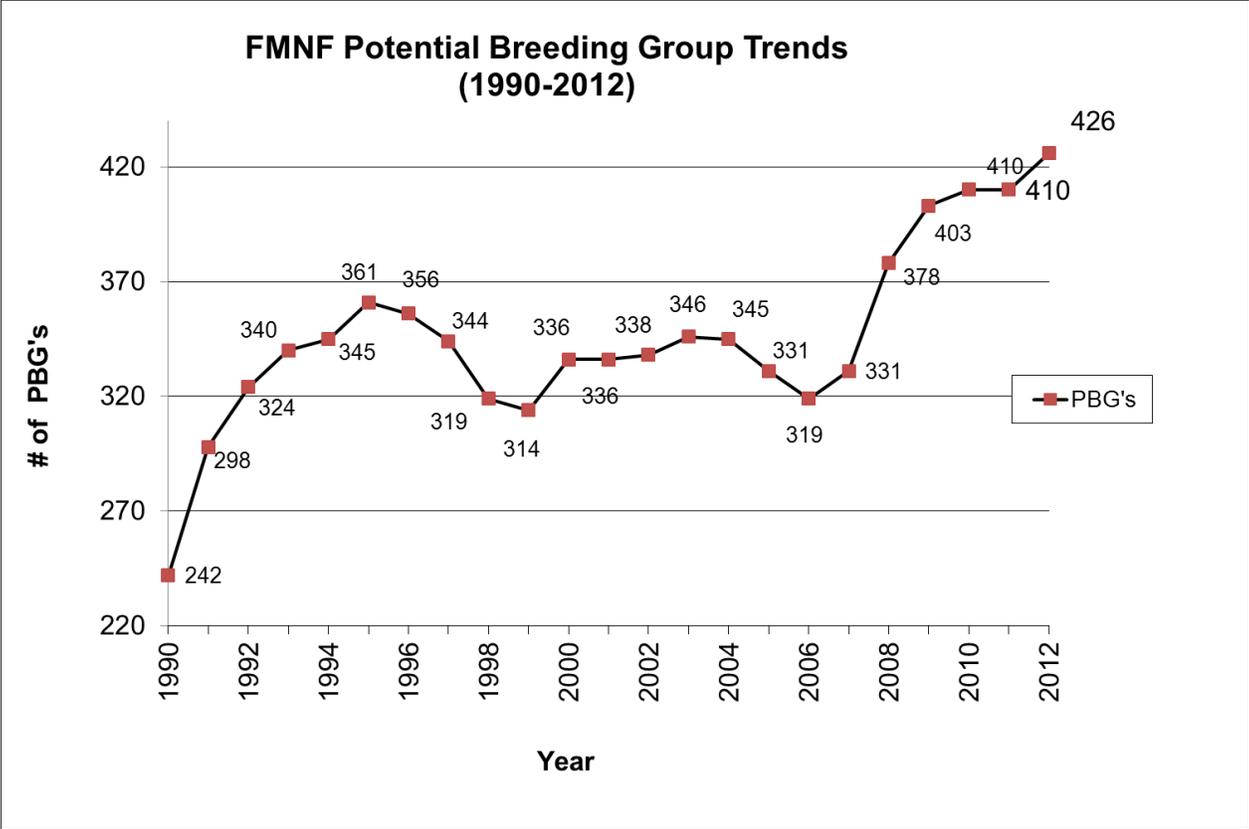


Figure 2. Potential Breed Group trends on FMNF since 1990.

