CHAPTER 5.

SPECIES AND HABITAT ASSESSMENTS AND CONSERVATION STRATEGIES

Linking Terrestrial and Aquatic Systems

Early in the Plan text development process we discussed the value of different organizational styles with respect to linking terrestrial and aquatic systems. Within the framework that we settled on, we found it necessary to address the specific needs of terrestrial and aquatic species separately within the Plan. However, we do not wish to perpetuate the notion that aquatic and terrestrial systems should be thought of as separate and disconnected entities; these systems are highly connected and are heavily influential on one another (e.g., upland land clearing activities can result in increased erosion and sedimentation in adjacent lowland and riparian habitats; water quality impacts can reduce aquatic species population sizes, leading to food limitations for terrestrial species with an aquatic food base). Within the following sections (Chapters 5A, 5B, 5C), we have identified conservation strategies that, when implemented in coordination, capture ecosystem level actions that emphasize the cumulative positive impacts to both terrestrial and aquatic communities. We support the view that the North Carolina conservation community as a whole should work towards more comprehensive management and conservation of aquatic and terrestrial resources alike.

Population Objectives

Due to the strategic (not operational) nature of this report, we have not identified population objectives for each and every species mentioned herein. However, as a starting reference, we include a list of existing resources that provide this type of information for species groups appropriate to North Carolina (Table 5.1).

For the majority of our fish and wildlife taxa, we are, as of yet, unable to assess specific population objectives, due to data limitations and knowledge gaps that must first be filled. Birds and marine fish species are two groups for which data does exist to assess population level objectives. These objectives have been developed through the cooperative efforts of specific conservation partnerships (e.g., the North American Bird Conservation Initiative, regional Fisheries Management Councils). Recovery plans for species on the Federal Threatened and Endangered species list also identify population objectives related to species recovery thresholds. Priorities for other species groups now focus on simply collecting enough information to support valid population size estimates.

Table 5.1. Sources of population objectives for species groups in North Carolina.

Group	Conservation Plan	Citation/Resource
Landbirds	Partners in Flight South-Atlantic Coastal Plain Bird Conservation Plan	Hunter et al. 2001
	Partners in Flight Piedmont Bird Conservation Plan	Cooper and Demarest 1999
	Partners in Flight Southern Blue Ridge Bird Conservation Plan	Hunter et al. 1999
	Partners in Flight North American Landbird Conservation Plan	Rich et al. 2001
Waterbirds	North American Waterbird Conservation Plan	Kushlan et al. 2002
	Southeast US Region Waterbird Conservation Plan	SAMBI 2004
Waterfowl	North American Waterfowl Management Plan	NAWMP Committee 1998
Shorebirds	Southeastern Coastal Plain - Caribbean Regional Shorebird Plan	Hunter et al. 2000
SAMBI area waterfowl, waterbirds, shorebirds, landbirds	South Atlantic Migratory Bird Initiative implementation plan	Watson and McWilliams 2004
Endangered and threatened species	Species recovery plans (see Appendix I)	USFWS Threatened and Endangered Species System Webpage (http://ecos.fws.gov/tess_public/TESSWebpage)
Coastal and marine fisheries[1]	Fisheries Management Plans	Mid-Atlantic Fisheries Management Council (http://www.mafmc.org) South-Atlantic Fisheries Management Council (http://www.safmc.net)

[1]See the Marine Systems section (Chapter 5C) for a listing of species for which Fisheries Management Plans are available.

Setting Priorities at Multiple Scales

Within the following sections (Chapters 5A, 5B, 5C) we detail threats, priority survey, monitoring and research needs, and broader conservation priorities, for terrestrial and aquatic systems alike. We have organized information in Chapters 5A and 5B such that individual sub-sections (e.g., a particular terrestrial habitat or a river basin) can, to a large extent, 'stand alone' as a resource to make conservation planning decisions at that particular scale. Within each section we have attempted to not only identify but also to prioritize implementation needs. Chapter 5C (Marine Systems) contains the same type of information, but the format of this section differs (based, to a large degree, on the extent and availability of existing information and resources). Nevertheless, it, too, lays out clear species and habitat conservation priorities in the marine environment along North Carolina's coast.

In order for the Plan to be a useful planning tool, priorities set at an individual habitat or basin scale must also fit within the context of priorities set at a broader level. For example, among all of the specific needs and activities identified in the Plan, how should priorities be set across habitats or basins, across activities, or at higher organizational levels (program or agency-wide)? And how do all of those priorities work to advance the goals of the Plan? In the following chapter (Chapter 6) we synthesize that type of information.

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A. Terrestrial Systems

Biodiversity in Terrestrial Ecosystems

The southeast region of the United States contains some of the highest rates of faunal and floral biodiversity in the world (Ricketts et al. 1999). The Appalachian/Blue Ridge Forest (along with the adjacent Mixed Mesophytic Forest type) is one of the world's richest temperate broadleaf forest types. Two major forest types found in the southeast are 'globally outstanding' (meaning they are exceptional in species richness and endemism rates): Appalachian/Blue Ridge Forest and Southeastern Mixed Forest. Amphibian species richness and endemism rates are higher in the southern Appalachian region than anywhere else in the country; the pattern for land snails is the same. Finally, Mid-Atlantic Coastal Forests contain the most diverse assemblage of freshwater wetlands in all of North America (Ricketts et al. 1999).

Among southeastern states, North Carolina contains some of the highest species diversity rates—the state ranks fourth in the number of total vertebrate species, with more amphibians than any other state in the nation and more mammal species than any other state east of Texas.

Unfortunately, the southeast also contains some of the most endangered ecosystems in the country: southern Appalachian spruce-fir, longleaf pine forest and savanna, eastern grasslands, coastal communities, and forested wetlands (Noss et al. 1995). Threats to habitats across the region include fragmentation, conversion to other habitat types, suppression of fire, and outright loss due to development (Noss et al. 1995, Ricketts et al. 1999). Since 1990, forest cover in North Carolina has decreased by 5 percent. In 2002, forests covered 18.3 million acres, or 59 percent of the land area, compared with 19.3 million acres and 62 percent previously (Brown 2004).

Concerns over species imperilment are also great. Across the southeast, there are 132 terrestrial vertebrate species that are of conservation concern, as listed by state Natural Heritage Programs (Trani 2002). These are dominated by amphibians and reptiles. As of 2005, more than one-fifth of North Carolina's native mammal species are designated as rare and in need of special protection. The same applies to more than one-quarter of the bird species, more than one-third of all reptiles, and almost one-quarter of all amphibians.

Assessments of Terrestrial Conservation Priorities

Numerous state, regional, and national-scale efforts have provided a foundation on which to build the conservation priorities addressed within each of the individual habitat sections that follow. Some efforts have been focused on identifying species priorities, others have gone beyond this (or bypassed it) to propose strategies for long-term conservation. To the greatest extent possible and where applicable, the guidance provided by these important efforts has been incorporated into this Plan. The following is a brief review of some of the more influential literature that applies to terrestrial conservation priorities and strategies in North Carolina.

Species Priorities and Conservation Strategies

Information and literature regarding conservation priorities and strategies for birds far outweighs that of any other terrestrial species group in the nation. Many of the recommendations and priorities highlighted for birds within the following habitat sections have grown out of the efforts of the various North American Bird Conservation Initiative (NABCI) programs. These programs form a base from which to expand and improve bird conservation efforts in the state and the region. NABCI is made up of four principle bird conservation programs: Partners in Flight (PIF), the North American Waterfowl Management Plan (NAWMP), the US Shorebird Conservation Plan, and the North American Waterbird Conservation Plan. The national, regional, and (in the case of Partners in Flight) state-based publications of each of these programs are useful in identifying species priorities, species and habitat objectives, and conservation strategies necessary to implement bird conservation for the group:

North American Bird Conservation Initiative

- US Shorebird Conservation Plan (Brown et al. 2001)
  - Southeastern Coastal Plains-Caribbean Regional Shorebird Plan (Hunter et al. 2000)
- North American Waterbird Conservation Plan (Kushlan et al. 2002)
  - Southeastern US Region Waterbird Conservation Plan (Hunter 2004, DRAFT)
- North American Waterfowl Management Plan (NAWMP Committee 2003)
  - Atlantic Coastal Joint Venture Strategic Plan (ACJV 2004)
- PIF North American Landbird Conservation Plan (Rich et al. 2001)
  - Southern Blue Ridge (Hunter et al. 1999)
  - Piedmont (Cooper and Demarest 1999)
  - South Atlantic Coastal Plain (Hunter et al. 2001)
  - North Carolina PIF Bird Conservation Plain (Johns et al. 2005)

The South Atlantic Migratory Bird Initiative (SAMBI) formed to provide a regional scale framework for the conservation of waterfowl, shorebirds, waterbirds, landbirds, and other high priority species (e.g., northern bobwhite and American woodcock) (Watson and McWilliams 2004, DRAFT). This framework utilizes existing national and regional plans of the NABCI programs to build a framework for regional bird conservation that integrates common goals and objectives of these national and regional plans.

The *Management of North Carolina's Colonial Waterbirds* (Parnell and Shields 1990) was completed well before the genesis of NABCI. This document provided much of the groundwork for the North American Waterbird Conservation Plan, as it pertains to North Carolina.

As previously mentioned, there are (as of yet) no comparable documents for mammals, amphibians, or reptiles. To the degree that priorities are implicit in federal and state protection and conservation lists, however, existing protected species lists and the efforts of the NC Natural Heritage Program in listing rare animal species of the state (LeGrand et al. 2004) are useful sources of prioritization information for these species groups, in addition to birds.

Other resources that serve as sources of broad conservation recommendations for various terrestrial species groups include:

North American Bat Conservation Partnership, Strategic plan – This plan is intended to provide a framework and direction for other local, state, and federal bat conservation and management plans. The plan provides broad goals and priority actions across research, education, and management activities.

Habitat management guidelines for amphibians and reptiles of the southeastern United States (Bailey et al. 2004) – This document provides habitat management and conservation guidelines and recommendations for land managers and private landowners that are practical to include with other management objectives on the landscape.

Species recovery plans – Recovery plans provide detailed conservation recommendations and management requirements for the recovery of listed-species. See Appendix I for a list of species with recovery plans in North Carolina.

By state statute, the Commission maintains a Nongame Wildlife Advisory Committee to help guide nongame wildlife management policies and actions. This body, in turn, relies on taxa-specific Scientific Advisory Councils to make recommendations for policies and actions. Specifically regarding terrestrial groups, these councils recommend bird, mammal, amphibian and reptile species for state listing as endangered, threatened, and species of concern, as well as potentially injurious non-native species. Publications, bulletins, and informal communications are periodically produced by these bodies that contain these and other recommendations for action by the Commission.

In anticipation of passage of the Conservation And Reinvestment Act, in 1999 the Commission prepared a draft Wildlife Diversity Plan that identified a number of general needs and objectives for wildlife management, conservation education, and recreation in the state (NCWRC 1999). That draft was generally a precursor of this Plan. Primary objectives stated in that document were to protect and enhance native wildlife populations and to enhance public awareness and appreciation

of wildlife through education, outreach, and recreation opportunities. A list of general priority actions to meet the general objectives was identified; however, no specific priorities or strategies were recognized.

Landscape Priorities and Conservation Strategies

In 1999, researchers with the World Wildlife Fund published *Terrestrial Ecoregions of North America: a conservation assessment* (Ricketts et al. 1999) to highlight the biological distinctiveness of North American ecoregions, assess the level of threats facing each ecoregion, and set forth recommendations for preserving and restoring biodiversity in those ecoregions. Their findings highlight the southeastern United States as supporting among the highest rates of biodiversity in the nation (and for some species groups, the world); Appalachian/Blue Ridge Forest and Southeastern Mixed Forest are 'globally outstanding' in their species richness and endemism rates. Mid-Atlantic Coastal Forests contain the most diverse assemblage of freshwater wetlands in North America. Many of the conservation recommendations made across the three ecoregions[1] that intersect North Carolina's boundaries are echoed within the individual habitat sections that follow. They include: *Appalachian/ Blue Ridge Forests* – identify and protect a regional system of large habitat blocks; restore linkage of appropriate habitat between large blocks; *Southeastern Mixed Forests* – enhance protection of Forest Service areas to increase biodiversity protection in the last remaining blocks; improve fire management regimes; inventory the last remaining sites to identify biodiversity priorities; *Mid-Atlantic Coastal Forests* – improve management for biodiversity conservation (particularly fire management) on federally owned lands; establish corridors among protected lands in the region; improve implementation of state programs for the protection of tidal and nontidal wetlands; enact and implement effective forest management programs at the state level, including economic incentives for good forest practices.

The Nature Conservancy operates on the principle of protecting biological diversity and functional landscapes through land conservation. Toward that end, their efforts to set ecoregional site conservation priorities represent some of the most directed land conservation work (Groves et al. 2003). Their process relies heavily on Natural Heritage Program data and expert feedback. Within the North Carolina portion of the Southern Blue Ridge, Piedmont, and Mid-Atlantic Coastal Plain ecoregions, The Nature Conservancy has identified a total of 464 sites that, if protected, would likely ensure the survival of the three ecoregion's native plants, animals, natural community types, and critical ecological processes (The Nature Conservancy 2000; The Nature Conservancy and NatureServe 2001; M. Bucher, pers. comm. 2004). The Nature Conservancy has also conducted a freshwater biodiversity assessment of the southeastern United States (Smith et al. 2002). That effort helped to identify critical areas for freshwater biodiversity conservation in the region, among them approximately 70 priority sites in North Carolina (Figure 5A.1).

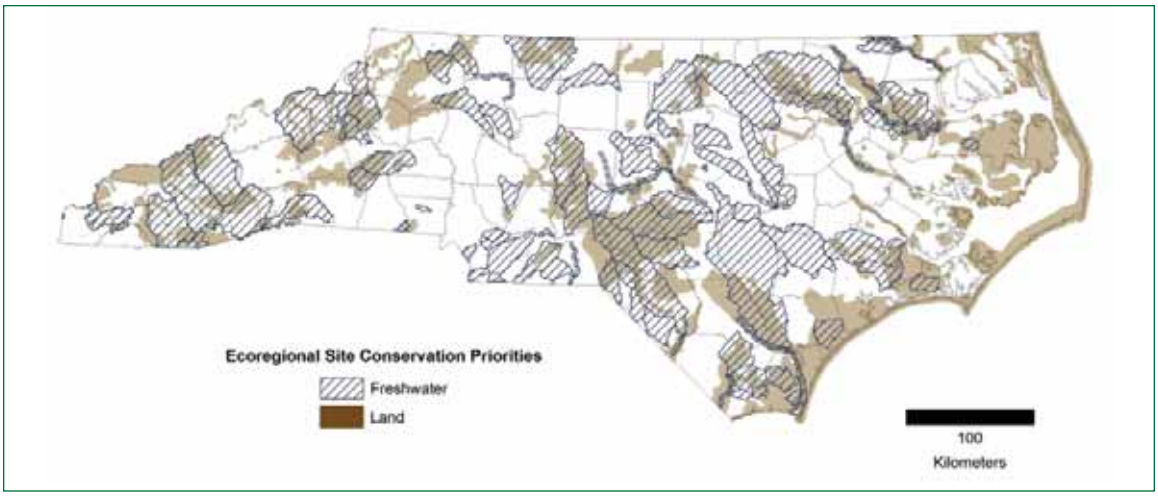

Figure 5A.1. Ecoregional site conservation priorities in North Carolina, as identified by The Nature Conservancy.

[1]These ecoregions, as defined by Ricketts et al. 1999, roughly coincide with the ecoregional designations used in the Plan (the Southern Blue Ridge, Piedmont, Mid-Atlantic Coastal Plain).

Ecoregion Descriptions

In the following sections, we address species and habitat conservation across the three distinct ecoregions of North Carolina, each typified by unique landscape and habitat features (Figure 5A.2)

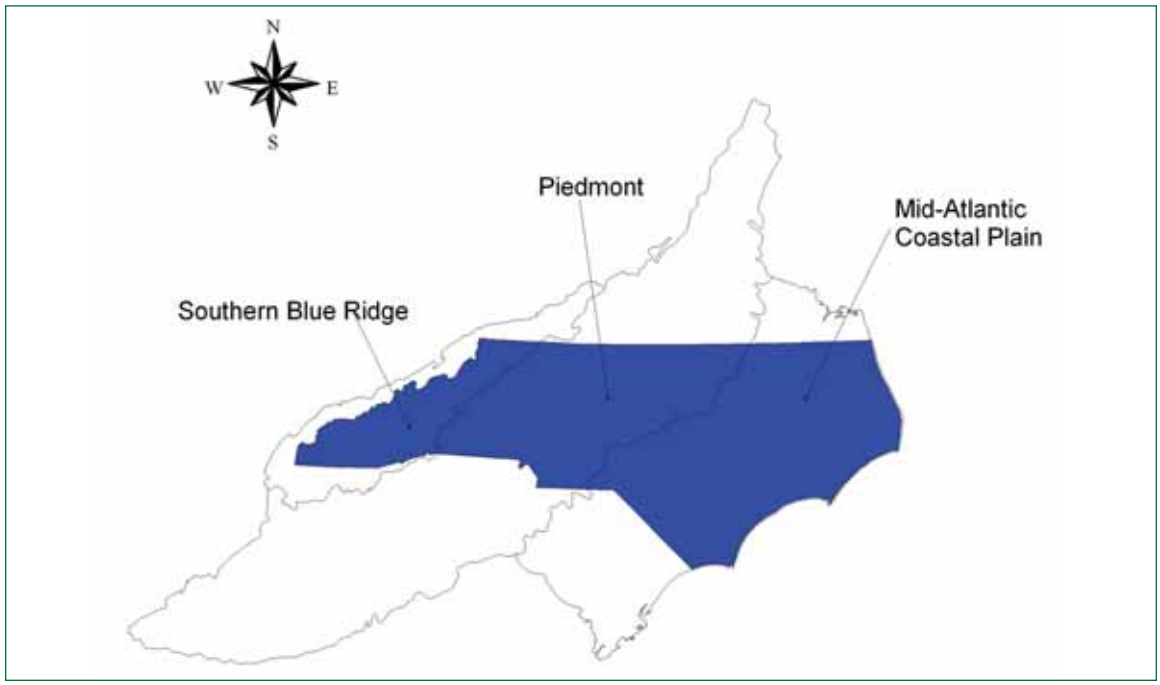

Figure 5A.2. Ecoregions of North Carolina, based on Bailey 1995 (source: NC GAP).

Southern Blue Ridge

The mountainous western portion of North Carolina makes up the majority of the Southern Blue Ridge ecoregion (Figure 5A.2). Elevations reach 6,684 feet (Mt. Mitchell) and habitats range from high peak spruce-fir forest to low floodplain valleys. The spatial heterogeneity of the ecoregion's topography (slope, aspect, and elevation) and its unique geologic history has resulted in a broad array of biodiversity. Moreover, the region receives the highest rainfall in the United States east of the Cascades, and is home to a range of climate types from warm temperate to boreal. The combination of these conditions, and the fact that this ecoregion escaped glaciation, has provided specialized habitat for the evolution and persistence of a vast and diverse floral and faunal assemblage, including over 400 endemic species—the most found in any ecoregion in North America (Ricketts et al. 1999).

The southern Appalachian region is the world's center for plethodontid salamander diversity (Ricketts et al. 1999). According to the Southern Appalachian Biodiversity Institute, nearly 10% of global salamander diversity and 10% of freshwater mussel diversity occur in this region. Why is species diversity so high in the region? For many typically "northern" species, the Southern Blue Ridge is the southern limit of their distribution. In addition, gradients in elevation, aspect, slope, and rainfall contribute to a range of available niches and habitats.