Compartments in the Core Area

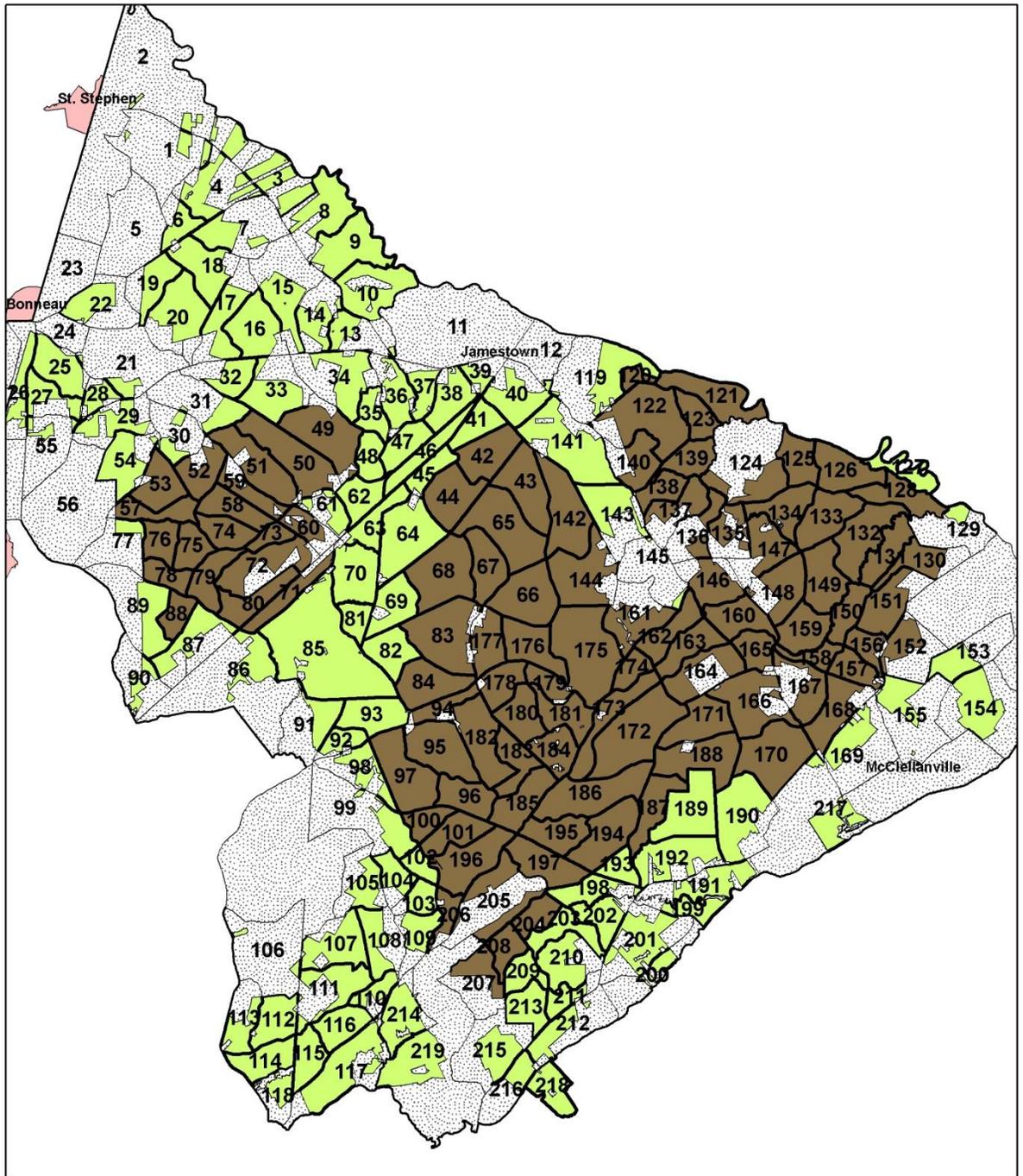


Figure 3. Core Burn Area map. Core Burn Area is in brown. Prescribed burning has and continues to occur outside of the Core Burn Area, but compartments in the Core Burn Area have been consistently burned on a 2-3 fire return interval since the 1990's.

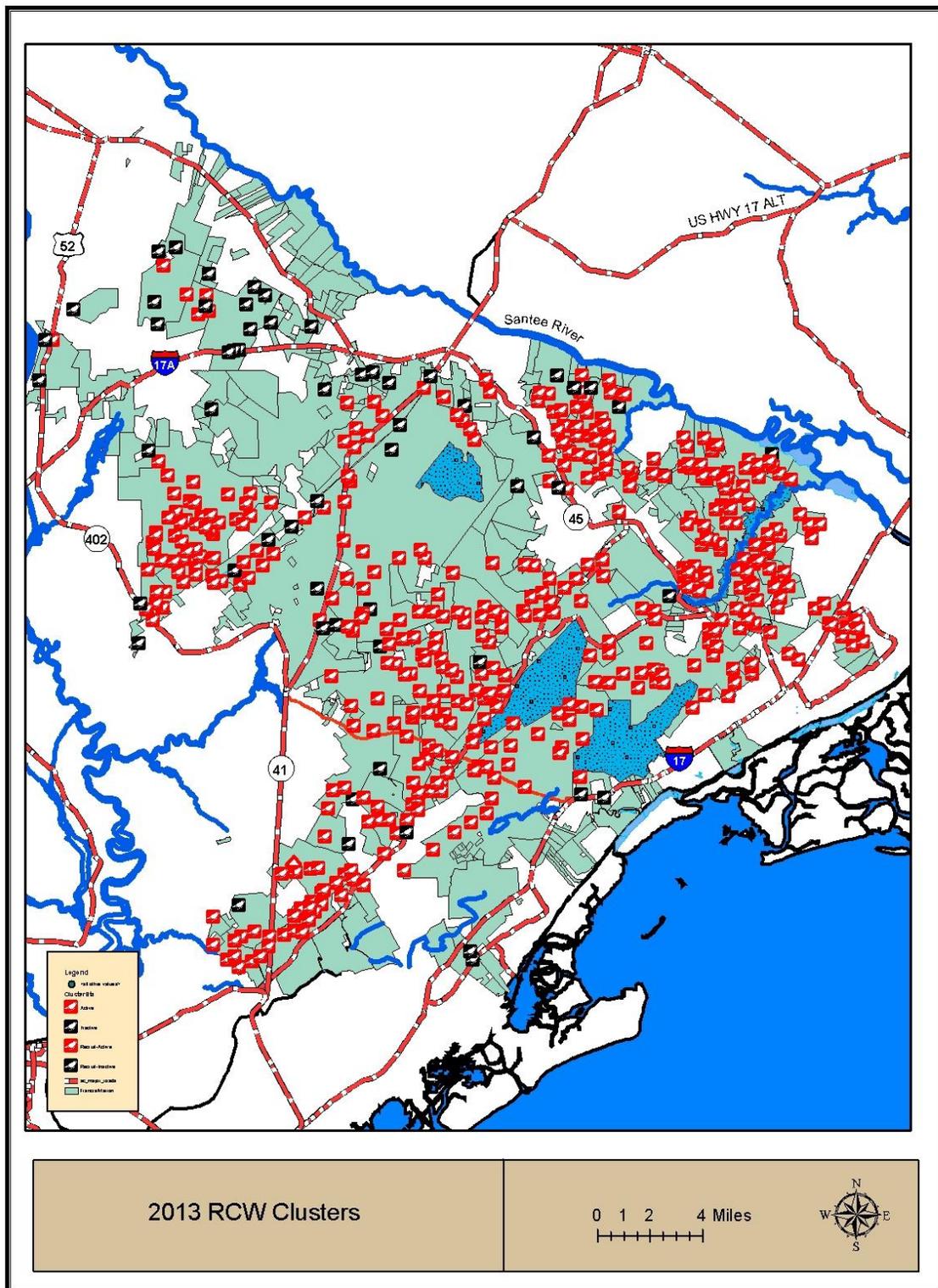


Figure 4. Active and inactive RCW clusters on the FMNF. Black bird symbols represent inactive clusters and red symbols represent active clusters.