Many of the factors impacting species conservation in this region can be traced to larger habitat-level issues. The decline of high elevation forests is one of the most pressing habitat concerns in the region. The southern Appalachian spruce-fir forest is considered the second most endangered ecosystem in the United States (Noss et al. 1995). The major cause of the decline is attributed to an exotic insect pest, the balsam woolly adelgid. Timber harvest early in the twentieth century also contributed to the forest loss. Loss of spruce-fir forest has severely limited habitat availability for many bird species endemic to the region (Hunter et al. 1999). Other habitat loss issues include succession of high elevation heath and grass balds, homogeneous maturity of forested stands

(resulting in a lack of under-story and mid-story development), water quality concerns due to growth and development, wetland draining and filling for agriculture and development, and habitat fragmentation due to development in floodplains and on slopes.

Piedmont

The Piedmont ecoregion makes up the central portion of North Carolina (Figure 5A.2). Habitats range from mid-elevation forest and bogs at the edge of the Blue Ridge escarpment, to low floodplain valleys towards the east.

Species diversity for some animal groups is relatively high in the Piedmont. According to the World Wildlife Fund, Southern Mixed Forests (which encompasses the Piedmont ecoregion as defined by Bailey 1995) rank among the top 10 ecoregions in North America in richness of amphibians, reptiles, and birds, and among the top 10 ecoregions in number of endemic reptiles, amphibians, butterflies, and mammals (Ricketts et al. 1999). In the context of the eastern United States, many northern and southern species overlap their ranges in North Carolina and in the context of the state, examples of both predominantly montane and coastal fauna are found within the Piedmont region. However, many of the natural habitats within the Piedmont have been altered by human development and intensified forestry and agricultural practices. Less protected public land exists in the Piedmont compared to the Mountain and Coastal Plain regions of the state. Remaining hot spots of biodiversity include high quality stream, floodplain, and wetland habitats, in addition to well managed farm and forest lands.

Many of the factors impacting species conservation in this region can be traced to larger habitat-level issues. Species diversity and conservation in the Piedmont is heavily impacted by rapid development and growth throughout the region. Over the past two decades, North Carolina has been one of the most rapidly growing states in the nation, and the bulk of the population increases have occurred around Piedmont urban areas. Patterns of growth in the Piedmont have favored sprawling sub-divisions outside of city cores, putting even greater pressures on wildlife habitats and diminishing the quality of life for many urban residents. The US Forest Service has documented a sharp loss in forest land cover in counties surrounding the larger Piedmont urban areas (such as Charlotte and Raleigh) between 1990 and 2002 (Brown and Sheffield 2003).

In addition to the direct loss of habitat from human development, wildlife populations are also threatened by habitat degradation and fragmentation in the Piedmont. Habitat fragmentation limits area-sensitive species and isolates other species, making populations more vulnerable to disturbance, disease, and depredation. Increased road and transportation development projects have impacted populations in ecologically sensitive areas. Roads can separate amphibian breeding locations and provide substantial barriers to seasonal animal migration pathways. Increased human development also brings an increased risk of the introduction of exotic species.

Mid-Atlantic Coastal Plain

The Mid-Atlantic Coastal Plain ecoregion makes up the eastern portion of North Carolina (Figure 5A.2). This region is typified by flat land and low elevations, extending inland to the Piedmont fall-line and eastward to the coastal beach and dune systems on the Atlantic Ocean.

This ecoregion ranks among the top 10 in the continent in number of reptile, bird, and tree species (Ricketts et al. 1999). North Carolina's Coastal Plain is particularly diverse from an avifauna standpoint because it falls at the northern end of the range for many southeastern breeding species and the southern end for many northeastern breeding species. In fact, North Carolina is the only state where some species such as the piping plover are found all year (the state falls within the southern extremity of their breeding range and the northern extremity of their wintering range).

Many of the factors impacting species conservation in this region can be traced to larger habitat-level issues. Habitat loss is one of the most obvious threats. Longleaf pine was historically found in all but the wettest sites in coastal North Carolina. Today it exists across less than 3% of its former range (Frost 1993). Habitat fragmentation due to land conversion (e.g., agriculture, development, roads) and fire suppression also impact habitats in the Coastal Plain. As habitats become more dissected, fragments become smaller and more isolated, sometimes leading to a loss of ecological function.

Fragmentation disrupts dispersal of many species, especially those that migrate between wet lowlands and dry uplands, and can negatively affect population dynamics and reproductive success. Furthermore, prescribed burning becomes more difficult in fragmented areas, due to smoke management and liability issues. Fragmentation can be particularly destructive to species that do not move well across roads, such as many reptiles and amphibians.

North Carolina's coast is bordered by a system of barrier islands divided by inlets. Of the 316 miles of oceanfront coastline in the state, 150 miles (47%) of it is developed. Of the remaining portion, only 30 miles of coastline are not impacted by a roadway, beach driving or continued dredge material disposal. Beach renourishment is a common tool used to protect infrastructure as the barrier islands undergo regular patterns of erosion and accretion. Renourishment can have negative effects on turtle and bird nesting, and on the invertebrate food base of shorebirds. Other methods of beach stabilization, such as relocating inlets and preventing natural inlets from migrating, are also becoming more common. These activities can also have deleterious effects on early successional beach nesting birds by preventing spit formation and overwash and leading to increased vegetation. As development increase along the coastline, many non-native plants and animals proliferate and become problematic. Raccoons, foxes, and feral cats that were historically absent from most of the barrier islands are now taking advantage of trash dumps, fish bait and other food sources left behind by humans. These animals are particularly adept at finding and eating beach nesting bird chicks and eggs, and turtle hatchlings and eggs.

Water quality concerns stemming from local development, agriculture, livestock, and sources originating in upstream Piedmont cities, are impacting aquatic vertebrate and invertebrate species in the Coastal Plain. Direct impact to aquatic fauna can indirectly affect terrestrial vertebrates (e.g., insectivorous small mammals) that rely on aquatic species as their primary food source.

Biological Needs: Knowledge Gaps and Ubiquitous Concerns

In order to address species and habitat conservation needs, it is important to first acknowledge our current state of understanding about the species groups highlighted within this portion of the Plan.

Mammals

While we collect extensive data and information about managed mammalian game species (e.g., black bear, white-tailed deer), we are at the very earliest stages of understanding the life history and habitat needs of most of our native nongame mammals. A few select areas of the state have been the focus of much of the existing mammal work (e.g., the coast, the Sandhills); the majority of the state has yet to be extensively surveyed. Currently, the most critical information needs are basic surveys, inventories, research and monitoring, especially for bats and small mammals across the state. In addition, simply the compilation of pertinent mammalian studies from disparate sources would be useful in providing a solid foundation of work from which to build.

Amphibians and Reptiles

There is dire need for standardized statewide surveys and monitoring of our amphibians and reptiles. A North Carolina Partners in Amphibian and Reptile Conservation program was developed in 2004 to help facilitate efforts toward this need. As with mammals, we have only a very basic understanding of many of our amphibian and reptile species. Basic surveys, research, and monitoring are the most pressing concerns. Habitat-specific long-term monitoring data is severely needed in order to assess population trends.

Birds

Compared to most of the other taxonomic groups, we have better knowledge and understanding of many of our bird species. Waterfowl and other migratory birds are managed through support of cooperative agreements such as the Atlantic Coast Joint Ventures and the South Atlantic Migratory Bird Initiative. A Partners in Flight program has been underway since 1993 in North Carolina.

Monitoring through the Breeding Bird Survey, point counts, Migration Monitoring, and Monitoring Avian Productivity and Survivorship (MAPS) stations should be continued or increased because long-term trend data are critical to assess population changes. Additional monitoring and research related to breeding productivity and the migration periods are needed. The conservation needs of North Carolina birds center mainly on habitat management, restoration, and protection (especially of spruce-fir forest, bottomland hardwood forest, quality early successional habitats, longleaf pine communities and coastal beach and estuarine habitats). However, there are still basic survey and research needs associated with the following groups: montane hardwood and high elevation birds, marsh birds, bottomland hardwood birds, goatsuckers, raptors, inland colonial nesting waterbirds, and shorebirds.

Terrestrial Invertebrates

The NC Natural Heritage Program tracks species within all the aforementioned terrestrial taxa, in addition to rare species in the following invertebrate groups: terrestrial gastropods, arachnids, crustaceans, millipedes, mayflies, stoneflies, caddisflies, dragonflies, damselflies, flies, moths, butterflies, grasshoppers and katydids, beetles, true bugs, and annelids. However, the Commission does not have jurisdiction over most of these taxa, and there is a scarcity of biologists focused on these groups. Knowledge levels and data availability for insects, terrestrial gastropods, and arachnids are among the lowest of any animal group in the state. However, these taxa are an integral part of the ecosystems they share with other invertebrate and vertebrate species. Opportunities to expand our knowledge and understanding of these groups should be taken when possible, as should the establishment of habitat-based projects that are mutually beneficial to these groups and to higher taxa. For more information on invertebrate conservation needs, see Appendix D.

Other Needs

Filling all knowledge gaps for every taxonomic group is arguably not necessary to achieve effective conservation. Effective monitoring and management of terrestrial communities can generally be achieved through focused attention on key elements of those communities among the more well-known birds, mammals, amphibians, and reptiles. Even this, however, is a daunting challenge. Realistically, all necessary tasks cannot be accomplished by the Commission alone. Sharing and consolidation of data from various sources to more completely assess information gaps and help meet vital goals for inventory and monitoring must be improved. The NC Natural Heritage Program is an important partner in this effort. Improvements should be made in sharing data between the two organizations and broadening the scope of data captured between them. Other state and federal agencies (e.g., US Fish & Wildlife Service, US Forest Service), universities and museums (e.g., NC Museum of Nature Sciences), nonprofit organizations (e.g., The Nature Conservancy, NC Audubon), and certain industries (e.g., forestry) are engaged, to various degrees and purposes, in monitoring of terrestrial communities. These and other sources of data should be exploited to the greatest practical extent that their quantity and quality will allow.

Cooperation and coordination is also essential to fulfill research needs for basic life history and ecology, resolve taxonomic problems, vulnerability to specific threats, restoration techniques, etc. Opportunities to partner and leverage limited funds should be explored and pursued to the maximum extent possible.

Organization and Content

In the following sections, priority terrestrial and semi-aquatic species (mammals, birds, amphibians, and reptiles) are referred to within the context of their associated terrestrial habitats. The ecoregion (Section level) as defined by Bailey (1995) is the broadest level of organization. We identified a total of 23 habitat types (modified from NCNHP 2001), found across the three ecoregions as such (Table 5A.1):

Table 5A.1. Habitats, by ecoregion, across North Carolina.

		Ecoregion		
		Mid-Atlantic Coastal Plain	Piedmont	Southern Blue Ridge
Terrestrial habitats	Beach/dune	X		
	Estuarine communities	X		
	Maritime forest/shrub	X		
	Tidal swamp forest and wetlands	X		
	Nonalluvial mineral wetlands		X	
	Small wetland communities	X	X	
	Wet pine savanna	X		
	Pocosin	X		
	Dry longleaf pine forest[4]	X	*	
	Lakes and reservoirs	X	X	
	Riverine aquatic communities	X	X	X
	Floodplain forest	X	X	X
	Early successional	X	X	X
	Oak forest (& mixed hardwoods/pine)	X	X	X
	Dry coniferous woodlands	X	X	X
	Mesic forest	X	X	
	Low elevation cliffs/rock outcrops[4]		*	X
	High elevation rock outcrops			X
	Caves and mines			X
	Bogs and associated wetlands[4]		*	X
	Cove forest			X
	Northern hardwoods			X
	Spruce-fir forest			X

These habitats represent all of the major habitat types in the state. Each habitat section offers a more detailed view of the threats, needs, and conservation priorities of that particular habitat. Priority species associated with each habitat are listed in table form at the start of the section. Map Series 5A shows the location and extent of the habitat in the ecoregion (see *Note*). Supporting references are included to direct readers towards other information sources that might be useful to review for conservation planning in the habitat. See Appendix G for a complete list of habitat associations of priority species, by habitat and ecoregion.

It is important to point out that each habitat may not be of equal importance to every priority species listed therein (e.g., a particular habitat may be obligate breeding habitat for one species, but an over-wintering habitat for another). Details of these differences are highlighted within the text of each habitat section. We direct readers to use the species tables at the beginning of each habitat section as a resource to identify the broad range of priority species that may use the habitat (potentially at different times of the year).

[4]Some habitats are found at the periphery of or in scattered locations within a second ecoregion not designated in the table above. To reduce redundancy, we have simply made note of these instances within the text of the primary habitat section and we have indicated that recommendations therein would apply to the habitat, wherever it is found. A (*) indicates additional ecoregion(s) where the habitat can be found.

Note: The findings of the recently completed NC Gap Analysis Project (NC GAP) are applicable to the terrestrial portion of this Plan. NC GAP staff assisted us in developing habitat coverage maps using their 1992 landcover data, and in conducting analyses on our subset of priority terrestrial species (aquatic species were not included in NC GAP analyses). The habitat maps are referenced in each habitat section that follows (Map Series 5A). All NC GAP-based analyses, including predicted species distributions maps for the majority of our terrestrial priority species, are documented in Appendix K.

Data disclaimer: 1992 (30 meter pixel) satellite imagery data was used to create the habitat maps. This data, therefore, may not accurately represent the location and extent of the habitats as they currently exist. The scale of the data makes representation of narrow or scattered habitats difficult (e.g., Southern Blue Ridge floodplain forest). In addition, it should be noted that not all vegetation types represented in the maps (e.g., early successional and agricultural areas) are representative of quality *wildlife habitat*.

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Southern Blue Ridge Ecoregion

1. **Spruce-fir forest** – Spruce-fir forests occur on high mountaintops in western North Carolina, generally above 4,500 feet in elevation. These forests are considered Pleistocene relicts that have become isolated from boreal forests of the northern United States and Canada. Many of the species of plants and animals found in this community type are more common further north and have either evolved here, isolated from their northern cousins or remain in small areas where elevation provides similar conditions to more northern latitudes. Spruce-fir forests are often comprised of components of northern hardwood and northern red oak forests mixed with red spruce at elevations from about 4,500 feet to 5,500 feet, with spruce becoming dominant, followed by Fraser fir dominance above 6,000 feet.

   These forests have been, and remain threatened due to impacts from human activities (including residential development, recreational development, and historic land use for logging or grazing), non-native insects (especially the balsam woolly adelgid), air pollution, and natural factors such as insects, isolation, and climate. Indeed, this habitat is listed as the second most endangered ecosystem in the United States (Noss et al. 1995).

   Spruce-fir communities provide critical breeding habitat for many landbirds of conservation concern according to Partners in Flight (brown creeper, northern saw-whet owl, black-capped chickadee) that are likely endemic to these high peaks (Pashley et al. 2000, Rich et al. 2004, Johns 2004). Spruce-fir also provides critical habitat for a host of plant and animal species found nowhere else in North Carolina.

Priority species associated with spruce-fir forest:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Accipiter striatus*	Sharp-shinned Hawk	SR
	Aegolius acadicus	Northern Saw-whet Owl	T
	Carduelis pinus	Pine Siskin	
	Certhia americana	Brown Creeper	SC
	Dendroica magnolia	Magnolia Warbler	SR
	Dendroica pensylvanica	Chestnut-sided Warbler	
	Loxia curvirostra	Red Crossbill	SC
	Picoides villosus	Hairy Woodpecker	
	Poecile atricapilla	Black-capped Chickadee	SC
	Wilsonia canadensis	Canada Warbler	
Mammals	*Glaucomys sabrinus*	Northern Flying Squirrel	E (E)
	Microtus chrotorrhinus	Rock Vole	SC
	Mustela frenata	Long-tailed Weasel	
	Sorex cinereus	Masked Shrew	
	Sorex dispar	Rock Shrew	SC
	Sorex fumeus	Smoky Shrew	
Amphibians	*Desmognathus wrighti*	Pigmy Salamander	SR
	Plethodon glutinosus sensustricto	Northern Slimy Salamander	
	Plethodon welleri	Weller's Salamander	SC

A. *Location and condition of habitat (see Map 5A.1):*

There are currently 6 significant areas of spruce-fir habitat in Western North Carolina, including portions of Grandfather Mountain, Roan Mountain, the Black/Craggy mountains, the Great Balsam mountains, the Plott Balsam mountains, and the Great Smoky mountains. Red spruce habitats of lesser size or with somewhat different ecological community associates occur in a few other locations, including Long Hope Valley, Beech Mountain, and Alarka Laurel. Estimates of the amount of spruce-fir habitat are quite variable depending upon a number of factors including the estimation methods and habitat definition. The Partners in Flight Bird Conservation Plan for the Southern Blue Ridge (Hunter et al. 1999) identifies over 66,000 acres of spruce-fir forest in the southern Blue Ridge physiographic province and the Southern Appalachian Assessment (SAMAB 1996) identifies over 75,000 acres in North Carolina and Tennessee. The vast majority of these areas occur in North Carolina at the locations listed above.

Most of the spruce-fir habitat in North Carolina is located on public land, or private lands with permanent conservation easements, with estimates of 90-95% in conservation ownership in the southern Blue Ridge physiographic province including North Carolina, Tennessee, and Virginia (Hunter et al. 1999, SAMAB 1996). However significant private ownership of spruce-fir habitat occurs in the Plott Balsams and Black/Craggy mountains, and to lesser extents in several other ranges.

B. *Problems affecting species and habitats:*

Spruce-fir habitats in North Carolina are now found within a narrow range of suitable conditions, isolated from each other and the rest of their range. This condition alone makes them more susceptible to perturbation and catastrophic events that could significantly affect their availability into the future. In addition, much of the spruce-fir habitat in North Carolina and throughout the southern Appalachians has been significantly altered due to a number of factors including historic logging, fire, exotic insects, historic grazing, and recreational development. Much of the spruce was logged in the early 20th century and in some areas (notably the Great Balsams) slash fires burned not only the coarse woody debris, but also the organic soil, which has subsequently inhibited the re-development of spruce and fir forests over large areas (Schafale and Weakley 1990).

In the latter part of the 20th century, the balsam wooly adelgid (*Adelges piceae*) began to have severe negative impacts upon Fraser firs throughout the region, resulting in the death of most of the mature fir of the high elevation forests. While some Fraser fir remains in certain locations, the majority of late successional fir has been killed and often replaced by young fir, mixed northern hardwoods, and open, herbaceous habitats. The removal of mature Fraser fir from the canopy has profound implications for the spruce-fir ecosystem and the continued existence of several unique plants and animals (Nicholas et al. 1999).

In addition, during the latter part of the 20th century, the Blue Ridge Parkway was completed through western North Carolina. The Parkway traverses most of the high elevation islands of spruce-fir habitat. The Parkway and its associated development (the motor road, vistas, and visitor facilities) have had a significant impact on the amount of spruce-fir habitats available. More recent negative impacts upon spruce fir forests include insect outbreaks in several areas including Roan Mountain, the Black Mountains, and the Great Balsam mountains. Some research has shown that recent increases in acid precipitation in the mountains of western North Carolina may have impacts on forest health and productivity, particularly in the high mountains (Schafale and Weakley 1990, Hunter et al. 1999).

The wildlife species associated with spruce-fir forest have suffered losses due the impacts of all of these activities and events. Certainly the local relative abundance of many birds and mammals has decreased as the availability of spruce-fir habitats has declined (e.g., red crossbill, brown creeper, pine siskin, black-capped chickadee, northern saw-whet owl, northern flying squirrel). The fact that these habitats are so small and isolated from each other could have a negative impact upon genetic health of individual populations, as well as demographic effects upon populations.

C. Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:

- **Surveys** – Surveys are needed to determine the distribution, relative abundance, and status of all wildlife species associated with spruce-fir forests.
  - Focus survey priorities on species believed to be declining, at risk, or exclusively dependent on the rare spruce-fir forest communities (e.g., red crossbill, brown creeper, black-capped chickadee, rock vole, rock shrew, northern flying squirrel, Weller's salamander, pigmy salamander).
  - Give secondary priority to surveys for species for which current distribution information is more available (e.g., northern saw-whet owl), or for species associated with additional, more extensive habitats (e.g., masked shrew, smoky shrew, hairy woodpecker, Canada warbler, sharp-shinned hawk, northern slimy salamander).