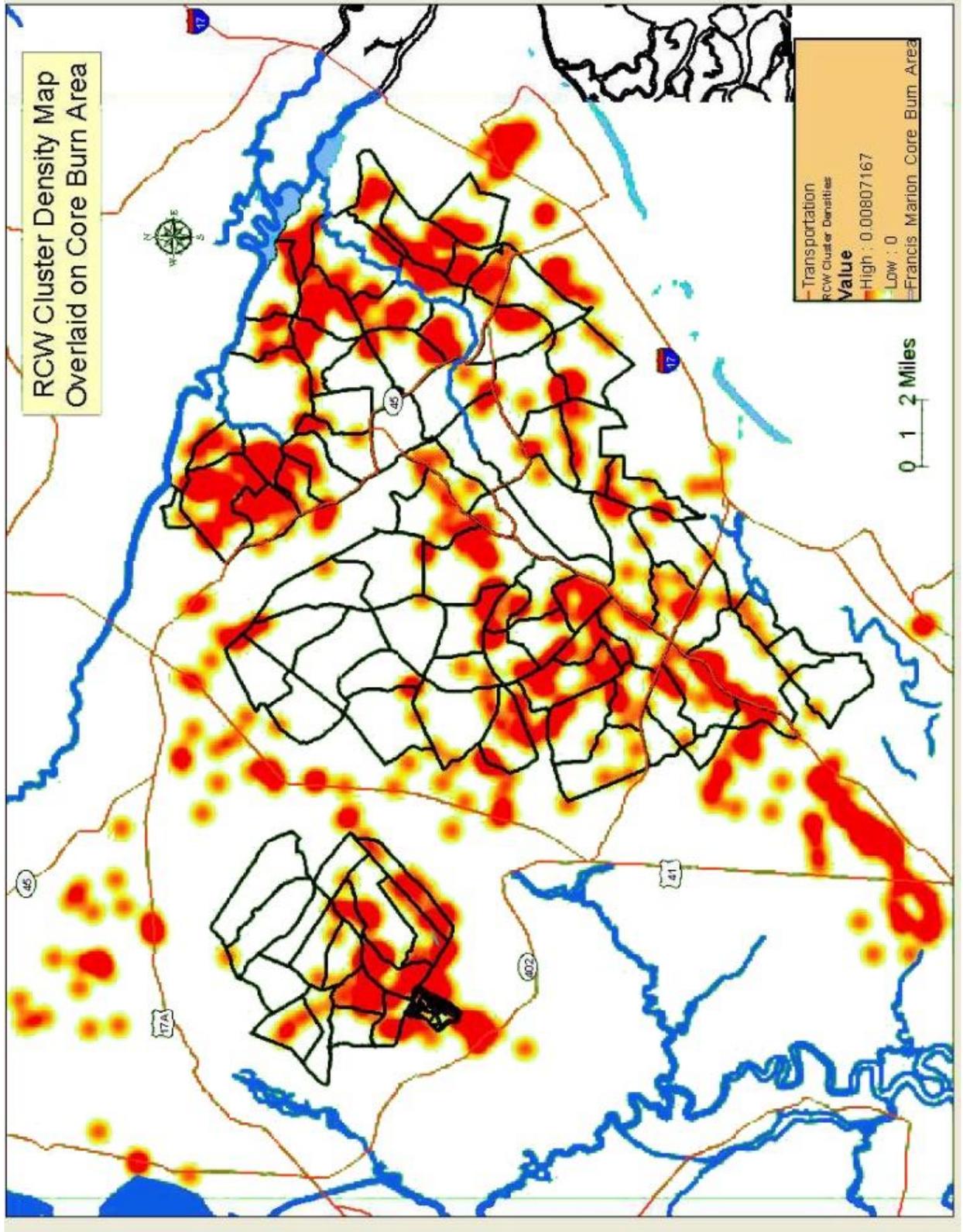


Figure 5. RCW cluster density overlaid on Core Burn Area compartments. Red represents highest density of clusters, while white represents areas where the clusters are absent. Core Burn Area