- **Monitoring** – Monitoring systems need to be expanded and/or targeted to be able to assess current population status and trend information for all wildlife species associated with spruce-fir forests. Priorities include:
  - Establish MAPS Stations, migration banding stations, or other means to monitor population status and trends for bird species not adequately sampled under existing monitoring protocols (i.e., BBS).
  - Establish monitoring systems and protocols for small mammal population status and trends including northern flying squirrel, rock shrew, and rock vole.
  - Establish monitoring systems and protocols for spruce-fir associated amphibians such as Weller's and pigmy salamanders.
  - Establish mechanisms for monitoring the distribution and condition of spruce-fir habitats through time.

- **Research** – Priority research needed for spruce-fir habitats and their associated species includes not only studies on the population biology of wildlife species, but also ecological relationships between the species, their habitats, and the biological, physical, and chemical habitat components. The following are currently recognized research needs.

  Genetics
  - Studies to explore the degree of endemism of Southern Appalachian populations (e.g., pine siskin, red crossbill, northern saw-whet owl, black-capped chickadee).
  - Studies to explore the degree of genetic isolation of species restricted to high elevations (e.g., northern flying squirrel, rock vole, rock shrew, Weller's salamander, northern saw-whet owl).

  Habitat
  - Studies to document ecological relationships between habitat use and availability for all taxonomic groups.
  - Studies to effectively map and/or model spruce-fir habitats both within and between habitat islands.
  - Studies on the impact of air pollution and climate change on the future availability of spruce-fir forests in North Carolina.
  - Studies to document forest management and restoration techniques that will benefit the habitat and associated species.

  Population demographics
  - Research on population demographics including trends, population structure, survivorship, reproduction, and population viability for all spruce-fir associated species/groups.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

While the vast majority of spruce-fir habitat in North Carolina is currently under conservation ownership by either state and federal government agencies or conservation groups (e.g., The Nature Conservancy), there remain areas of private ownership (particularly in the Plott Balsams and Black/Craggy Mountains), which, if developed in the future, could hasten the decline of the habitat as well as the species which depend upon it. In addition, the state and federal agencies which own/manage these habitats have goals and objectives which can conflict with conservation objectives for the habitat. For example state and federal parks have objectives to provide visitor services and developed recreational facilities that have, and could continue to decrease the availability or suitability of spruce-fir habitats under their jurisdiction. It is important to understand the influence of specific land uses within the landscape on ecological communities to avoid or mitigate associated impacts on wildlife species of concern (Rodewald 2003).

Many of the state and federal agencies take a passive role towards management of forest communities on their lands, particularly communities or habitats which support rare or endangered species, like spruce-fir forests do. While this management scenario may be beneficial in some instances for some habitats, it may not be appropriate to sustain habitats and associated species that are in decline and/or have very limited distribution to begin with. There are opportunities for active management of spruce-fir forests that could increase its distribution, health, and longevity that are not currently being pursued. Conservation actions that are appropriate and necessary to sustain spruce-fir forests and their inhabitants include both protection measures (acquisition/easement etc.) and management.

Protection Actions

- Assess, monitor, and mitigate impacts of existing management of state and federal holdings.
- Eliminate or minimize negative affects of future development of state and federal government holdings (state and federal parks, US Forest Service recreation developments).
- Acquire additional acreage of spruce-fir habitat through purchase, conservation easement, or other perpetual management agreements.

Habitat Management and Restoration Actions

- Continue efforts to study and develop management tools to ensure Fraser fir survival.
- Consider, implement, and evaluate effectiveness of spruce restoration in non-forested areas.
- Develop and/or implement techniques for managing pure spruce stands to include habitats components of the entire spruce-fir/northern hardwood community (i.e., thinning).
- Test silvicultural techniques to re-introduce spruce into formerly disturbed areas that have regenerated in northern hardwood or northern red oak communities (i.e., thinning and underplanting).

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Southern Blue Ridge Ecoregion

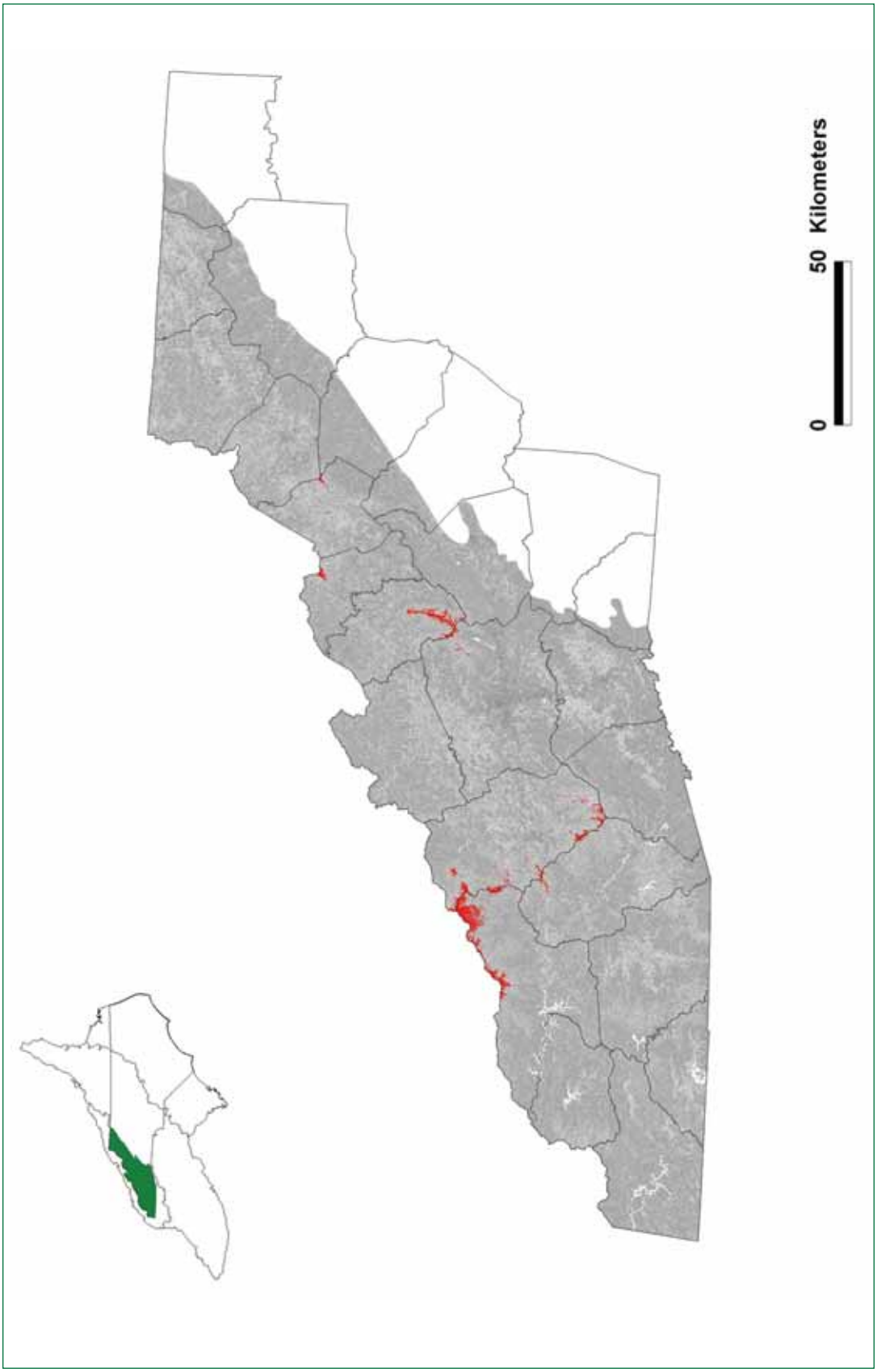

Figure 5A.1. Spruce-fir habitats in the Southern Blue Ridge ecoregion of North Carolina (in red) (data source: NC GAP, 1992).

2. **Northern hardwoods** – Northern hardwood forests are found on high elevation sites (generally above 4000 feet, but more often above 4500 feet) throughout western North Carolina with abundant rainfall and a cool climate. High elevation climate, slope, aspect and past disturbance are critical ecological determinants of the distribution of northern hardwood forests today.

   These habitats can be quite variable and can include several ecological sub-types such as boulderfield forests and beech gaps. Dominant tree species include yellow birch, American beech, yellow buckeye, and sugar maple. Understory vegetation varies considerably from dense rhododendron to open sedge, with numerous potential combinations of herbaceous and shrub components (NCNHP 2001). Generally, the ecological boundaries of northern hardwood forest are not well defined, and therefore the ecotones are wide and contain a diverse mixture of components from the adjoining habitat(s). Northern hardwood forests share some ecological components with high elevation red oak forests. However, they are more likely to occur on northerly aspects, with more cool moist conditions. Often components of spruce-fir habitats are present in sub-dominant numbers within northern hardwood communities, and increase in dominance along the elevation gradient to a point where spruce-fir becomes the dominant community. Northern hardwoods grade to cove hardwoods at lower elevations and the distinction can be difficult to discern, with many species occurring in both types.

   Northern hardwood forests provide habitat for numerous wildlife species which also rely heavily on spruce-fir forests. Because of the spatial relationship between them, and the fact that they share many ecological components and plant species, northern hardwood forests are critical to maintaining many species of birds and mammals dependent upon spruce-fir habitats. In addition, northern hardwood plant species may be critical components of spruce-fir habitats even in their sub-dominant role. Consider, for example, the fact that many spruce-fir dependent wildlife species are cavity nesters. Yellow birch, beech, sugar maple and buckeye often provide more abundant natural cavities and decaying wood than spruce or fir for species such as northern flying squirrels, yellow-bellied sapsuckers, black-capped chickadees, northern saw-whet owls, and other wildlife. While the northern hardwood habitat can be defined in general terms, ecologically, it is and possibly should be considered in association with spruce-fir forest for the purposes of maintaining ecological relationships and sustainability.

A. Location and condition of habitat (see Map 5A.2):

Northern hardwood forests in western North Carolina are concentrated in many of the same high elevation areas as spruce-fir forests, however they are more widespread throughout the region owing to their respectively lower elevation range. Significant amounts of northern hardwood forest occur in the Great Smoky Mountains, Great Balsams, Plott Balsams, Black/Craggy Mountains, Unicoi Mountains, and in the vicinities of Roan Mountain, and Grandfather Mountain. While most of the available northern hardwood forest is associated with these high elevation mountain ranges, significant amounts are present in other areas of suitable elevation throughout the region, such as in the Amphilobite mountains in Ashe and Watauga counties and in the Nantahala mountains in Macon county.

In western North Carolina, estimates of the amount of northern hardwood forest have not been definitively made, however the Southern Appalachian Assessment estimated approximately 56,000 acres (SAMAB 1996), and the US Forest Service estimates 46,000–56,000 acres on the Pisgah and Nantahala National Forest (USFS 2001). Estimates range from 68–80% of the acreage of northern hardwood forest in older (60+) age classes (Hunter et al. 1999, USFS 2001). Regardless of the estimates used, most of the available northern hardwood forest in North Carolina can be found on federally owned lands including US Forest Service (Pisgah and Nantahala National Forests) and National Park Service (Blue Ridge Parkway and Great Smoky Mountains National Park). A small percentage does occur on state-owned lands, and other conservation ownerships (e.g., The Nature Conservancy, local land trusts, etc.).

Priority species associated with northern hardwoods:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Accipiter cooperii*	Cooper's Hawk	SC
	Accipiter striatus	Sharp-shinned Hawk	SR
	Aegolius acadicus	Northern Saw-whet Owl	T
	Certhia americana	Brown Creeper	SC
	Coccyzus erythropthalmus	Black-billed Cuckoo	SR
	Dendroica pensylvanica	Chestnut-sided Warbler	
	Pheucticus ludovicianus	Rose-breasted Grosbeak	
	Picoides villosus	Hairy Woodpecker	
	Poecile atricapilla	Black-capped Chickadee	SC
	Sphyrapicus varius	Yellow-bellied Sapsucker	SC
	Vermivora chrysoptera	Golden-winged Warbler	SR
	Wilsonia canadensis	Canada Warbler	
Mammals	*Glaucomys sabrinus*	Northern Flying Squirrel	E (E)
	Lasionycteris noctivagans	Silver-haired Bat	SR
	Mustela frenata	Long-tailed Weasel	
	Napaeozapus insignis	Woodland Jumping Mouse	
	Parascalops breweri	Hairy-tailed Mole	
	Scalopus aquaticus	Eastern Mole	
	Sorex cinereus	Masked Shrew	
	Sorex dispar	Rock Shrew	SC
	Sorex fumeus	Smoky Shrew	
	Sorex hoyi winnemana	Southern Pygmy Shrew	
	Sorex palustris	Water Shrew	SC
	Sylvilagus obscurus	Appalachian Cottontail	SR
Amphibians	*Ambystoma maculatum*	Spotted Salamander	
	Desmognathus wrighti	Pigmy Salamander	SR
	Plethodon aureolus	Tellico Salamander	SR
	Plethodon chattahoochee	Chattahoochee Slimy Salamander	
	Plethodon glutinosus sensustricto	Northern Slimy Salamander	
	Plethodon richmondi	Southern Ravine Salamander	
	Plethodon welleri	Weller's Salamander	SC

Hunter et al. (1999) and Schafale and Weakley (1990) suggest that the available acreage of northern hardwood habitat is actually greater now than in the past, primarily due to expansion of northern hardwoods into areas formerly occupied by spruce-fir forests. In fact, there are places which may have been spruce or fir forests where previous disturbances (fires, grazing, etc.) have resulted in northern hardwood stands. It remains to be seen whether these places, under natural regimes will ultimately become mixed northern hardwood/spruce stands or whether spruce will eventually attain dominance. However, it must also be considered that significant development has and continues to occur in northern hardwood habitats on private lands throughout the region. Primarily this has been residential development and the rate of it has likely increased recently, making an estimate of current northern hardwood habitat availability relative to past availability difficult.

B. Problems affecting species and habitats:

The aging of many northern hardwood stands has resulted in closed canopy conditions and decreasing habitat for bird species that rely on diverse understory development, such as Canada warbler. Lack of disturbance has reduced available habitat for disturbance-dependent species such as golden-winged warbler and yellow-bellied sapsucker (Hunter et al. 2001). In turn, the impacts to other wildlife from stand level disturbance will need to be examined. For example, soricids such as masked and smoky shrews can respond favorably to forest disturbance in northern hardwoods (Ford et al. 2002), but this may not be true for other small mammals or salamanders. Many of the former fir forests and logged or grazed areas are regenerating into northern hardwood stands without a conifer component (spruce or fir). Development pressure includes threats from a large increase in second homes and recreation facilities. Many non-native pathogens are a potential problem for several tree species in this ecosystem, including hemlock woolly adlegid, balsam woolly adelgid, gypsy moth and beech scale. The isolated nature of several populations of wildlife, such as northern flying squirrel, northern saw-whet owl, black-capped chickadee and Weller's salamander, is likely detrimental to the genetic flow and overall long-range health of the species.

C. Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:

- **Surveys**
  - Initiate surveys for rare salamanders like Weller's, pygmy, seepage, and Tellico, as well as more common species such as ravine salamanders, to determine their actual distribution and better define their habitat associations.
  - Continue survey work on northern flying squirrel distributions within and between known populations. Questions remain, such as: *Are there additional populations? Within populations how much suitable habitat occurs? What are the spatial relationships between patches of suitable habitat?*
  - Conduct shrew surveys to determine the distribution of long-tailed, pygmy and water shrews and surveys to document the response of shrews to disturbance/management.
  - Conduct surveys for more common mammals such as Appalachian cottontails, bats (particularly silver-haired and hoary bats), woodland jumping mice.
  - Conduct bird surveys to document breeding distribution (e.g., black-billed cuckoo).
  - Conduct bird surveys for golden winged warbler, black-capped chickadees, brown creeper, yellow-bellied sapsucker, and other high elevation birds.
- **Monitoring** – Monitoring of population trends for all high elevation species, including those associated with northern hardwood forest, needs to be developed and implemented with top priority towards rare species and secondary priority towards all species occurring in this relatively rare community of the North Carolina landscape.
  - Establish more MAPS stations, point counts, and migration banding stations; montane birds are not adequately picked up in BBS routes.
  - Continue montane bird population monitoring (e.g., northern saw-whet owl, brown creeper, black-billed cuckoo, yellow-bellied sapsucker, rose-breasted grosbeak, and others that may be found at the upper or lower ranges of this habitat).
  - Establish monitoring systems and protocols for small mammal population status and trends including northern flying squirrel, rock shrew, water shrew.
  - Establish monitoring systems and protocols for bats (e.g., hoary, silver-haired and other bats) and other mammals (e.g., Appalachian cottontails) associated with northern hardwood communities.
  - Establish monitoring systems and protocols for northern hardwood associated amphibians such as Weller's and pigmy salamanders.

- **Research**

  Genetics

  – Conduct genetic studies across taxonomic groups to assess degree of population isolation/gene flow, and determine taxonomic status (primarily bird taxa thought to be southern Appalachian endemics).

  Habitat

  – Conduct species specific research needed for northern saw-whet owls, yellow-bellied sapsuckers, black-capped chickadees, golden-winged warbler to answer the question: *How are they using the available habitat?*
  – Initiate habitat use studies for many species to assess use of microhabitats, forest age classes and habitat spatial relationships.
  – Conduct research on habitat management techniques to successfully establish mixed spruce-northern hardwood stands in non-forested areas or appropriate pure/young northern hardwood stands.
  – Conduct research on habitat management techniques to maintain suitable habitat for disturbance tolerant species such as golden-winged warbler and yellow-bellied sapsucker.

  Population demographics

  – Initiate demographic studies of neotropical migrants through nest searching, spot mapping, telemetry.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

While much of the available northern hardwood forest in North Carolina occurs on conservation lands, that does not in and of itself ensure the continued existence of many of the species associated with it. Conservation actions necessary to conserve those species and the habitat itself include both protection and management of the community. Given the small proportion of the landscape occupied by northern hardwood forest, it and its associated species need to be protected from significant loss due to development or other factors. The current habitat and connectivity of isolated patches certainly needs to be protected through conservation ownership acquisition or easement. In addition, management of existing northern hardwood forests and adjacent habitats (particularly spruce-fir forests) needs to be expanded to ensure that we provide the complete mix of age class, composition, and conditions necessary to sustain populations of a wide range of species that utilize northern hardwood forests. The effects of edge and fragmentation need to be considered for forest interior wildlife in northern hardwood habitats (Manolis et al. 2000, Rosenberg et al. 2003).

Specific actions necessary include:

– Acquire additional acreage of northern hardwoods habitat through purchase, conservation easement, or other perpetual management agreements.
– Increased connectivity among habitat patches, both through acquisition or management of adjacent stands. Preservation of large tracts of minimally disturbed older forests may be key to maintaining forest litter amphibian populations.
– Consider and implement strategies to enhance the greater high elevation communities (particularly the spruce-fir/northern hardwood forest complex) by expanding the current distribution of mixed spruce/northern hardwood forest through appropriate means and at appropriate locations (e.g., establishing a subdominant spruce component in pure northern hardwood stands)
– Consider and implement silvicultural management at appropriate locations to enhance understory development, provide regeneration and habitat for disturbance dependent species or early successional species, and enhance mature forest conditions in young to middle-aged pure stands.