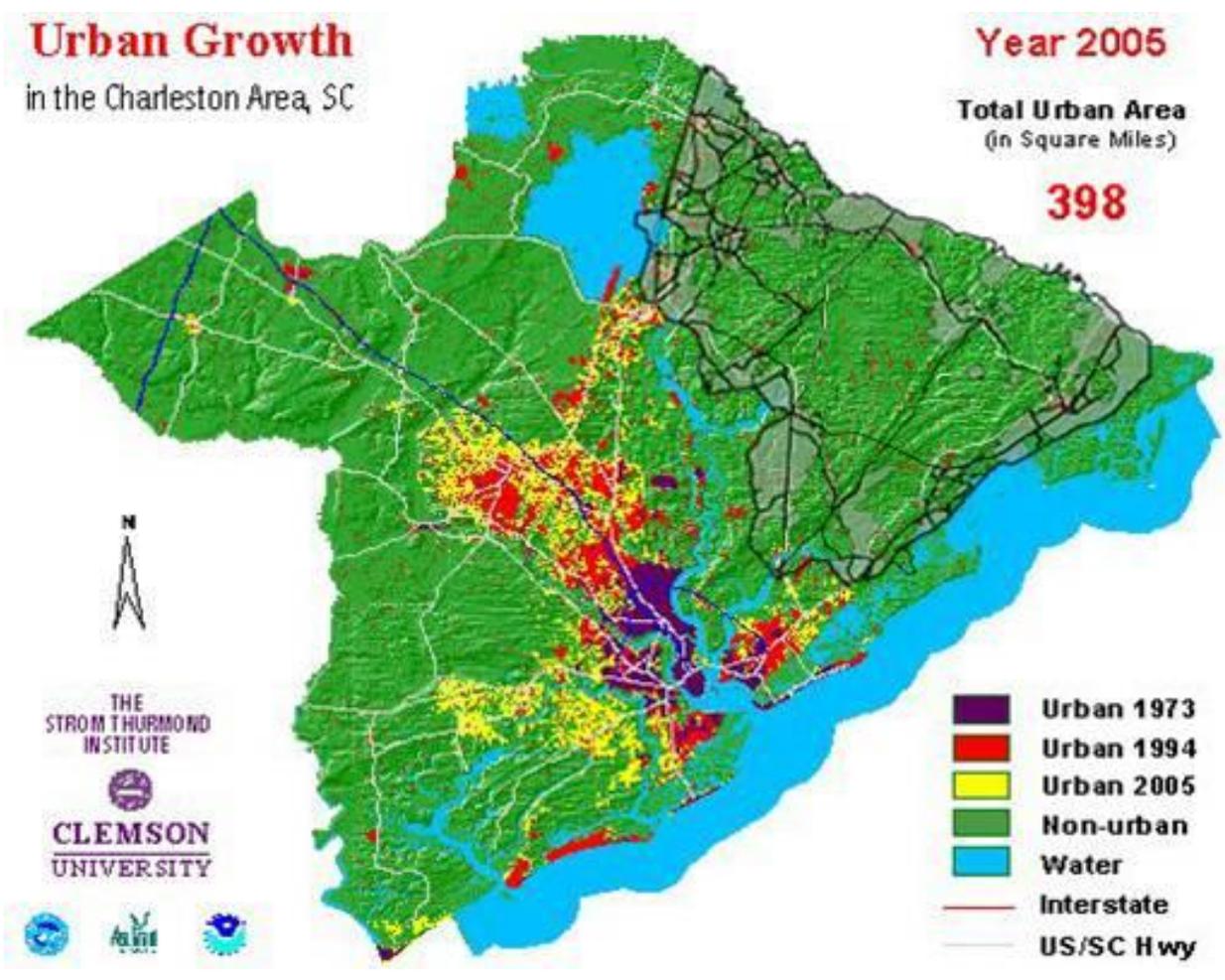


Figure 5. Map depicting the estimated urban area of Berkeley, Charleston and Dorchester counties in 2005.

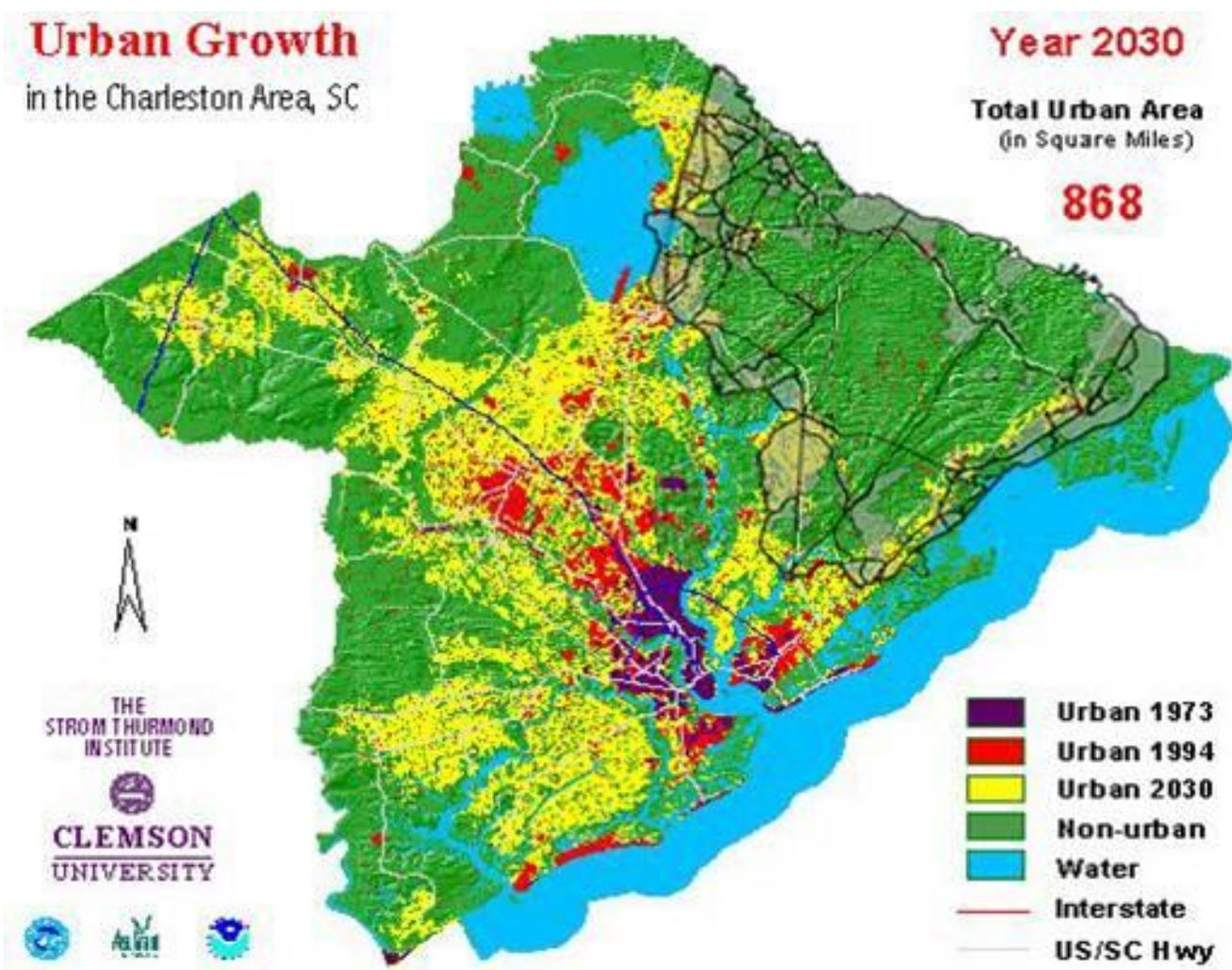


Figure 6. Map depicting the potential urban area of Berkeley, Charleston and Dorchester counties in 2030.