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Southern Blue Ridge Ecoregion

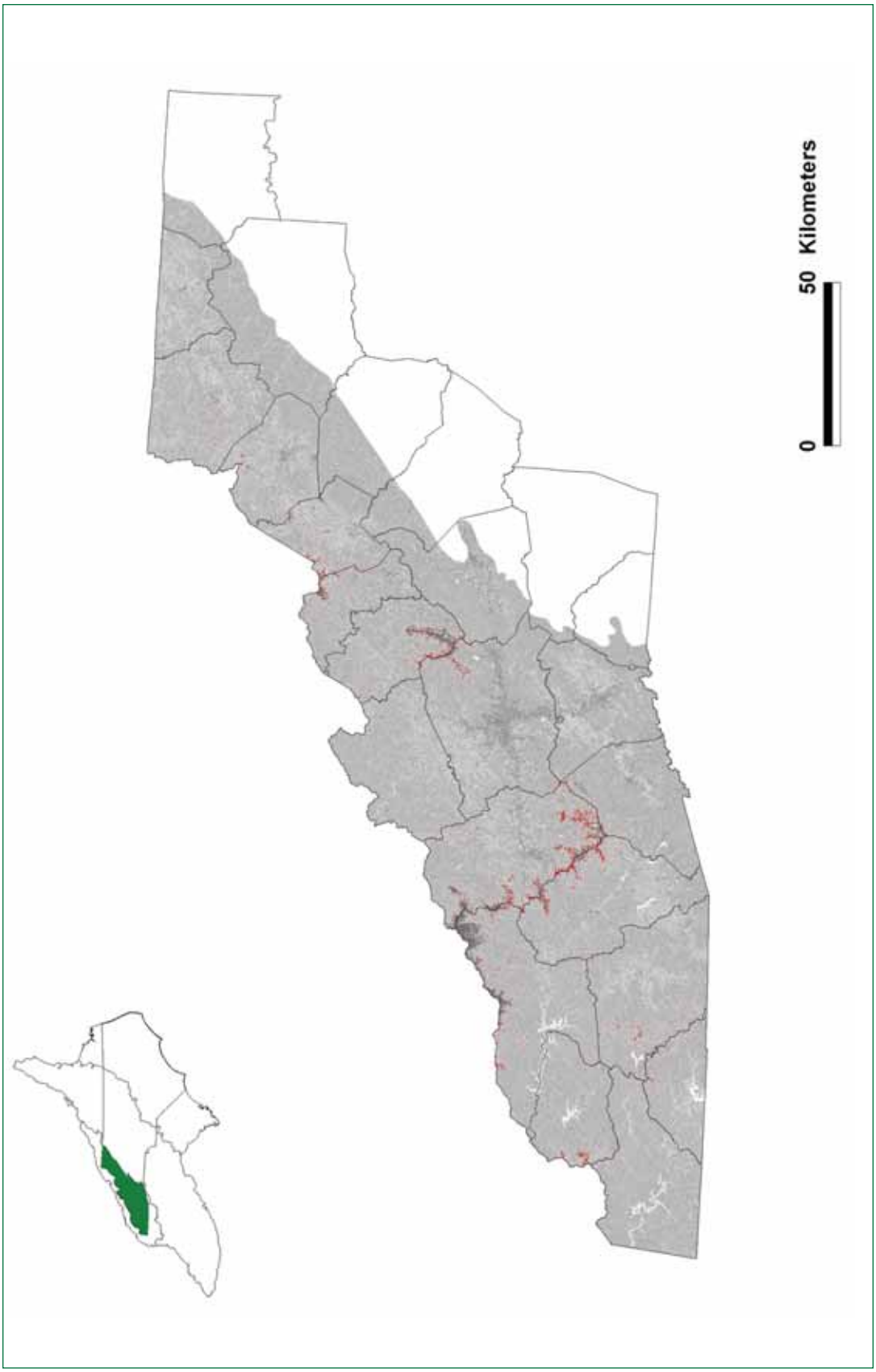

Figure 5A.2. Northern hardwood habitats in the Southern Blue Ridge ecoregion of North Carolina (in red) (data source: NC GAP, 1992).

3. **Cove forest** – Montane cove forest occurs in low to mid-elevation sites in moist, protected areas. Coves are generally stable, uneven-aged climax forest, characterized by a dense tree canopy. Other plant community classification systems refer to cove forests as mixed mesophytic hardwoods (SAMAB 1996) or differentiate between acidic coves and rich (circumneutral soils) coves (Schafale and Weakley 1990). Common tree species may include: yellow poplar, sugar maple, yellow buckeye, basswood, beech, black cherry, white ash, red maple, hemlock, black birch, umbrella tree, fraser magnolia, and northern red oak. Generally, rich coves have a relatively open midstory with a dense herb layer of ferns and numerous herbaceous plants, and acidic coves have a dense midstory, often comprised of rhododendron and dog hobble, with a sparse herbaceous layer. Canopy gap dynamics play a large role in regeneration (NCNHP 2001).

   Appalachian cove hardwood forests represent some of the most diverse ecosystems in the world outside of tropical zones (Hunter et al. 1999). An amazing assortment of trees and herbaceous vegetation, coupled with topographic, microclimatic, and soil characteristics combine to provide an extremely productive habitat for numerous mammals, amphibians, and birds. High numbers of endemic salamanders are present (Petranka 1998), and population densities of these animal groups in cove hardwood forests make these extremely important habitats.

Priority species associated with cove forest:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Accipiter cooperii*	Cooper's Hawk	SC
	Accipiter striatus	Sharp-shinned Hawk	SR
	Certhia americana	Brown Creeper	SC
	Coccyzus americanus	Yellow-billed Cuckoo	
	Coccyzus erythropthalmus	Black-billed Cuckoo	SR
	Colaptes auratus	Northern Flicker	
	Contopus virens	Eastern Wood-Pewee	
	Dendroica cerulea	Cerulean Warbler	SR
	Helmitheros vermivorous	Worm-eating Warbler	
	Hylocichla mustelina	Wood Thrush	
	Limnothlypis swainsonii	Swainson's Warbler	
	Picoides villosus	Hairy Woodpecker	
	Sphyrapicus varius	Yellow-bellied Sapsucker	SC
	Wilsonia citrina	Hooded Warbler	
Mammals	*Mustela frenata*	Long-tailed Weasel	
	Napaeozapus insignis	Woodland Jumping Mouse	
	Scalopus aquaticus	Eastern Mole	
	Sorex cinereus	Masked Shrew	
	Sorex fumeus	Smoky Shrew	
Amphibians	*Ambystoma maculatum*	Spotted Salamander	
	Ambystoma opacum	Marbled Salamander	
	Aneides aeneus	Green Salamander	E
	Desmognathus aeneus	Seepage Salamander	SR
	Desmognathus wrighti	Pigmy Salamander	SR
	Plethodon aureolus	Tellico Salamander	SR
	Plethodon chattahoochee	Chattahoochee Slimy Salamander	
	Plethodon glutinosus sensustricto	Northern Slimy Salamander	
	Plethodon longicrus	Crevice Salamander	
	Plethodon richmondi	Southern Ravine Salamander	
	Plethodon ventralis	Southern Zigzag Salamander	
Reptiles	*Heterodon platirhinos*	Eastern Hog-nosed Snake	
	Virginia valeriae valeriae	Eastern Smooth Earthsnake	

A. Location and condition of habitat (see Map 5A.3):

Cove hardwood habitat is well represented in the mountains of western North Carolina. The Southern Appalachian Assessment (SAMAB 1996) categorized over 3.1 million acres of their study area as mixed mesophytic hardwood forest. Hunter et al. (1999) estimated that within that total, the Southern Blue Ridge physiographic province (mostly NC, but with portions of TN, GA, and SC) contributed approximately 1 million acres of cove hardwoods. The US Forest Service (2001) estimated through ecological mapping that there was over 1.8 million acres of cove hardwood forest in the southern Appalachians of TN, NC, GA, and SC and approximately 300,000 acres of cove hardwood forest occurs on its lands in western North Carolina, on the Pisgah and Nantahala National Forests. Of course, direct measurement of the amount of cove hardwood habitat currently in North Carolina is not possible, so depending upon the methods used to estimate, and the data upon which estimates are based, the overall availability of cove hardwoods is, at best a crude estimate.

If estimating the amount of cove hardwood is difficult, defining its condition is impossible. Most would agree that the majority of cove hardwood forest in western North Carolina is currently in mid-late successional stages (SAMAB 1996, Hunter et al. 1999). Likewise, over 81% of the cove hardwood forest on the Pisgah and Nantahala National Forests is over 60 years old (USFS 2001).

B. Problems affecting species and habitats:

In general, the most significant problem affecting cove hardwood habitat is its conversion to other uses, primarily in the form of residential development, though estimates of the amount of cove hardwoods lost to development are unavailable. Residential development in mountain coves often differs from development in other habitats of the region, in that homes and associated spaces are often interspersed within the forest. The result may be that direct habitat loss as a result of the houses and associated structures may be more limited than other types of development. However, the reduction in quality of the habitat by virtue of being bisected by roads and driveways can certainly have significant impact upon the wildlife species of the forest (Rosenberg et al. 2003). Another potential problem affecting cove hardwood habitat is the advent of several exotic pest species which could have a significant impact upon the health of the forest, including the hemlock wooly adelgid, gypsy moth, and beech scale, as well as several non-native plants. And finally, timber harvesting and conversion to other forest types (white pine) or other uses on private lands in certain areas can also decrease the availability of this habitat in the future.

Problems of individual species associated with cove hardwood forests include isolation or extremely limited ranges of populations (e.g., cerulean warbler, crevice salamander). That could lead to increasing chances of genetic depression or stochastic events having negative consequences for the sustainability of populations. Some bird species which require a diverse understory may be impacted by the aging of stands, which can result in decreased plant diversity until the stand reaches age classes sufficient to produce canopy gaps (Hunter et al. 2001).

C. Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:

- **Surveys** – Initial efforts need to be directed towards surveys to determine current baseline distribution and status of species associated with cove hardwood forest for which that information is lacking. There are also numerous species associated with cove forests that are believed to be relatively common or have stable populations. However, in truth, we lack baseline information about actual distribution and status for most species that are considered common.

– Focus initial survey efforts on state-listed species, and others that may be declining (e.g., Cooper's hawk, sharp-shinned hawk, brown creeper, black-billed cuckoo, cerulean warbler, yellow-bellied sapsucker, green salamander, seepage salamander, pigmy salamander, Tellico salamander, and zigzag salamander).
– Next, conduct surveys to understand current status of species believed to be more common, from which we can measure future population changes. Examples of such species include: Swainson's warbler, silver-haired bat, long-tailed weasel, woodland jumping mouse, eastern mole, smoky shrew, masked shrew, spotted salamander, marbled salamander, ravine salamander, eastern hognose snake, and eastern smooth earthsnake.

- **Monitoring** – Protocols and procedures developed during surveys for these various taxa should subsequently provide a means to convert from a baseline survey mode, to a long-term population trend monitoring mode at all times of the year. Long-term population trend monitoring will be critical for planning conservation measures, setting goals, and measuring achievements. In addition, other monitoring systems and protocols for certain taxa (i.e., MAPS or BBS) may need to be enhanced such that species not covered by current efforts receive special attention.
- **Research** – In addition, priority research topics for cove hardwood associated species currently envisioned include:

Genetics
– Green salamander movement/habitat use and genetics studies.

Habitat
– Habitat use studies for certain bird species (especially cerulean warbler and yellow-bellied sapsuckers).
– Studies of bird, amphibian, and vegetation responses to gap management or specific timber harvest regimes (e.g., cerulean warbler, Swainson's warbler, yellow-bellied sapsucker, and various plethodontid salamanders).

Population demographics
– Studies of neotropical migrant birds to get information on demographics through nest searching spot mapping, telemetry.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

As with all of our habitats, human population growth and its associated development is consuming or altering cove hardwood habitat rapidly. We must continue to add to our base of conservation ownership for future generations of the wildlife species associated with the habitat, as well as the use and enjoyment of them by future generations of North Carolinians.

Additional conservation measures that need to be considered will grow out of the research, survey, and monitoring mentioned above, however measures can be pursued now to help achieve both research and conservation goals regarding understory development and gap management. With the vast majority of cove hardwood habitat in mid successional stages, efforts should be directed towards increasing older age classes of cove hardwoods by both lengthening harvest rotation recommendations for timberland owners, and exploring whether we can mimic old growth gap dynamic conditions through selective harvesting techniques in mid-late successional cove hardwood stands. These and other measures to promote the development of diverse understory, particularly in acidic coves, should be pursued.

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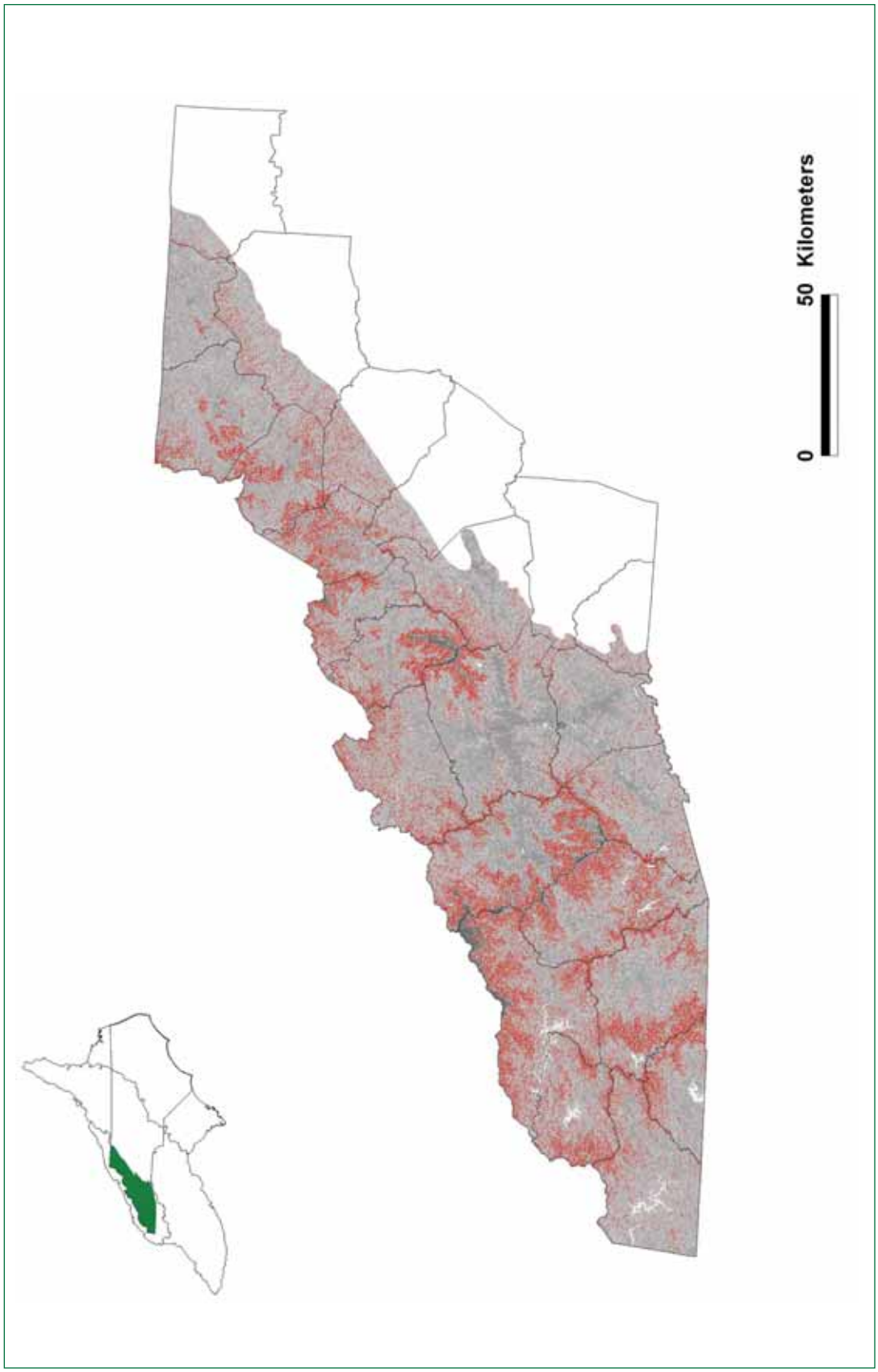

Figure 5A.3. Cove forests in the Southern Blue Ridge ecoregion of North Carolina (in red) (data source: NC GAP, 1992).

Southern Blue Ridge Ecoregion

4. **Early successional habitats** – Early successional mountain habitats may range from relatively ancient grassy balds on or adjancent to broad ridgetops (containing a variety of unique grass and herb species) to shrub-dominated heath balds (alder, rhododendron and mountain laurel are common dominant species) to lower elevation fields, meadows, pastures, and clear cuts resulting from agriculture or forestry activities. Human influences, herbivore grazing, and environmental factors such as topographic position, climate, and natural fires have all played a role in the creation and maintenance of montane early successional areas. Grassy balds seem to have arisen in response to climatic and animal influences in the late Pleistocene and have been maintained by wild herbivores and, since the 1840s, by domestic livestock (Weigl and Knowles 1999). The balds support unique plant species and communities and many rare animal species (often with northern affinities) found nowhere else in the Southeast. They are also important stop-over habitats for migrating birds. Heath balds, resulting from fire, cutting, or other disturbances, are often invaded by forest and support only a few specialized vertebrates (e.g., alder flycatcher). The remaining open grassy areas are basically montane "old fields" which have occasionally been invaded by bald species but generally are either in agricultural use or have been abandoned to forest. All of these habitats have been modified by human activity and all are subject to natural succession once controlling mechanisms—such as grazing or cutting- have been eliminated. Without management—the return of the management factors—natural succession will limit the longevity of these habitats and their dependent plant and animal species.

   Though many montane early successional habitat types support species uniquely dependent on them, other types provide little benefit to plant and animal species, especially those patches of small size, and thus could only be considered marginal wildlife habitat at best. These kinds of places generally reflect human use and activity as the primary goals of their management and include a number of places such as large lawns, monoculture hayfields, golf courses, residential development and even urban development. While each of these areas may support a limited amount of food and other habitat requirements of certain wildlife species, the array of both plant and animal species utilizing them is quite limited, and therefore they are not considered high quality early successional wildlife habitats. They may, however, play a role in the overall landscape scale habitat selection process of certain early successional species, provide transitional habitats, or provide habitat for a limited number of other species. Therefore, in a general sense or at a large scale, they can be included as part of the overall early successional habitat matrix, though most of the priority early successional species require a more diverse plant community than is often provided at these kinds of sites.

A. Location and condition of habitat (see Map 5A.4):

Because early successional habitat can include many different kinds of areas, from grassy balds to agricultural areas and recently harvested forest stands, the amount and distribution of it is constantly changing. However, a recent estimate indicated that roughly 70% of the southern Appalachian landscape (Southern Appalachian Assessment data from SAMAB 1996) is covered in forest. Therefore, 30% is non-forest condition, including semi-permanent early successional habitat such as grassy balds, heath balds, and old fields. The majority portion (26%) of that estimate was types of early successional plant communities that may, but most often do not provide quality wildlife habitat such as developed areas, agricultural areas, and water. In fact, Hunter et al. (1999) estimate that the amount of semi-permanent early successional bird habitat in the Southern Blue Ridge region (which is mostly western North Carolina) is probably much less than in other parts of the Southern Appalachian Assessment area. Their estimate was that approximately 1% of the Southern Blue Ridge is comprised of semi-permanent early successional habitat like balds and old fields. Furthermore they estimate that less than 10% of the forests in the region are in early successional stages.

Regardless of how it is measured, high quality early successional wildlife habitat in the mountains of western North Carolina is limited and may be declining as a percentage of the landscape due to numerous factors. The declines of grassland bird species for example is attributed to not only actual loss of habitat but also degradation of remaining tracts because of improper or inadequate management and encroachment of exotic vegetation, as well as fragmentation of habitat patches into small isolated units (Johnson and Igl 2001).

Priority species associated with montane early successional/grass bald habitat:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Ammodramus savannarum*	Grasshopper Sparrow	
	Caprimulgus vociferus	Whip-poor-will	
	Chordeiles minor	Common Nighthawk	
	Colinus virginianus	Northern Bobwhite	
	Dendroica discolor	Prairie Warbler	
	Dendroica pensylvanica	Chestnut-sided Warbler	
	Dolichonyx oryzivorus	Bobolink	
	Empidonax alnorum	Alder Flycatcher	SR
	Empidonax traillii	Willow Flycatcher	
	Eremophila alpestris	Horned Lark	
	Falco sparverius	American Kestrel	
	Icterus spurius	Orchard Oriole	
	Passerculus sandwichensis	Savannah Sparrow	SR
	Pooecetes gramineus	Vesper Sparrow	SR
	Scolopax minor	American Woodcock	
	Spizella pusilla	Field Sparrow	
	Sturnella magna	Eastern Meadowlark	
	Tyrannus tyrannus	Eastern Kingbird	
	Tyto alba	Barn Owl	
	Vermivora chrysoptera	Golden-winged Warbler	SR
	Vermivora pinus	Blue-winged Warbler	SR
Mammals	*Microtus chrotorrhinus*	Rock Vole	SC
	Microtus pennsylvanicus	Meadow Vole	
	Mustela nivalis	Least Weasel	SR
	Sylvilagus obscurus	Appalachian Cottontail	SR
	Zapus hudsonius	Meadow Jumping Mouse	
Reptiles	*Crotalus horridus*	Timber Rattlesnake	SC
	Eumeces anthracinus	Coal Skink	
	Opheodrys vernalis	Smooth Greensnake	SC
	Terrapene carolina	Eastern Box Turtle	

B. Problems affecting species and habitats:

There are a number of situations and conditions that have had, and continue to have a significant impact upon the availability, distribution, and quality of early successional habitat in the region. Some of them are natural processes such as succession, grazing (by native herbivores historically) and wildfire; others have been the result of gradual changes in human activities through history such as the progression from native American agriculture and land use practices, through early agricultural practices to modern agricultural practices. And finally, some of the conditions are the result of relatively rapid and large scale changes due to urban and rural development. Depending upon how the question is framed, each of these things can be a problem or challenge to the continued existence of quality early successional habitat in the region.

At least some grassy balds and heath balds are shrinking due to the effects of succession brought on by a lack of disturbance activities (NCNHP 2001). Agricultural practices have changed over time to favor "clean farming" practices including monoculture fields and pastures, limiting fallow field management, and minimal field borders and stream buffers. Invasive and exotic plan species also pose a major threat to early successional habitats, especially in riparian areas (e.g., tree of heaven, princess tree, Japanese stilt grass, oriental bittersweet, kudzu, privet). These species outcompete the native flora and ultimately reduce the quality and quantity of available early successional habitat. And finally, human development (residential, urban, etc.) in the region is essentially consuming and permanently removing wildlife habitat of all kinds. These and other political, social, and economic factors combine to pose a significant threat to the continued existence of early successional wildlife habitat in the region.

Besides problems associated with maintaining an adequate supply of quality early successional habitat in the region, there are a number of other problems faced by individual priority wildlife species including:

– Cowbirds present at low elevations (< 2500 feet) in disturbed areas (urban/suburban/agricultural) and potential impacts on songbird productivity
– Small isolated populations of some species (e.g., golden-winged warbler, alder flycatcher, rock vole), with greater potential for demographic, stochastic, and genetic impacts
– Appalachian cottontail displacement or dilution by eastern cottontails (Bunch, pers. comm.)

Many of the priority wildlife species are associated with particular landscape contexts, in addition to early successional habitats. In other words it is not enough to provide a small patch of early successional habitat surrounded by significant forested or developed areas. Populations of most bird species associated with grassland, shrub-scrub habitats and disturbed areas in forested habitats have declined steeply (Hunter et al. 2001). Most of the priority species of early successional habitat (e.g., grasshopper sparrow, vesper sparrow, orchard, prairie warbler, eastern meadowlark, meadow vole, meadow jumping mouse, etc.) are found in relatively open landscapes, or must have minimum amounts of early successional habitat in the area. This adds a level of complexity to the problem of maintaining an adequate supply of early successional habitat, in that the amount of habitat must be provided, but also in the proper sized patches and within the proper landscape context for it to be utilized by certain species.

C. *Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:*

- **Surveys** – Immediate efforts should be directed towards determination of the distribution and status of rare species or those believed to be declining (e.g., alder flycatcher, loggerhead shrike, savannah sparrow, vesper sparrow, golden-winged warbler, blue- winged warbler, rock vole, Appalachian cottontail, timber rattlesnake, and smooth greensnake). We currently lack baseline information on the distribution and status of most remaining priority species including whip-poor-will, willow flycatcher, American kestrel, common nighthawk, bobolink, horned lark (*breeding distribution*), dickcissel, least weasel, meadow jumping mouse, coal skink, and box turtle. Efforts to establish their current distribution and status are necessary to determine whether additional conservation measures will be necessary.

- **Monitoring** – After we have determined current distribution and baseline information on populations of the priority species, we must develop, adapt, or enhance long-term monitoring efforts for the entire suite of priority species associated with early successional habitats. For some taxonomic groups, monitoring efforts need to be expanded or enhanced. For example, additional Breeding Bird Survey routes or point counts may need to be established in selected areas or habitats and more attention paid to the migration period and wintering ecology of early succesional birds. Additional MAPS stations could also be beneficial, as well as migration banding stations. Monitoring protocols and procedures do not currently exist for mammals or reptiles on the priority list, so they will need to be developed.

- **Research** – Potential research questions abound regarding the numerous priority species in this habitat. Priority research includes the need to study golden-winged warbler population response to timber harvests of varying sizes and landscape contexts. For many bird species associated with early succession habitats (e.g., whip-poor-will, common nighthawk, prairie warbler, bobolink, willow flycatcher, loggerhead shrike, horned lark, vesper sparrow, dickcissel), we lack information about life history, breeding habits, and micro-habitat needs. Further research regarding the genetic status of Appalachian cottontails relative to eastern cottontails would also be important to shape conservation strategies for the species into the future.

  Research into the most effective and efficient measures to create, restore, and maintain quality early successional habitat (e.g., timber harvest, prescribed burning, mowing, herbicides, intermittent farming, grazing, etc.) needs to be emphasized, as well as understanding the differential impact that these strategies may have upon the wildlife species associated with early successional habitat. A final research recommendation concerns the study of rivercane (*Arundinaria gigantea*) in terms of its function and importance to wildlife as early successional habitat along floodplain areas.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

The highest priority conservation action for early successional habitats is to protect the sensitive grassy bald and heath bald habitat that are critical to numerous plant and animal species. However, most of those areas are now located upon conservation lands of state or federal agencies or conservation groups. Protection of those sites requires active management of them to ensure that they retain the characteristics necessary to sustain both the plants and animals they currently support. Secondarily, we must ensure an adequate sustained supply of quality early successional habitat through a combination of management strategies and appropriate practices including prescribed burning, timber harvest, grazing, herbicide use, or other practices) upon both public and private lands. Other important conservation measures to consider for early successional habitat include:

- Acquisition of conservation lands by management agencies/organizations (we need more *quality* early successional habitat, e.g., grass balds).
- Consider increasing the size of timber harvest areas where appropriate to support greater variety and density of early successional “area sensitive” species.
- Control of exotic species (e.g., red cedar, fescue, miscanthus, japanese spirea, tree of heaven, princess tree).
- Continue and enhance efforts to implement conservation measures upon private lands, through various programs and initiatives (e.g., Farm Bill programs, CURE, stewardship program, etc.).
- Additional monitoring of balds and bald edges, and increased management of balds (as is now going on in the Great Smoky Mountains, Roan Mountain, and Whitetop, Virginia).
- Protection of known rattlesnake dens.

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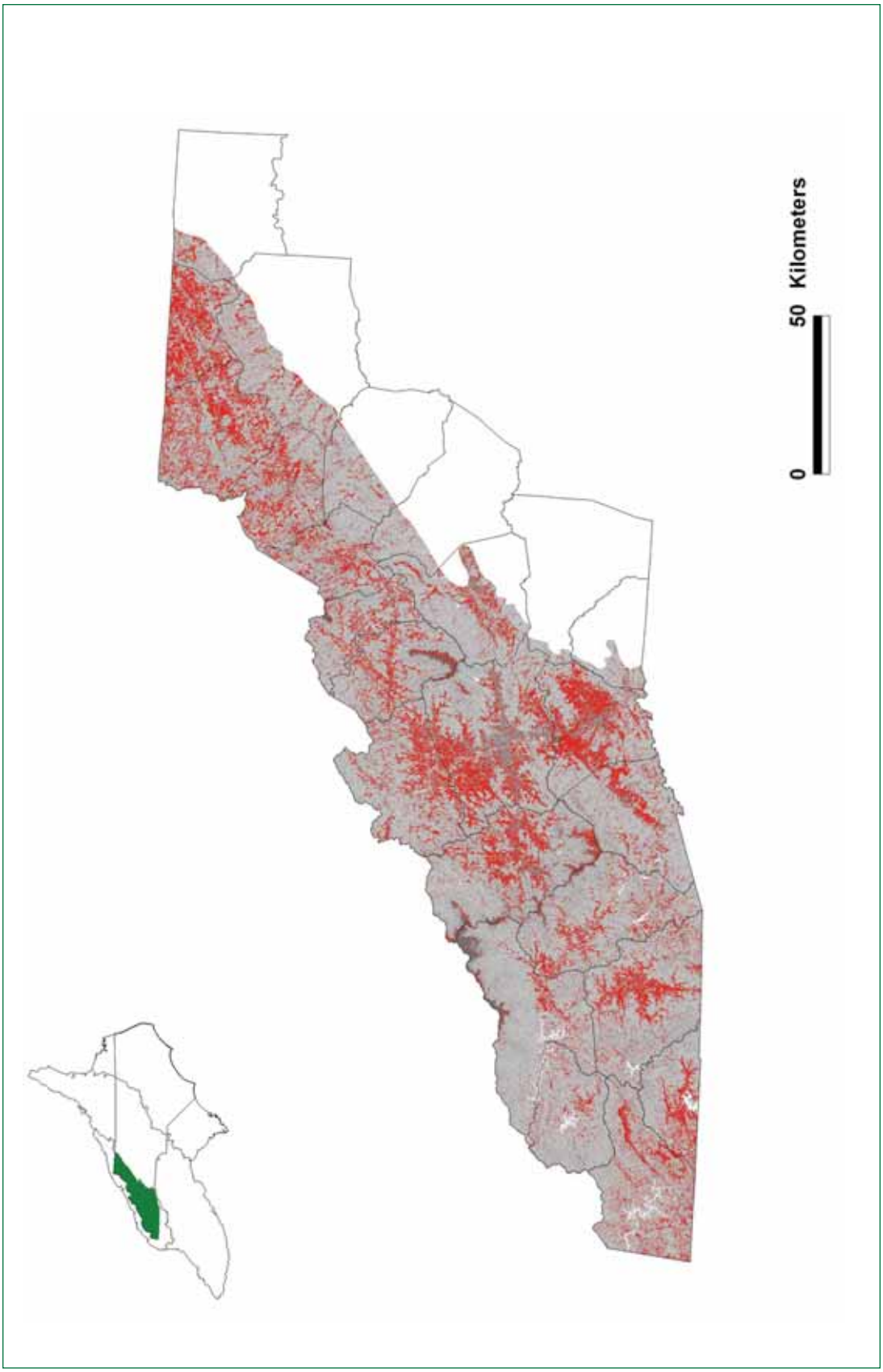

Figure 5A.4. Early successional habitats (including agricultural areas)in the Southern Blue Ridge ecoregion of North Carolina (in red) (data source: NC GAP, 1992). *Note: Due to the ephemeral nature of these habitats, this coveage may not be entirely accurate as of 2005. However, it should still give readers an indication of the extent of these habitats across the region.*

5. **Dry coniferous woodlands** – This habitat type occurs on sites that are dryer than most mountain sites, including ridgetops, spur ridges, and along steep slopes, generally in the low to middle elevations below 3,500 feet on southern or western aspects. These sites contain shallow, often extremely acidic soils. Dry coniferous woodlands are variously referred to or include ecological communities such as pine-oak heath (Schafale and Weakley 1990) and southern yellow pine (Hunter et al. 1999, SAMAB 1996). Typically, lower elevation sites are dominated by Virginia or pitch pine, which is replaced near 3,000 feet with dominance by table mountain pine. Canopy species may include table mountain pine, pitch pine, Virginia pine, chestnut oak, Carolina hemlock, or white pine. In addition, a wide variety of hardwood trees are often dispersed throughout this habitat including scarlet and chestnut oak, hickories, sourwood, black gum, and sassafras. The understory is often very dense mountain laurel or rhododendron, though some sites, particularly those which have experienced recurring fires, support diverse understories of a wide variety of *Vaccinium* and other ericaceous shrubs and herbs (NCNHP 2001).

   Fire and other disturbances have played a critical role in the establishment, maintenance, composition and structure of dry coniferous woodlands. There is little doubt that frequent fires are necessary to sustain this habitat, and that in the absence of fire, these communities generally succeed into hardwood forest conditions (Hunter et al. 1999). Table mountain pine and table mountain/pitch pine stands in particular can only reproduce in a fire maintained system due to their serotinous cones and shade intolerance. The distribution and abundance of table mountain-pitch pine habitat will likely change with active management and restoration, the invasion of exotic organisms and the impact of forest decline agents (Williams 1998).

Priority species associated with montane dry coniferous woodlands:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Accipiter cooperii*	Cooper's Hawk	SC
	Accipiter striatus	Sharp-shinned Hawk	SR
	Dendroica discolor	Prairie Warbler	
	Helmitheros vermivorous	Worm-eating Warbler	
	Loxia curvirostra	Red Crossbill	SC
	Melanerpes erythrocephalus	Red-headed Woodpecker	
	Sitta pusilla	Brown-headed Nuthatch	
Reptiles	*Crotalus horridus*	Timber Rattlesnake	SC
	Eumeces anthracinus	Coal Skink	

A. Location and condition of habitat (see Map 5A.5):

Dry coniferous woodlands are widespread in the southern Appalachians as a whole, however they are more common in the ridge and valley and Cumberland Plateau physiographic regions than in the Southern Blue Ridge of western North Carolina. The Southern Appalachian Assessment reported over 3.7 million acres of southern yellow pine forest throughout the entire southern Appalachian region (SAMAB 1996). However, within the Southern Blue Ridge portion (mostly NC, with small amounts of TN, GA, and SC), Hunter et al. (1999) report only 650,000 acres. The US Forest Service estimates only 31,000 acres of southern yellow pine forest on the Pisgah and Nantahala National Forests of Western North Carolina (USFS 2001). Owing to the relatively low elevations occupied by dry coniferous forests in the region, significant ownership of this habitat occurs in western North Carolina upon state owned lands (Thurmond-Chatham, South Mountains, and Green River Game Lands; South Mountains State Park; Dupont State Forest). Most of the dry coniferous woodland habitat occurs in the foothills region, or in the far western counties (e.g., Cherokee and Clay counties).

With respect to the condition of dry coniferous forest in western North Carolina, it can only be characterized as quite variable. Because of the relationship between fire and other disturbances and the maintenance of this habitat, some sites are relatively open woodlands; others are densely packed with understory shrubs and succeeding into hardwood forest. In general, most are middle aged stands. There are examples of both older and younger age classes represented across the landscape, and there are also particular areas managed more intensively with prescribed fires though such areas are not common relative to the amount that is not actively managed.

B. *Problems affecting species and habitats:*

The most significant problem affecting dry coniferous forests in North Carolina is the lack of regular fires needed to maintain and reproduce this habitat type. Fire suppression, or the inability to use fire as a management tool, is resulting in a decline in both quantity and quality of this habitat. Not only will these forests not be able to reproduce themselves without fire, but those stands which are not regularly burned often develop dense mountain laurel/rhododendron understories that shade out other shrubs and herbaceous plants, thus lowering the habitat quality and diversity of wildlife which could utilize the area. Another general problem associated with dry coniferous forest is the southern pine beetle. Beetle outbreaks can have significant impacts upon this habitat type, killing the dominant pine overstory. However, southern pine beetles are a native insect and periodic outbreaks are a natural occurrence. What makes pine beetle outbreaks detrimental to the habitat is often the lack of fire after an outbreak leading to the development of dry hardwood habitats and thus the loss of the coniferous habitat.

Additional problems faced by individual species associated with dry coniferous forest include the lack of early successional habitat of this type or conversion of this habitat to other pine habitat (i.e. white pine) for species such as prairie warblers, woodpeckers, and nuthatches. Timber rattlesnake persecution in these habitats also remains a significant threat. And again, lack of management of the stands decreases the quality of habitat for woodland hawks by decreasing prey abundance and limiting their ability to hunt in dense understory growth.

As with all habitats, human development is rapidly decreasing the availability of this habitat across the region. Not only are we losing the habitat to development, but development in or adjacent to these sites leads to a significant problem with respect to managing these habitats with prescribed fire. Even where dry coniferous forest management could occur, we are often limited in our abilities to use fire as a management tool, due to the proximity of residential or other development.

C. *Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:*

- **Surveys** – For all of the priority species associated with dry coniferous woodland, we need to intensify efforts to establish our knowledge of their distribution and status, particularly species for which broad scale monitoring (e.g., BBS for birds) has not provided adequate information, such as: brown-headed nuthatch, red-headed woodpecker, prairie warbler, Cooper's and sharp-shinned hawks, coal skinks, timber rattlesnakes..
- **Monitoring** – Monitoring protocols and procedures need to be developed or refined that will allow us to measure population trends of the priority wildlife species, as well as the health and distribution of this relatively rare habitat through time.
- **Research** – Research needs to continue on topics including efficient and effective means to manage and improve the quality and quantity of dry coniferous forest, with a particular eye towards techniques that are applicable in our developing landscape (e.g., *in the absence of fire, either as a natural event or as a management tool, what other means might be available to sustain this habitat across the landscape?*).

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

Besides research, surveys, and monitoring of the species and the habitat, two major conservation actions need to be pursued. First, we must protect as much of this habitat as possible from conversion to other habitats or from outright loss to human development. Acquisition for conservation ownership should be a high priority, as should the development and implementation of voluntary measures to conserve and manage dry coniferous forest on private lands. This can be pursued through existing or new programs to promote maintenance and appropriate management of this habitat on private lands (e.g., Farm Bill programs and other landowner incentive programs such as the Forest Landbird Legacy Program, or stewardship forestry). And second, we must do everything possible to promote appropriate management of dry coniferous forest on public land through increased use of prescribed fire as a management tool. Prescribed burning is necessary to promote understory development, as well as maintain overall habitat quality and function..