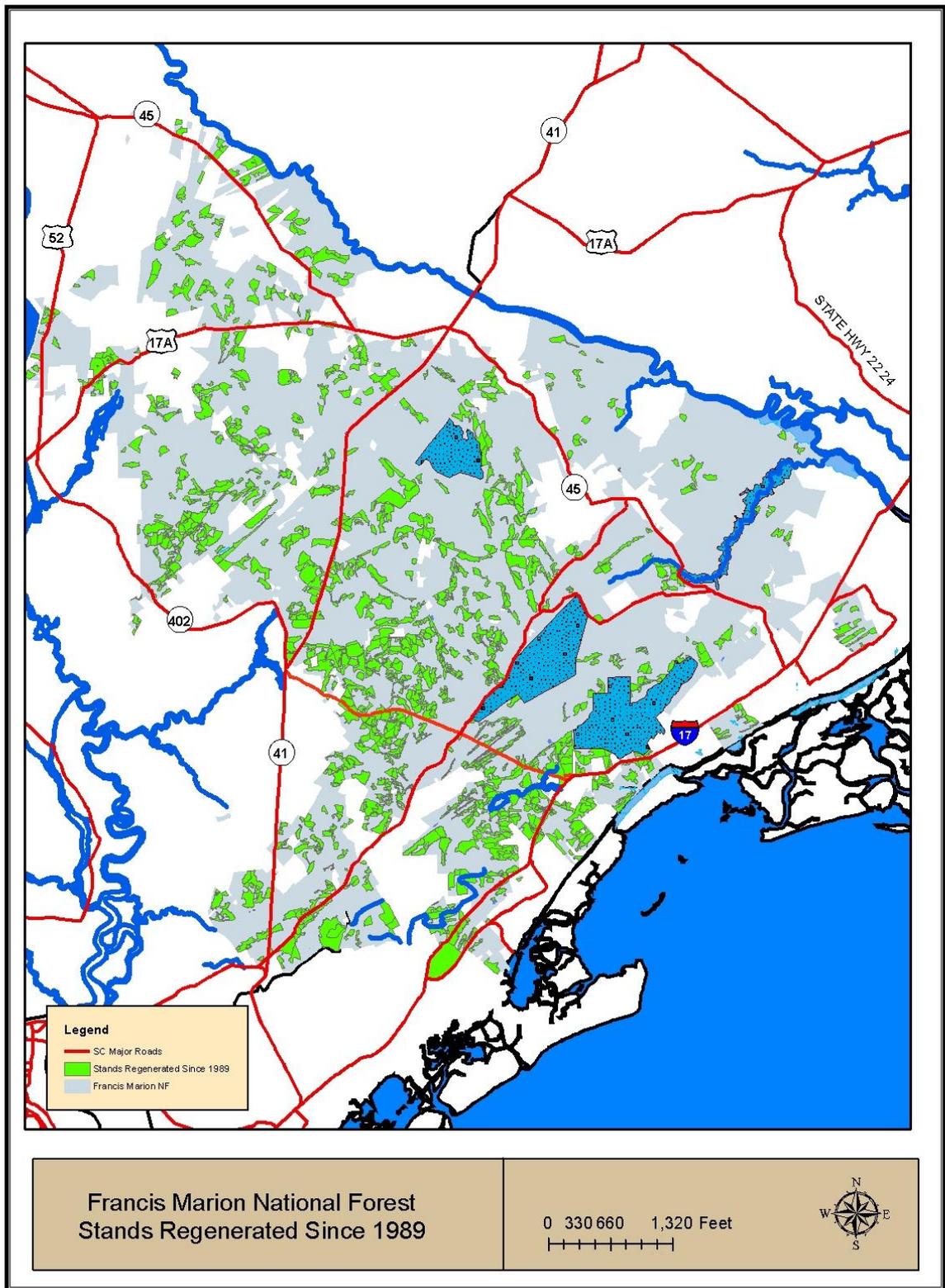


Figure 7. All stands regenerated on the FMNF since 1989. Approximately 92,000 acres.