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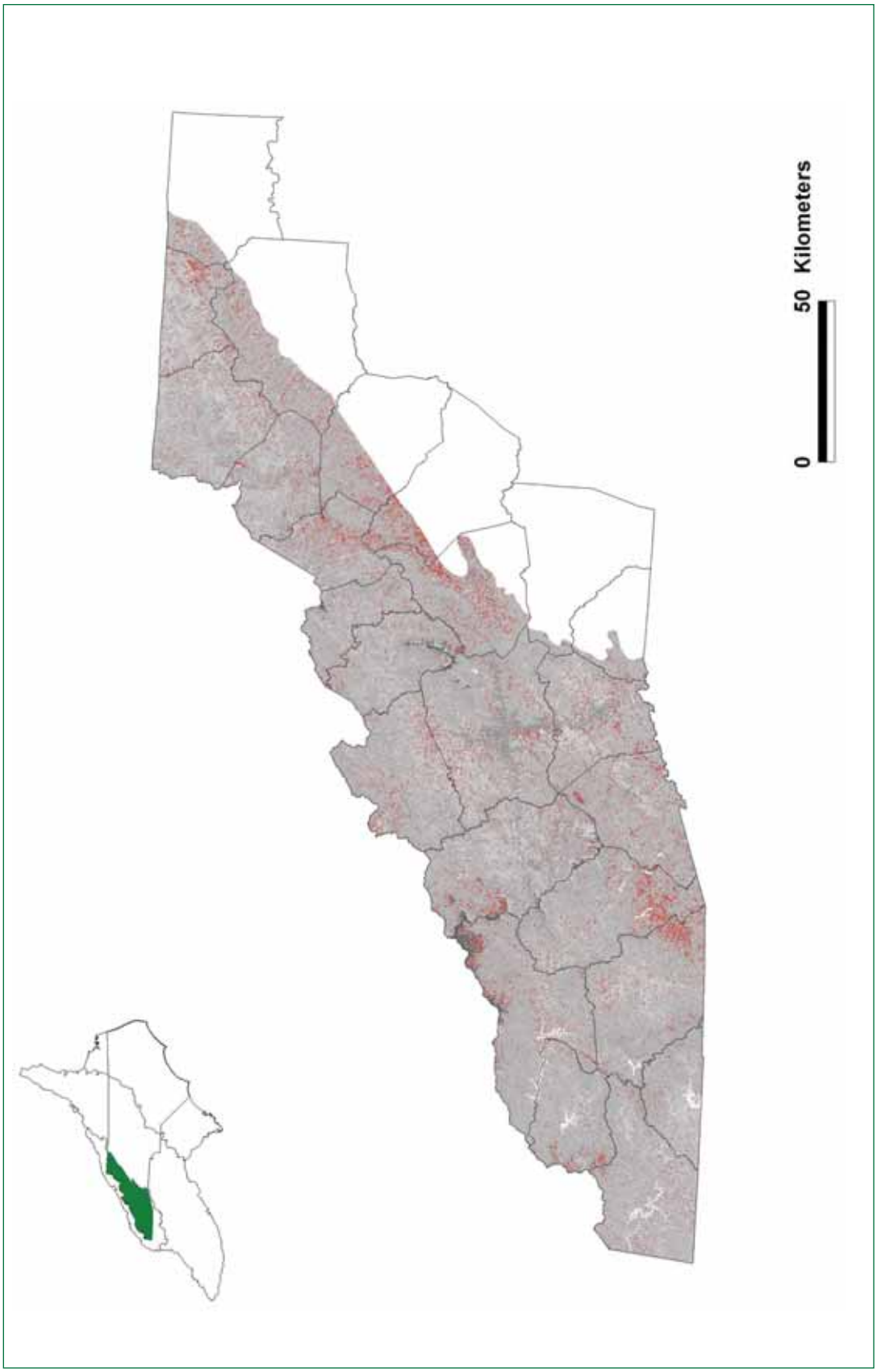

Figure 5A.5. Dry coniferous woodland habitats habitats in the Southern Blue Ridge ecoregion of North Carolina (in red) (data source: NC GAP, 1992).

6. **Oak forest (including mixed hardwoods and pine)** – Oak dominated forest is the most widespread and heterogenous habitat of the Mountain Region of North Carolina, and throughout the Southern Blue Ridge ecoregion on relatively dry slopes and ridges. This habitat is a complex mix of numerous ecological community types including: high elevation red oak, montane white oak, chestnut oak, montane oak-hickory, dry oak-hickory, dry-mesic oak-hickory, basic oak-hickory, pine-oak heath, and mesic mixed hardwood (Schafale and Weakley 1990). Other classification systems differentiate this habitat into categories such as oak-dominated forests and mixed pine-hardwood forests (Hunter et al. 1999). This habitat includes a range of moisture and topographic gradients, from dry to mesic and from the Piedmont to some of the highest mountain ranges. The driest sites are dominated by chestnut oak and/or scarlet oak, often with an understory of sourwood, black gum, and red maple. Montane oak-hickory forests, one of the most abundant ecological community types of this habitat, contain a mixture of oak species (often white oak dominates). Hickories may be present, and the understory/shrub layer vegetation is often quite diverse, supporting species such as flowering dogwood, flame azalea, and huckleberries. Red oak forests may dominate at medium to high elevations (most common community on high mountains) and on ridgetops where spruce-fir and northern hardwoods are absent or adjacent (NCNHP 2001).

   The importance of oak forest to wildlife of the region cannot be overstated, due to the overwhelming predominance of the habitat across the landscape, the variety of conditions encompassed, and the mast production capacity of this habitat. By virtue of the production of vast quantities of acorns, hickory nuts, and a wide variety of soft mast associates, the wildlife food production capacity of oak forests is immense. Coupled with the sheer amount of this habitat available, these factors make oak forests one of the most important habitats of the region to a significant variety wildlife species.

A. Location and condition of habitat (see Map 5A.6):

As a result of the variety of ecological classifications of this habitat, it is difficult to accurately assess the availability of this habitat in the state or region. The Southern Appalachian Assessment ascribed over 17.5 million acres in the seven states covered by their assessment (VA, KY, TN, NC, SC, GA, AL) to oak or mixed oak-pine categories (SAMAB 1996). Hunter et al. (1999) went further in classifying over 5 million acres of the Southern Blue Ridge physiographic province (including parts of VA, TN, NC, and GA, though the majority in NC) as the combination of oak dominated forests and oak-pine mixed forests.

The US Forest Service has utilized several classification systems and techniques to assess availability of a variety of forest types on their holdings within western North Carolina. Out of approximately 1 million acres in Forest Service holdings on the Pisgah and Nantahala National Forests, utilizing Continuous Inventory of Stand Condition data, they have estimated over 500,000 acres of upland hardwood and mixed pine-hardwood habitat; and ecological modeling conducted by the Forest Service estimated over 600,000 acres of various oak and mixed oak-pine habitats on the same two national forests (USFS 2001). Regardless of the specific classification system or boundaries employed, it is clear that oak dominated forests are the predominant forest habitat of the mid- and lower elevation mountains of western North Carolina.

Information regarding the condition of oak forest in the region is less readily available. Because oak forest is so common on both public and private lands, coupled with a variety of other factors (geographic, topographic, micro-climatic, etc.), this habitat has been subjected to a wide variety of natural and anthropogenic stresses which have shaped its current distribution and condition. The loss of American chestnut as a component of the landscape, development patterns, historic demands for timber products, fire suppression and a variety of other conditions have brought us to the current condition of oak forests today. Hunter et al. (1999) indicate that over half of the available oak forest habitat is currently in mid-late successional stages, with a very small proportion in early successional stages. The US Forest Service estimates that on the Pisgah and Nantahala National Forests, over 89% of upland hardwood and mixed pine-oak stands are more than 60 years old (USFS 2001). Extrapolating from these figures, the vast majority of oak forest on public lands of western North Carolina is currently in older age classes, though the percentage of older age classes on private lands in the region is smaller due to more active timber management strategies on private lands, but remains a majority nonetheless.

Priority species associated with montane oak & mixed hardwoods/pine forest:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Accipiter cooperii*	Cooper's Hawk	SC
	Accipiter striatus	Sharp-shinned Hawk	SR
	Caprimulgus vociferus	Whip-poor-will	
	Certhia americana	Brown Creeper	SC
	Coccyzus americanus	Yellow-billed Cuckoo	
	Coccyzus erythropthalmus	Black-billed Cuckoo	SR
	Colaptes auratus	Northern Flicker	
	Contopus virens	Eastern Wood-pewee	
	Dendroica cerulea	Cerulean Warbler	SR
	Helmitheros vermivorous	Worm-eating Warbler	
	Hylocichla mustelina	Wood Thrush	
	Melanerpes erythrocephalus	Red-headed Woodpecker	
	Oporornis formosus	Kentucky Warbler	
	Pheucticus ludovicianus	Rose-breasted Grosbeak	
	Picoides villosus	Hairy Woodpecker	
	Poecile atricapilla	Black-capped Chickadee	SC
	Sphyrapicus varius	Yellow-bellied Sapsucker	SC
	Vermivora chrysoptera	Golden-winged Warbler	SR
	Wilsonia canadensis	Canada Warbler	
	Wilsonia citrina	Hooded Warbler	
Mammals	*Mustela frenata*	Long-tailed Weasel	
	Mustela nivalis	Least Weasel	SR
	Parascalops breweri	Hairy-tailed Mole	
	Scalopus aquaticus	Eastern Mole	
	Sciurus niger	Eastern Fox Squirrel	SR
	Sorex cinereus	Masked Shrew	
	Sorex fumeus	Smoky Shrew	
	Sorex hoyi winnemana	Southern Pygmy Shrew	
Amphibians	*Ambystoma maculatum*	Spotted Salamander	
	Ambystoma opacum	Marbled Salamander	
	Aneides aeneus	Green Salamander	E
	Desmognathus aeneus	Seepage Salamander	SR
	Hemidactylium scutatum	Four-toed Salamander	SC
	Plethodon aureolus	Tellico Salamander	SR
	Plethodon chattahoochee	Chattahoochee Slimy Salamander	
	Plethodon glutinosus sensustricto	Northern Slimy Salamander	
	Plethodon longicrus	Crevice Salamander	SC
	Plethodon richmondi	Southern Ravine Salamander	SC
	Plethodon ventralis	Southern Zigzag Salamander	E
	Plethodon wehrlei	Wehrle's Salamander	T
	Pseudacris brachyphona	Mountain Chorus Frog	SC
Reptiles	*Crotalus horridus*	Timber Rattlesnake	SC
	Lampropeltis calligaster rhombomaculata	Mole Kingsnake	
	Ophisaurus attenuatus longicaudus	Eastern Slender Glass Lizard	
	Pituophis melanoleucus melanoleucus	Northern Pinesnake	SC
	Terrapene carolina	Eastern Box Turtle	
	Virginia valeriae valeriae	Eastern Smooth Earthsnake	

B. Problems affecting species and habitats:

With regard to oak forest habitat, three main categories of problems currently recognized include habitat loss, insects and/or diseases, and inappropriate management. Specifically, these include the following historic and ongoing problems:

- Loss or conversion of habitats (e.g., due to human development, agriculture).
- Increased development leading to greater degrees of habitat fragmentation.
- Amphibian species impacted by loss of embedded ephemeral pool habitats.
- Chestnut blight, oak decline, gypsy moths, and other diseases/pests may significantly affect the composition and diversity of hardwood stands throughout the Southern Appalachians.
- Fire suppression is a major factor affecting species diversity and richness, also affecting the composition, structure and diversity of hardwood stands throughout the Southern Appalachians.
- Homogeneity of stand age has resulted in decreasing habitat for bird species that rely on diverse understory development (lack of understory development).

Individual species associated with oak forest habitats may be experiencing problems other than those listed above that are not necessarily associated with oak forest habitat. Timber rattlesnakes and other snake species are subjected to persecution. Many species (e.g., cerulean warbler, black-capped chickadee, green salamander, seepage salamander, crevice salamander, Wehrle's salamander, northern pine snake) have such a small range or clumped distribution within North Carolina that they are more susceptible to stochastic or genetic population declines or local extirpations. Many neotropical migrant birds may also be experiencing winter range habitat loss. And finally, since there is such abundance and diversity of species associated with oak forests, we may not know the exact habitat or life history requirements of individual species that are limiting factors to their population stability.

C. Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:

- **Surveys**
  - Priority goes to gathering baseline information regarding the current distribution and status of oak forest associated species that are rare or declining (e.g., sharp-shinned hawk, cerulean warbler, black-capped chickadee, black-billed cuckoo, golden-winged warbler, eastern fox squirrel, green salamander, seepage salamander, four-toed salamander, Tellico salamander, crevice salamander, southern zigzag salamander, Wehrle's salamander, mountain chorus frog, timber rattlesnake, northern pine snake).
  - Next, expand surveys to include species for which we know very little about current status and distribution (e.g., whip-poor-will, Cooper's hawk, weasels, moles, shrews, bats, certain salamanders, and reptile species such as the box turtle).
  - Finally, compile, store and synthesize information about the status and distribution of more common species, developed through those approaches or other efforts.

- **Monitoring** – Monitoring efforts need to be established for numerous species groups for which no current framework exists. For many species groups (e.g., amphibians, reptiles, mammals), no current efforts are focused upon determination of population trends. Procedures and protocols must be developed that will allow us to determine whether populations of all of these animal groups are increasing or decreasing as a result of habitat changes through time. In addition to establishment or expansion of monitoring efforts at all times of the year for wildlife species associated with oak forest, we must work towards a consistent, comprehensive approach to monitoring the health, distribution, and availability of oak forests themselves. Knowing what the trends are for the habitat will be critical to understanding the dynamics of wildlife populations which depend upon them.
  - Expand monitoring frameworks to account for species that are not suited to traditional long-term monitoring protocols (e.g., hawks, goatsuckers, owls), or for species missed under systematic monitoring due to small population sizes or limited ranges in North Carolina (e.g., brown creeper, cerulean warbler, black-capped chickadee).

– Track oak habitat trends (e.g., rate of loss or conversion of the habitat and disease or pest affects) and consider trends in the development of long-term monitoring strategies for oak forests of the region.

- **Research** – Because the list of species associated with oak forest habitat is so broad, the potential research topics are innumerable. However, priority research efforts include:

Genetics

– Initiate genetic and morphological studies to clarify taxonomic status of numerous birds and amphibians (e.g., high elevation birds, plethodontid salamanders)

Habitat

– Conduct life history and habitat use research on northern pinesnake.
– Conduct habitat use studies of neotropical migrants (e.g., cerulean warbler, black-capped chickadee, many others) using telemetry.
– Conduct habitat use and life history studies for bat species that may potentially use this habitat (e.g., hoary, silver-haired, eastern small-footed, northern bats)
– Study population responses of plant and wildlife species to habitat manipulations (e.g., large scale prescribed burning, oak savannah creation, canopy gap creation, etc.)
– Conduct green salamander movement studies either around embedded rock outcrops or between rock outcrops

Other

– Establish studies to determine both direct and indirect impacts of pest control measures upon oak forest dependent species (e.g., *What is the impact of gypsy moth control strategies upon local and landscape scale wildlife populations? Upon invertebrates that serve as food for vertebrates?*)

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

Because oak forest habitat remains abundant and widespread, the most critical conservation activities revolve around gathering information about the wildlife species that utilize it and the habitat itself. We do not face the imminent threat of loss of the habitat as a whole, and therefore we must learn as much as possible about the species, the habitat, and their inter-relationships in order to develop concentrated strategies to both protect the most critical areas, and properly manage those under conservation protection. We cannot protect all oak forest in western North Carolina from loss or perturbation. We must understand what the most critical components are both ecologically and with respect to wildlife groups or species, and develop strategies to conserve and manage them. We must also recognize opportunities to act as soon as possible to protect landscape scale oak forests through both acquisition and other protection measures (voluntary incentives, cooperative agreements, easement programs) focused upon large tracts that will preclude future fragmentation or promote connectivity between existing conservation ownerships.

Within the land management realm, we must foster efforts to understand and implement appropriate management techniques (e.g., prescribed fire or thinning) for the benefit of the broadest array of oak forest dependent wildlife, while taking into account specific needs of wildlife with more restrictive requirements (Artman and Downhower 2003, Ford et al. 2000). We must encourage both study and dissemination of information about the impacts (both positive and negative) of various management strategies upon oak forest wildlife species. We must continue to pursue appropriate management of existing conservation lands including the use of prescribed burning to diversify structure and composition of forest understory, and other silvicultural techniques to promote regeneration, provide an array of age class and structural composition, and promote long-term economic sustainability of Appalachian oak forests. Changes in the Southern Appalachian landscape have reduced populations of some early successional birds that require disturbance and proper management in largely forested areas may be required to meet the needs of the wide array of wildlife (Marzluff et al. 2000, Klaus and Buehler 2001).

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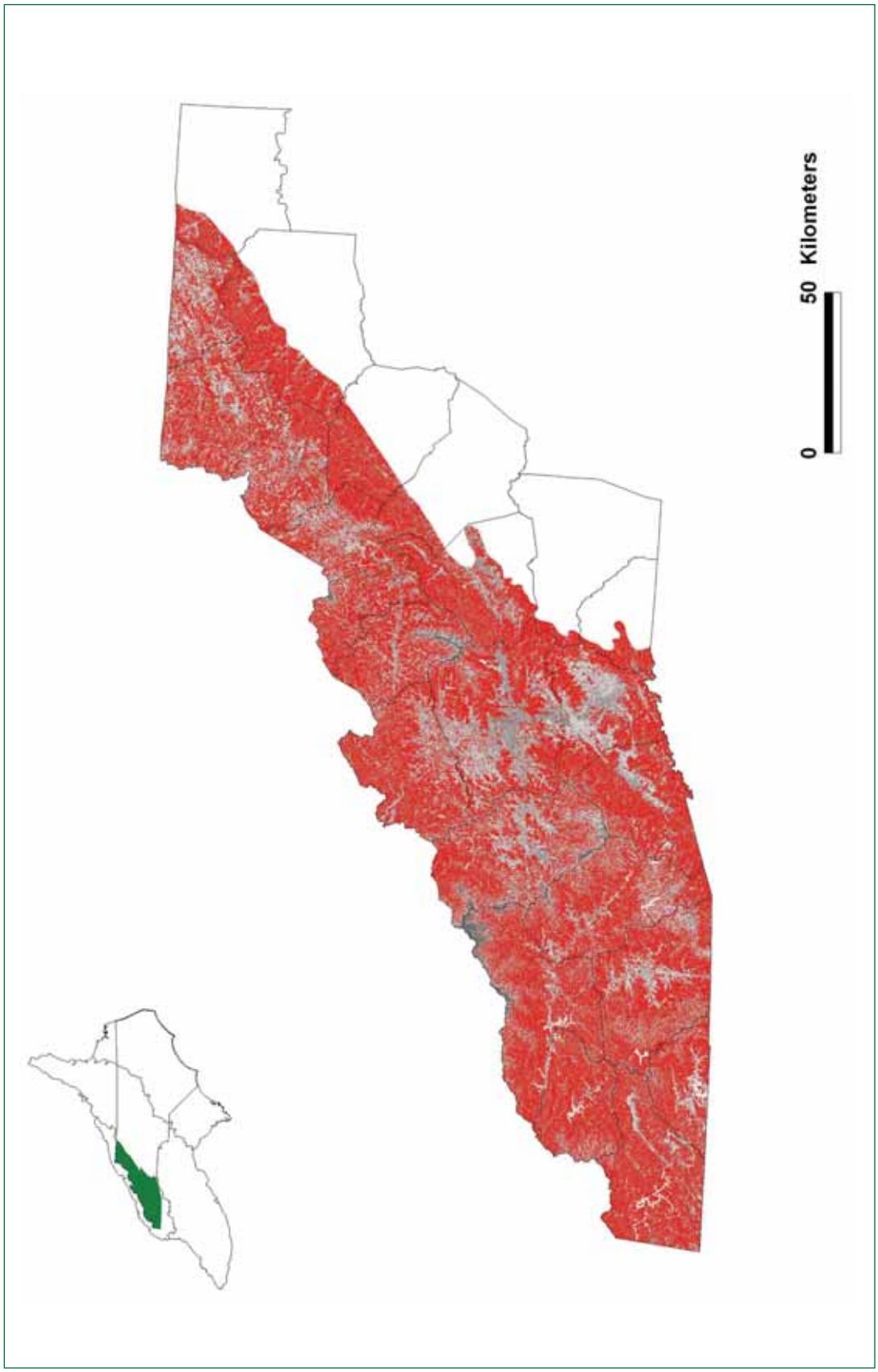

Figure 5A.6. Oak forest and mix hardwoods/pine habitats in the Southern Blue Ridge ecoregion of North Carolina (in red) (data source: NC GAP, 1992).

7. **High elevation rock outcrops** – High elevation rock outcrops are quite limited across the North Carolina landscape, however they are quite variable in terms of both geological and ecological condition. This habitat includes many distinct natural communities defined by Schafale and Weakley (1990) including boulderfield, rocky summit, granitic dome, acidic cliff, and mafic cliff, as well as some specific habitats less well defined or occurring within the context of other forest types including rock outcrops and talus slopes. In general they are found on ridgetops, peaks, and upper slopes where soils are thin and rock dominates the surface. We have not defined a lower elevation limit for this habitat type because there is extensive overlap between the plant community, animal community, and the physical condition of this habitat and the low elevation cliff/rock outcrop habitat. While high elevation rock outcrop habitat and low elevation cliffs/rock outcrops support many of the same animals and plants, there are species of both plants and animals that are found exclusively at high elevation rock communities (e.g., rock vole, long-tailed shrew, Allegheny woodrat, and several rare plant species), and others found only in low elevation cliffs/rock outcrop habitat (e.g., southern Appalachian woodrat, spotted skunk, crevice and Southern zigzag salamanders). The elevation limit for each of these species varies, but clearly there is a distinction between the animal assemblage at rock habitats that is dependent upon elevation.

   In general high elevation rock outcrops are open canopy communities with patchy vegetation due to variability in soil depth. Lichens and mosses occur on bare rock and other vegetation may develop in deep moss mats or crevices (oatgrass species, sedges, mountain dandelion). Woody plants or trees such as mountain laurel, Catawba rhododendron, table mountain pine, red spruce, and yellow birch may occur in the deepest soil mats, rock crevices, and at the edge of these habitats. Many rare plant species are associated with high elevation rock outcrop habitats. Certain high elevation rock outcrop habitats can occur within a forested setting (e.g., boulderfields within northern hardwood forests or small rock outcrops within any forest habitat) (NCNHP 2001).

Priority species associated with high elevation rock outcrops:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Falco peregrinus*	Peregrine Falcon	E
Mammals	*Microtus chrotorrhinus*	Rock Vole	SC
	Neotoma magister	Allegheny Woodrat	SC
	Sorex dispar	Rock Shrew	SC
Amphibians	*Aneides aeneus*	Green Salamander	E
Reptiles	*Crotalus horridus*	Timber Rattlesnake	SC
	Eumeces anthracinus	Coal Skink	

A. Location and condition of habitat[1]:

There is no current assessment available which characterizes the availability or distribution of the high elevation rock outcrop habitat. Owing to the small size, the dispersed nature, and the variability of types of this habitat, we have no means to determine the amount of it available, nor map where it occurs. However, it is certainly one of the most limited habitats in the state in terms of area, and also widely distributed throughout the mountains. High elevation rock outcrops obviously occur only in the highest mountain ranges of western North Carolina, notably in the Great Smokies, Plott Balsams, Great Balsams, Black/Craggy Mountains, Grandfather Mountain, Roan Mountain, and in the Amphibolite mountains of Ashe County. However, depending upon elevation, they can be found scattered just about anywhere that elevations allow. As with its distribution and abundance, we have no current means to assess the current condition of high elevation rock outcrop habitat across the region.

[1]A map of this habitat is not provided, due to scale and sensitivity issues.

Conditions vary, and each site can have a unique set of problems depending upon land ownership, historic uses, and a host of other potential variables that can affect the availability and use of a particular site by various animals. Many, but by no means all of the high elevation rock outcrop sites are found on conservation lands owned by the US Forest Service, National Park Service, and or The Nature Conservancy.

B. Problems affecting species and habitats:

High elevation rock outcrop habitats can be affected by numerous activities and situations, the exact nature of which remain specifically undetermined. Recreational activities such as hiking and rock climbing can have deleterious effects upon the plants and animals associated with the habitat as a result of trampling, habitat alteration, or even presence of people or human activities at or near the sites. Development (primarily housing) can and certainly has had an impact upon both the habitat as well as the species utilizing it. There has been suggestion that air pollution could be having an impact upon the high elevation rock communities of western North Carolina (TNC and SAFC 2000), however there has not been definitive evidence of air pollution impacts upon wildlife species associated with high elevation rock outcrops. However, each site can have a somewhat unique set of problems particular to it, ranging from almost no impact to a high degree of impact. Common threats across the range of high elevation rock outcrops include:

- Recreational activities (climbing and trampling) can have significant impacts upon both the physical characteristics of the site, as well as disrupting behavior patterns of particular wildlife species.
- Development (both recreational development and housing development in particular locations have, and continue to cause direct habitat loss and indirect impacts upon wildlife species dependent upon them).
- Intrusion by alder, rhododendron and other woody plants causing rock outcrops to become overgrown.

Individual wildlife and plant species can be affected by the problems mentioned above, however they may also face additional threats specific to either their particular location or the species itself. For example, timber rattlesnakes face threats in addition to habitat loss including being subject to collection, disturbance of hibernacula/gestation sites, and persecution. There has been considerable effort undertaken in the northeastern United States to determine the impact upon Allegheny woodrat populations from a roundworm parasite that may have impacted populations in that region (McGowan 1993, Stone et al. 1993), though no studies have been conducted within North Carolina to assess the level of threat posed to North Carolina woodrat populations. The decline of peregrine falcons during the last half of the 20th century has been widely attributed to the use of DDT and its concomitant effects on bird reproduction. The use of DDT was banned and peregrine restoration efforts occurred in the late 1980's and 1990's, however peregrine falcons still face threats due to habitat loss to development and recreation impacts at individual cliff sites. Furthermore, the North Carolina population remains at fairly low density, thereby increasing the threat of stochastic events having significant population impacts.

For many plant and animal species associated with high elevation rock outcrops we may not currently know the entire spectrum of threats that are affecting populations due to inadequate levels of study or knowledge. For example, green salamander populations in North Carolina may have experienced dramatic declines during the late 1970's and early 1980's (Wilson 2001). Various theories were promulgated to explain the apparent decline including impacts of air pollution, deforestation, development, disease, and over-collection (see Wilson 2001 for discussion), however there is no definitive cause for the apparent decline, and in fact, we do not really know if an overall population decline occurred or whether isolated impacts upon particular sites caused local declines. There remain many unknown problems which can and will impact high elevation rock outcrop communities and their fauna.

C. Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:

- **Surveys**

– Prioritize surveys for rock shrew, rock vole, coal skink, and timber rattlesnake.

- **Monitoring** .
  - Continue monitoring for green salamander, Allegheny woodrat, and peregrine falcon populations.
  - Initiate long-term monitoring (when baseline surveys permit) for the species mentioned above (rock shrew, rock vole, coal skink, timber rattlesnake).
- **Research**
  - Examine peregrine falcon productivity, contaminant effects (per US Fish & Wildlife Service monitoring plan, 2003), and juvenile dispersal (using satellite telemetry).
  - Examine green salamander habitat use/movements and genetic relationships within/between populations.
  - Examine parasite (*Baylisascaris*) prevalence in Allegheny woodrats.
  - Explore better ways to identify the distribution and characteristics of this habitat across the landscape.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

High elevation rock outcrops are extremely rare, have a very restricted range, and are subject to extreme environmental conditions. All existing habitats of this type should be high priorities for conservation action including:

- Habitat protection site management – closure of sensitive areas at certain times or permanently to stop direct (trampling, loss of habitat to recreation developments (trails, vistas, etc.) and indirect human impacts (disturbance).
- Maintenance of biologically significant areas, including peregrine falcon nesting areas, reptile den sites and significant salamander occurrences.
- Easements and land acquisition (potential for partnerships with NC Natural Heritage Program, The Nature Conservancy, and the NC Plant Conservation Program) to protect from long term impacts such as housing development.
- Management of outcrops to reduce intrusion by alder, rhododendron, and other species, which contributes to the disappearance of some vertebrates.

Supporting References

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US Fish & Wildlife Service (USFWS). 2003. Monitoring plan for the American peregrine falcon, a species recovered under the Endangered Species Act. US Fish & Wildlife Service, Divisions of Endangered Species and Migratory Birds and State Programs, Pacific Region, Portland, OR.

Wilson, C. R. 2001. Status of the green salamander (*Aneides aeneus*) in the Blue Ridge mountains. Masters Thesis. Appalachian State University. Boone, NC.

8. **Low elevation cliffs/rock outcrops** – This habitat category includes areas that are characterized by exposed rock, sometimes supporting forest canopy, but often these areas are too steep or rocky to support a closed canopy. These habitats can be found in the Southern Blue Ridge, but also in some areas of the Piedmont. Often these areas contain patchy vegetation, reflecting the variability in soil depth and moisture content. Seepage may provide some moisture for mosses, lichens, and wetland vegetation. This habitat type contains many different types of communities defined by Schafale and Weakley (1990) including low elevation granitic domes and rocky summits, acidic cliffs, mafic cliffs, and some boulderfields. In addition, many of the wildlife species associated with low elevation cliffs and rock outcrops occur in association with rock outcrops dispersed throughout other forest or habitat types in patches too small to be considered discreet communities of their own.

   Many wildlife species utilize rock outcrop habitat without regard to arbitrary elevational distinction (e.g., peregrine falcon), and others will utilize only high elevation rock outcrop habitats (at least according to what we currently know, e.g., rock voles and rock shrews). However, many wildlife species and even more plant species (Schafale and Weakley 1990) are either associated with high elevation rock communities or low elevation rock communities. The elevation limits for each species, however, are quite variable. Many low elevation rock outcrop species of plants and animals are restricted to ranges outside high elevation areas (e.g., crevice salamanders are only found in and around the relatively low elevation Hickorynut Gorge). Still other wildlife may occur in both high and low elevation rock communities, but for various reasons may reach higher densities or have wider distribution in low elevation rock outcrops (e.g., timber rattlesnakes).

   Some wildlife species may occupy/use low elevation rock outcrop communities, but may not necessarily be restricted to them (e.g., eastern woodrat). Finally, several species are often associated with low elevation rock outcrops, however we may not know the full extent of their range and distribution, nor specific factors that result in their selection of low elevation rock outcrops. The result is a wide array of animal species associated with low elevation rock outcrop communities, with varying degrees of exclusive use. Nonetheless, there are several wildlife species often associated with our generalized low elevation rock outcrop habitat.

Priority species associated with low elevation cliffs/rock outcrops:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Falco peregrinus*	Peregrine Falcon	E
Mammals	*Myotis leibii*	Small-footed Bat	SC
	Myotis septentrionalis	Northern Long-eared Bat	SC
	Neotoma floridana haematoreia	Eastern Woodrat	SC
	Spilogale putorius	Eastern Spotted Skunk	
Amphibians	*Aneides aeneus*	Green Salamander	E
	Plethodon longicrus	Crevice Salamander	SC
	Plethodon ventralis	Southern Zigzag Salamander	SC
Reptiles	*Crotalus horridus*	Timber Rattlesnake	SC
	Eumeces anthracinus	Coal Skink	

A. *Location and condition of habitat[1]:*

As with high elevation rock outcrop habitats, there is not currently a standardized definition of this habitat, nor capability to map and assess condition at each of these relatively small and dispersed habitats throughout western North Carolina. This habitat type is spread throughout the Mountains and upper Piedmont Region of the state (Piedmont examples include Sauratown Mountains inclusive of Pilot Mountain, the Crowders, the Uwharries, and South Mountains). Some specific sites have been characterized and studied, but many more have not, owing to their not being restricted to specific elevation or mountain ranges. They can and do occur just about anywhere in western North Carolina. Conditions also vary considerably within this habitat type, with a significant number having been impacted and/or lost due to numerous factors, while others remain functional "natural sites" and others yet specifically managed to minimize human impacts..

B. *Problems affecting species and habitats:*

As with high elevation rock outcrops, the two major problems most associated with the low elevation rock outcrops include development and recreational impacts. However, many more low elevation rock outcrops are subjected to short term habitat alterations (e.g., forestry operations) than high elevation rock outcrops due to land ownership patterns, proximity to markets, accessibility, and other factors. The extent and degree of impact associated with such temporary habitat alterations is unclear for most species. Regardless of the impacts or problems associated with short-term habitat modifications, the relative scarcity of low elevation rock outcrop habitat across the landscape of North Carolina, and reliance upon it by numerous wildlife species lends greater significance to the need to identify and manage these habitats appropriately to conserve wildlife.

Individual wildlife species associated with low elevation rock outcrops are subject to specific conditions of their habitats or their life histories and biology, which could be considered problems, depending upon the scale, location, extent, and duration. Many of the problems identified for high elevation rock outcrops and their associated species can impact species inhabiting low elevation rock outcrops (see discussion under "high elevation rock outcrops").

C. *Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:*

- **Surveys**
  - Conduct surveys for the southern zigzag salamander, crevice salamander, green salamander.
  - Conduct bat surveys (survey appropriate habitats for hibernacula or summer roosts).
  - Intensify efforts to determine eastern spotted skunk range and status.
  - Survey/develop baseline status and distribution information for coal skink, timber rattlesnake, peregrine falcon.
- **Monitoring** .
  - Continue annual monitoring of peregrine falcon nest cliffs to assess population status.
  - Establish protocols and regularly monitor green salamander and eastern woodrat.
  - Establish protocols and monitoring system for all priority wildlife species associated with low elevation rock outcrops upon completion of baseline inventories/surveys.
- **Research**
  - *See green salamander and peregrine falcon research needs under "High elevation rock outcrop" section*.
  - Study the impact of various management scenarios on the habitat and associated species.
  - Explore ways to identify the distribution and characteristics of this habitat across the landscape.

[1]A map of this habitat is not provided, due to scale and sensitivity issues.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

Given the relative rarity of low elevation rock outcrops across the state, measures need to be taken to conserve as much of this habitat as possible. This includes preservation measures, as well as conservation/management measures to ensure that species which rely upon these outcrops continue to be afforded the variety of habitat conditions desired into the future. Certainly a high priority should be placed upon acquisition or easement of land tracts which support low elevation rock outcrops due to the fact that they are not abundant, they have numerous rare plant and animal associates, and remaining sites are subject to significant threats associated with both recreational and other development pressures.

In addition, conservation actions that are necessary include assigning appropriate management schemes to rock outcrops upon conservation lands to minimize negative impacts from human activities including recreational use and development. Appropriate restrictions upon use of the areas need to be developed where none currently exist to minimize the direct impact upon the habitat and its occupants. The results of studies on the impact to low elevation rock outcrops from surrounding habitat modification should be incorporated into appropriate management recommendations to minimize impacts upon wildlife species utilizing the rock outcrop. Mapping of these sites in a GIS format would facilitate tracking changes over time in both the habitat, as well as the associated species; and facilitate landscape scale management of this rare habitat. Maintenance of biologically significant areas, including peregrine falcon nesting areas, reptile den sites and significant salamander occurrences, is critical.

Supporting References

Bailey, M. A., J. N. Holmes, and K. A. Buhlmann. 2004. Habitat management guidelines for amphibians and reptiles of the southeastern United States (DRAFT). Partners in Amphibian and Reptile Conservation.

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Schafale, M. P., and A. S. Weakley. 1990. Classification of the natural communities of North Carolina, third approximation. N.C. Department of Environment and Natural Resources, Natural Heritage Program, Raleigh, NC.

9. **Caves and mines** – Caves are found scattered across the Southern Blue Ridge physiographic province, and some do occur in other regions of the state as well. There are several different types of caves, however the most common types of caves are solution caves, fissure caves, and rock shelter/boulder caves. These types differ primarily in the way they are formed. Solution caves are created by the action of water, dissolving the underlying rock to form tunnels. Over time, solution caves get larger and larger and are generally the most extensive (size and length of passage). There are a few areas of North Carolina with underlying limestone geology which lend themselves to solution cave formations. Most notably the Nantahala Gorge and North Fork Catawba River/Linville Mountain area of western North Carolina and parts of the coastal plain are underlain with limestone (marble, dolomite, and marl respectively).

   Fissure caves are formed by movement of the earth's surface which results in cracks of the rock layers. Depending upon the actual events which spawn the development, fissure caves have varying sizes and configuration. Fissure caves occur in many places in North Carolina, though one of the most well known (in fact one of the largest known fissure cave systems in the world) occurs in Hickorynut Gorge in Rutherford County (Cato Holler, pers. comm.).

   Rock shelter/boulder caves are formed by erosive forces, weather events, earth surface movements and other factors, which essentially leave spaces underneath/behind surface rock. The vast majority of caves in North Carolina are rock shelter/boulder caves. Owing to their diversity of formation, differing geology, and range in the state, caves in North Carolina are quite variable in terms of both the plant and animal communities adapted to, and found in them.

   In addition, an extensive mining history in North Carolina has provided numerous subterranean excavations which can and do mimic environmental conditions of natural caves. Like caves, mines come in many shapes and forms, depending upon numerous factors. There are many mines which do not provide conditions similar to those found in caves such as open pit mines, strip mines, and quarries. Our definition of the caves and mines habitat type is intended to include only mines which include subterranean excavations such that conditions inside the mine shafts and tunnels resemble conditions in caves. That being said, the range of variability of those conditions is extensive.

Priority species associated with caves and mines:

Group	Scientific Name	Common Name	State Status (Federal Status)
Mammals	*Corynorhinus rafinesquii*	Rafinesque's Big-eared Bat	T
	Corynorhinus townsendii virginianus	Virginia Big-eared Bat	E (E)
	Myotis grisescens	Gray Bat	E (E)
	Myotis leibii	Small-footed Bat	SC
	Myotis septentrionalis	Northern Long-eared Bat	SC
	Myotis sodalis	Indiana Bat	E (E)
	Neotoma magister	Allegheny Woodrat	SC
Amphibians	*Eurycea longicauda*	Longtail Salamander	SC

A. Location and condition of habitat[1]:

As mentioned previously, caves and mines are found throughout North Carolina. The majority of documented caves occur understandably in the Mountain Region of western North Carolina, though there are some caves present in all regions of the state, including the coastal plain. The North Carolina Cave Survey has documented over 1,300 caves in the state (Cato Holler, pers. comm.). We have no accurate assessment of the availability of abandoned mines in North Carolina, and certainly have no idea as to their individual suitability for use by cave dwelling animals or plants. Certainly, some portion of the mines do function similarly to caves in

[1]A map of this habitat is not provided, due to scale and sensitivity issues.

providing the range of microhabitat conditions which cave obligate species need. Usually, the larger the mine excavations and the air volume within are important correlates of use by cave dwelling animals. Many smaller mines do support minor levels of use, or use by small numbers of individuals, however the bigger the mine, the bigger the chances for it to be used by wildlife (particularly bats of various species).

Given the variability in cave types, mine types, and a host of different substrates, orientations, positions on the landscape, etc., the condition of caves and mines in North Carolina is quite variable. Caves and mines occur across all land ownership types. Several of the most significant sites have received attention in the past to protect resources (wildlife or geological in most cases). At least three caves and two mine complexes currently have bat friendly gates installed to prohibit or regulate human entry and subsequent impacts upon cave resources. Various surveys and investigations have been conducted in many caves and mines in attempts to document significant wildlife or geological resources, though no comprehensive evaluation has ever occurred. Certain wildlife groups (i.e. bats) have been surveyed in a portion of the caves on an irregular schedule over the past couple of decades. Therefore, not only is the condition of caves and mines quite variable in North Carolina, but our state of knowledge about the use of caves and mines by plants and animals is extremely variable.

B. *Problems affecting species and habitats:*

In many states, and throughout the world, many caves have been developed into tourist attractions, often with lighting, tours, gates, etc. All of these activities have resulted in both habitat conditions for cave dwelling animals, as well as disrupted normal behavior patterns, effectively eliminating habitat for many cave animals. In the Southern Blue Ridge Ecoregional Conservation Plan, recreation is the greatest threat to cave and cave species conservation (TNC and SAFC 2000). That would include both developed tourist caves, as well as recreational caving/exploration. Thus far, only one cave complex has been developed as a recreational destination in North Carolina, however you would be hard-pressed to find a cave or mine that doesn't experience some level of human visitation. Many of the wildlife species that use caves, if not the caves themselves have been and continue to be impacted by human activities including both direct impacts (e.g., repeated disturbance during bat hibernation), as well as indirect impacts (e.g., habitat changes that make microhabitat conditions inside the cave or mine unsuitable).