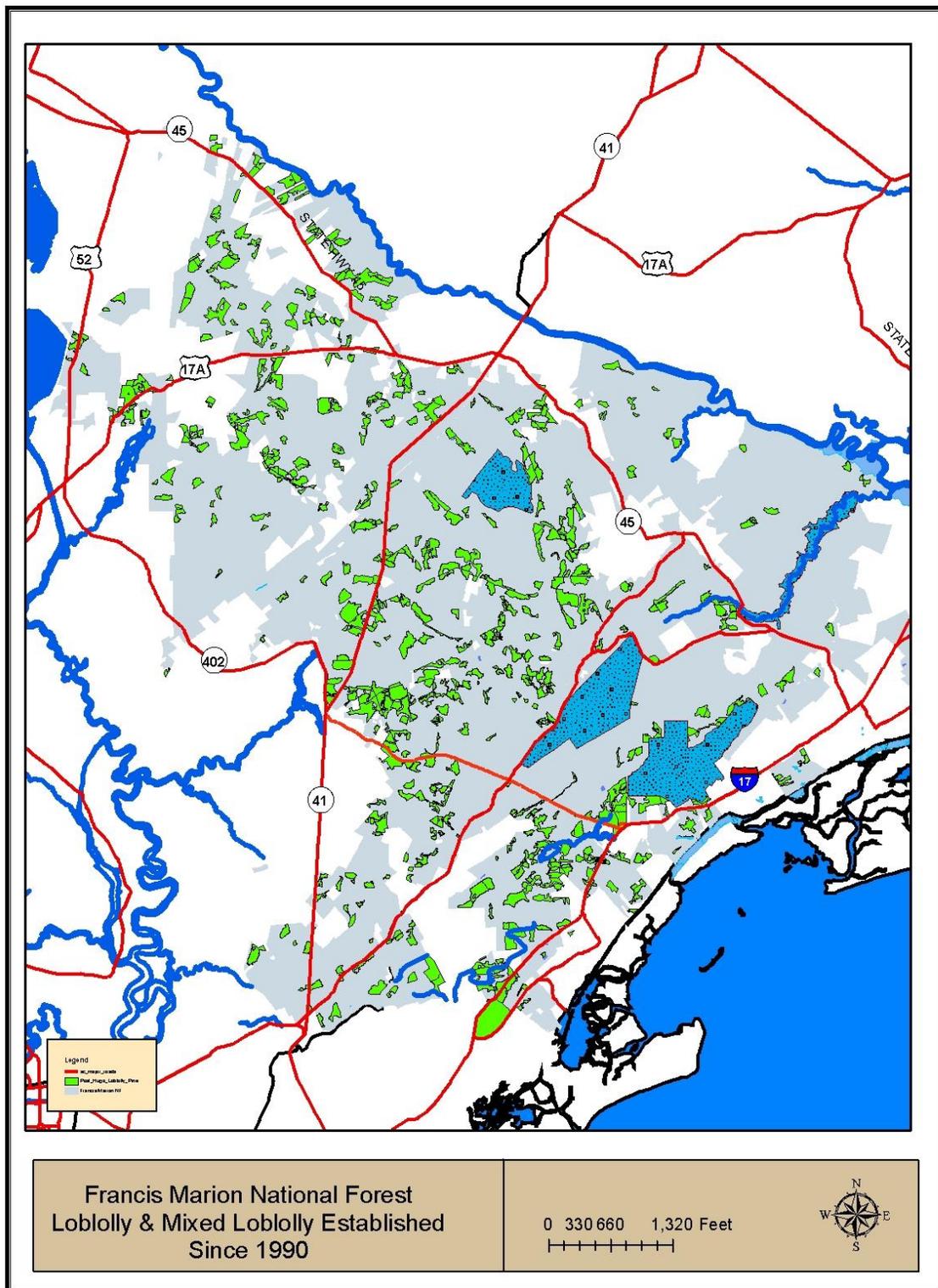


Figure 8. Loblolly and mixed loblolly established on the FMNF since 1990. Approximately 31,000 acres.