In addition to the recreational impacts, certainly many smaller caves and mines have most assuredly been impacted by development. However, there is little to no documentation of this actually having occurred. Nonetheless, given the amount of development that has occurred in North Carolina over the last century, it seems very likely that at least some cave habitat has been impacted.

C. *Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:*

- **Surveys**
  - Conduct bat surveys in caves and mines that have not been previously evaluated.
  - Survey for potential nesting birds in caves such as turkey vulture, black vulture and common raven..
- **Monitoring**
  - Establish and implement long term monitoring protocol to document bat use of significant cave/mine roosts.
  - Develop protocols and procedures for long-term bat banding study and data storage throughout the state.
  - Establish protocol for periodic monitoring and assessment of Allegheny woodrat populations.

- **Research**
  - Longtail salamander research: in some areas of its range, the longtail salamander occurs often associated with caves, or portions of caves. No investigation of its habitat use has ever occurred in North Carolina, and could be undertaken in conjunction with more generalized research on this species distribution, status and habitat in the state.
  - Consider studies to document maternity sites used by bats from specific hibernacula (e.g., find maternity colonies utilizing radio telemetry of individual Virginia big-eared bats that hibernate in known caves/mines, or track any Indiana or gray bats captured to their maternity sites or hibernacula).

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

We must develop a comprehensive, prioritized list of significant caves including the factors which add significance (e.g., roost of endangered bats, rare geologic formations, other rare plants or animal use). We must also acquire additional cave habitat through purchase, conservation easement, or other perpetual management agreements (potential for partnerships with NC Natural Heritage Program, The Nature Conservancy). Lastly, we must pursue the development of plans for protection of caves where necessary to protect roosting bats or other cave resources, where feasible, and where cost effective (e.g., gating like at Cranberry Mine, limiting access).

Supporting References

Bailey, M. A., J. N. Holmes, and K. A. Buhlmann. 2004. Habitat management guidelines for amphibians and reptiles of the southeastern United States (DRAFT). Partners in Amphibian and Reptile Conservation.

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10. **Bogs and associated wetlands** – This habitat type is a complex of multiple natural communities found throughout the western portion of the state. These include: swamp forest-bog complex, Southern Appalachian bog, Southern Appalachian fen, Hillside seepage bog, high elevation seep, and meadow bogs. In addition, these wetlands can be contained in landscapes of montane/piedmont alluvial forest and contain floodplain pool communities (Schafale and Weakley 1990). In some areas, beavers play a significant role in shaping the hydrologic and vegetative characteristics of these wetlands. Various ecologists, botanists, biologists and others can and do distinguish among these various communities, depending upon the species composition, hydrology, soils, or structure of the vegetation. Because of the complex nature of these communities, the interspersion of them, and the fact that they support many wildlife species in common, they are treated similarly under the habitat category of bogs and associated wetlands, and will be henceforth commonly referred to as "mountain bogs," regardless of whether they occur in the Southern Blue Ridge or upper Piedmont physiographic provinces.

    Mountain bogs are among the rarest communities in the Southern Appalachians and in North Carolina. Unlike northern bogs of glacial origin, mountain bogs form in poorly drained depressions or on gentle slopes, generally in relatively flat valley bottoms that are not subject to flooding. They are often small (less than 2 acres), dispersed, and hydrologic regimes are quite varied from site to site. Most often they are fed by seepage or springs, however some are associated with beaver activity and thus impoundment of surface waters. Small remnant bog communities can also be found in the headwater areas of some artificial impoundments as well. Some are permanently wet, some intermittently dry, and still others contain both wetter and dryer areas. Generally, they are underlain by wet organic or mucky mineral soils, which are very acidic, though a few can be relatively basic (NCNHP 2001).

    Vegetation is quite variable in mountain bogs. True Southern Appalachian bogs contain a very diverse mix of herbaceous and woody vegetation. Other types of mountain bogs are dominated by herbaceous vegetation only. The exact composition of vegetation is dependent upon numerous factors including, but not limited to: hydrology, soils, geographic location, disturbance history, current land use activities, and other factors. In fact, the hydrology and current land use of particular sites may be the most important factors that determine the current vegetation composition and structure of mountain bogs. For some, natural hydrologic factors result in what appears to be a relatively stable plant community (at least in the short term) dominated by herbaceous vegetation and sphagnum. Others seem to be more subject to natural successional processes that may, over time, shift the communities from open, herbaceous dominated areas towards more wooded communities like swamp forests or alluvial forests. Beavers have played a significant role in the formation and maintenance of many mountain bogs (Somers et al. 2000). While the role of beavers in creating and maintaining wetlands across the regional landscape can be debated in terms of its historical extent and impact, it is certain that they have had a role in shaping the availability of various wetland types across the Southern Appalachian landscape. Human activities such as livestock grazing play a major role in the current vegetation makeup of mountain bogs.

    The variability of the sites, their hydrology, and their current condition make a listing of plant species difficult, and potentially misleading, since each site can be quite different. However many species of plants, in various combinations, are associated with mountain bogs. Shrub species common to many mountain bogs include rhododendron, alder, rose, and poison sumac. Tree species may include red maple, white pine, hemlock, pitch pine, river birch, and occasionally red spruce. Herbaceous vegetation commonly includes many species of *Juncus* and sedge along with numerous herb species, and sphagnum mats. At least four federally endangered plants are associated with mountain bogs. Numerous other herbaceous plants and several animal species that are state-listed or rare are also associated with mountain bogs, including the bog turtle, mole salamander, four-toed salamander, and alder flycatcher. Mountain bogs, though very limited in their distribution and availability across the landscape are one of the most significant habitat types of the state for rare plants and animals (TNC and SAFC 2000), and they support a disproportionate amount of the overall composition of plants and animals found here as well.

Priority species associated with mountain bogs and wetlands:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Empidonax alnorum*	Alder Flycatcher	SR
	Empidonax traillii	Willow Flycatcher	
	Vermivora chrysoptera	Golden-winged Warbler	SR
Mammals	*Microtus pennsylvanicus*	Meadow Vole	
	Zapus hudsonius	Meadow Jumping Mouse	
Amphibians	*Ambystoma maculatum*	Spotted Salamander	
	Ambystoma opacum	Marbled Salamander	
	Ambystoma talpoideum	Mole Salamander	
	Eurycea guttolineata	Three-lined Salamander	
	Hemidactylium scutatum	Four-toed Salamander	
Reptiles	*Clemmys muhlenbergii*	Bog Turtle	
	Thamnophis sauritus sauritus	Common Ribbonsnake	

A. Location and condition of habitat[1]:

As defined, mountain bogs encompass many diverse habitats throughout the western portion of the state. Historically, more attention has been paid to bogs and wetlands of the Mountain Region than those of the Piedmont, with a few exceptions. Many of the bogs (of various types) within the mountains have been identified and studied, owing to the number of rare plants and animals associated with them. However several upper Piedmont bogs and wetlands have been identified and studied as well. Perhaps less well studied have been Piedmont region wetlands that fall outside the known range of rare species, or in other wetland habitats found more commonly throughout the Piedmont, such as Piedmont alluvial forests, swamps, and upland pools. Within the Southern Blue Ridge province, the Southern Appalachian Assessment (SAMAB 1996) identified over 72,000 acres of wetlands. This figure represents less than 1% of the Southern Appalachian landscape. Certainly, not all of these wetlands can be considered mountain bogs, however, depending upon numerous factors and processes, much of that acreage could support similar suites of plants and animals most often associated with mountain bogs. In addition, many mountain bogs were not included in the Southern Appalachian Assessment due to their small size and their inability to be detected through the remote sensing tools applied in the assessment (Landsat imagery). The US Fish & Wildlife Service (2002) estimates that at one time there were 5,000 acres of bogs in North Carolina. Depending upon the classification methods used for wetlands or bogs, estimates of mountain bog habitat availability are quite variable. Nevertheless, mountain bogs comprise a small fraction of the landscape of the region.

Mountain bogs (and 'meadow' bogs) are distributed throughout the Mountain and upper Piedmont of North Carolina, with examples as far east as Forsyth and Gaston Counties. Most of the known occurrences of them are situated along (both above and below) the Blue Ridge escarpment, or in the northwestern (Ashe and Alleghany) and southwestern (Cherokee, Macon, Clay) counties. Over 60% of the SAA wetlands identified (SAMAB 1996) occurred on privately owned lands. It is likely that overall, the percentage of mountain bog habitat in private ownership is even greater than that.

The condition of mountain bogs is quite variable. What is clear, however, is that significant amounts of mountain bog habitat have been converted to other uses, primarily through draining, filling, or impoundment. Some estimates indicate that fewer than 500 acres of mountain bogs in North Carolina remain (USFWS 2002). Again, regardless of how they are

[1]A map of this habitat is not provided, due to scale and sensitivity issues.

defined, mountain bogs have suffered dramatic declines at the hand of humans. There are examples of various types of mountain bogs remaining that provide a reference for the "natural" condition of these habitats, however there is much debate as to what constitutes natural conditions due to both anthropogenic and other forces involved. Situations such as beaver control and fire suppression by humans may not have occurred at all mountain bog sites, but their indirect impact upon mountain bog habitats through facilitation of secondary succession certainly has occurred at some sites. In general, some bogs support a mix of open and closed canopy, maintained by hydrology, elevation, and other natural factors. Others may be open canopied (dominated by herbaceous vegetation) due to active management of vegetation or other land uses (grazing). Many are certainly affected by hydrologic changes (i.e. ditches or drains), but retain some of the functional qualities and wildlife habitat of their former states.

B. Problems affecting species and habitats:

Many things have had an impact upon the availability of mountain bogs. Certainly, a significant number of bogs have been destroyed to make way for industrial, commercial and residential development. Agriculture in North Carolina, both historically and currently, plays a significant role in the availability and condition of mountain bogs. Numerous bogs have been destroyed by agricultural practices including draining, filling, or pond creation. However, many of the remaining mountain bogs are located on agricultural lands dominated by livestock grazing. In fact, most of the more productive bog turtle sites that remain today are found upon grazed lands. This could be due to many factors, though certainly grazing by livestock retards or even stops the successional process in some wetlands, therefore maintaining the open conditions that bog turtles and other bog species require. Mowing and prescribed burning of certain bogs has had similar effects in some cases. This is not to suggest that agricultural management should be prescribed for all mountain bogs. Clearly some activities are detrimental, though agricultural practices can be helpful tools in managing mountain bog habitats in some situations.

The largest scale problem affecting mountain bogs and wetlands in general has been and continues to be the conversion of these habitats to other land uses. Whether for agriculture or other types of development (roads, housing, or other development), significant amounts of mountain bog habitat have been destroyed. In some cases destruction has been complete removal of the habitat from an area. In other cases, it has been focused on altering the hydrology through ditches or pipes, or even conversion to small ponds. In addition to the direct impact of habitat loss on the species occupying sites that are destroyed, there are secondary impacts upon populations of such species associated with them becoming more isolated from each other. Many mountain bogs are small in size, though often situated upon the landscape in such a manner as to be hydrologically connected. These connections support important movement corridors for wildlife from one small site to another, thus creating local populations of particular species not associated with a single site, but a larger complex of sites within the drainage. Therefore, loss of even small sites within a local population can have an impact, which in turn can affect the overall population of the particular species.

A significant problem for some mountain bogs, or at least for some species associated with them (i.e. bog turtle), is secondary succession of the plant communities at particular sites. This is not a problem at all sites, however succession does change community composition of certain sites, in terms of both the plants and animals found there. Some of the wildlife species associated with mountain bogs require open, herbaceous habitat (bog turtle, golden-winged warbler, meadow vole, meadow jumping mouse, bog lemming) while others prefer closed canopy wetlands (salamanders). Many species are found in mountain bogs with mixtures of open areas and shrubby areas, with a few trees. When succession is allowed to proceed open areas often become shrubby, followed over time by the development of closed canopy swamp forests. Regardless of the factors responsible for allowing succession to proceed (fire suppression, hydrologic diversion, or other disturbance factors), many bogs that formerly provided either open or mixed open/shrub habitat are becoming closed canopy swamps, thus becoming unsuitable for many mountain bog dependent species of wildlife.

The priority amphibians associated with mountain bogs are all salamanders, though there certainly are a much larger number of amphibians found in mountain bogs. These salamanders, for the most part (mole, four-toed, marbled, three-lined, and spotted salamanders) require pools of water for breeding purposes. They are associated with mountain bogs, to the extent that mountain bogs (as defined here) often contain pools of water that are utilized as breeding habitat. Their association with mountain bogs is less related to the bog being spring fed, muddy, or with specific plant associations than many of the other priority mountain bog species. These species are more suited to treatment of their threats/problems within the depression communities habitat type. Nevertheless, loss of wetland habitat in general is a significant problem for these species.

C. *Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:*

- **Surveys** – For many of the priority species associated with mountain bogs, we do not have a clear understanding of their current distribution within the state. We must undertake surveys to gather baseline information on the distribution and status of most of these species.
  - Prioritize species that are state or federally listed as endangered, threatened, or special concern (bog turtle, mole salamander, four-toed salamander), or those often utilizing mountain bog habitats (Alder flycatcher).
  - Secondarily prioritize species facing significant threat, thought to be declining, or those for which we have limited information on their distribution and status (golden-winged warbler, willow flycatcher, American woodcock, rails, meadow jumping mouse, spotted salamander, marbled salamander, three-lined salamander, common ribbonsnake).
  - Work to develop a model to predict habitat for bog turtles, based on characteristics at known localities; this could lead to additional survey sites for other bog herpetofauna.
- **Monitoring** – Once we have completed surveys to determine the distribution and status of these priority species, efforts must shift immediately towards long term monitoring of their populations. In some instances it may take years of study to determine the complete distribution and status of a given species. Given the limited availability and threats facing mountain bog habitat, considerable effort needs to be expended to determine if populations are increasing, decreasing, or remaining stable. Particularly for species that are state or federally listed or thought to be declining, we must establish long-term monitoring efforts to learn what is happening not only within local populations, but on a regional or range-wide basis. It will be imperative to have this information both for planning conservation measures as well as gauging the success of measures undertaken.
- **Research** – Specific research needs are innumerable regarding these species and their habitat relationships.

  Genetics
  - Genetic studies to determine degree of gene flow between populations and to assess overall population health for species restricted to this habitat (i.e. bog turtle), given the isolated nature of mountain bogs.
  - Genetic studies of other priority species to examine degree of isolation.

  Habitat
  - Document the habitat relationships of priority species; for most species, we do not know how dependent they are upon mountain bog habitats, relative to other habitat types.
  - Determine of the microhabitat preferences and requirements of species utilizing mountain bogs. We must document whether specific hydrological and biological requirements of these priority species are being met under current management regimes, and to do that we must understand how these species are utilizing the habitat.

Management practices

- Examine the effects of different management strategies upon various taxa to document effective measures to manage these habitats into the future (e.g., determine the impact of various controlled grazing regimes or physical removal of woody vegetation).
- Investigate the potential of beavers to create bogs and associated wetlands when previously none occurred; or where beavers were removed, research the possibility of reintroducing the species to these habitats to create wetland habitat.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

First and foremost we must establish frameworks for gathering the information required to substantiate all conservation actions that we might undertake. The baseline surveys, population trend data, and habitat relationships are the foundation of knowledge upon which all future conservation actions must be undertaken. That does not mean that other conservation measures are not needed immediately. On the contrary, given what we do know about the limited availability and threats facing mountain bogs, we need to begin now with both information gathering as well as habitat protection measures. Habitat protection measures necessary throughout the planning horizon need to focus upon utilizing existing regulatory frameworks to protect both the habitat and these species (e.g., state and federal endangered species laws, wetland protection laws, etc.). Government conservation programs and incentives (e.g., Farm Bill programs) and partnerships with private landowners need to be fully utilized to stem the conversion of suitable bogs to other uses. Since those measures are not available or effective for all species or situations, aggressive steps to acquire conservation ownership of mountain bogs should be actively pursued in concert with state and federal agency partners (e.g., US Fish & Wildlife Service, US Forest Service, National Parks Service, Natural Resources Conservation Service, NC Division of Parks, NC Natural Heritage Program, local governments, etc.) as well as private conservation partners (e.g., The Nature Conservancy, land trusts). Recently completed soil survey mapping efforts may assist partners in identifying wetland soils, to prioritize potential restoration sites (considering size, adjacency, and other factors).

As conservation ownership of mountain bogs increases, we must devise programs or processes to facilitate the dissemination of information and guidance, as well as implementation of actual land management practices upon such lands to effectively maintain suitable habitat for the species dependent upon mountain bogs. Specific bog management needs include the control of woody encroachment and succession, the maintenance (and where necessary, restoration) of natural surface water and groundwater hydrology (using ditch plugs, temporary dams, level spreaders, or other engineering devices), the restoration of herbaceous vegetation, and the prohibition of take of rare bog-related species (e.g., bog turtle). We already know that passive management of these sites can lead to their loss through succession. We must establish the framework and means to ensure that management of these sites takes into account all the habitat needs of the species, and focuses upon providing for those needs in a cost effective, sustainable manner into the future. In some cases, habitat protection and management may not be sufficient to sustain populations or re-establish them. Measures necessary to re-introduce species at specific locations, under proper management scenarios may need to be examined and implemented to ensure healthy geographic and genetic populations are sustained.

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11. **Floodplain forest** – Floodplain forests of the Southern Blue Ridge physiographic province in western North Carolina are ecologically rich and diverse. Montane floodplain forests are relatively narrow and do not contain well-developed levees, sloughs and ridges. They are generally restricted to larger streams and rivers with relatively low gradients, since smaller, high gradient streams often do not have representative floodplains, but instead have riparian zones embedded within other habitat types. They are subject to sporadic high-intensity flood events of short duration. The most common ecological communities associated with floodplain forest in the Mountain Region are montane alluvial forest and piedmont/low mountain alluvial forest. However, floodplain forests of the mountains often contain small amounts or isolated patches of swamp forest, swamp forest-bog, floodplain pools and semipermanent impoundments (Schafale and Weakley 1990).

    In these floodplains, the forest canopy contains a mixture of bottomland and mesophytic (moderately moisture tolerant) species including eastern hemlock, yellow poplar, yellow birch red maple, and others. In areas where floodplain landforms are apparent, levees may contain sycamore, river birch and box elder. Common shrub layer components include rhododendron, dog-hobble and alder. Herb layers can be quite different from site to site. Floodplain pools that occur in small depressions and are flooded for a portion of the year are important sites for breeding amphibians.

Priority species associated with montane floodplain forest:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Coccyzus americanus*	Yellow-billed Cuckoo	
	Limnothlypis swainsonii	Swainson's Warbler	
	Oporornis formosus	Kentucky Warbler	
	Wilsonia citrina	Hooded Warbler	
Mammals	*Myotis sodalis*	Indiana Bat	E (E)
	Sorex fumeus	Smoky Shrew	
Amphibians	*Ambystoma maculatum*	Spotted Salamander	
	Ambystoma opacum	Marbled Salamander	
	Ambystoma talpoideum	Mole Salamander	SC
	Desmognathus aeneus	Seepage Salamander	SR
	Eurycea guttolineata	Three-lined Salamander	
	Eurycea junaluska	Junaluska Salamander	T
	Eurycea longicauda	Longtail Salamander	SC
	Hemidactylium scutatum	Four-toed Salamander	SC
	Plethodon glutinosus sensustricto	Northern Slimy Salamander	
	Pseudacris brachyphona	Mountain Chorus Frog	SC
Reptiles	*Clemmys muhlenbergii*	Bog Turtle	T (T)
	Crotalus horridus	Timber Rattlesnake	SC
	Heterodon platirhinos	Eastern Hog-nosed Snake	
	Lampropeltis getula getula	Eastern Kingsnake	
	Terrapene carolina	Eastern Box Turtle	

A. Location and condition of habitat (see Map 5A.11):

Floodplain forest is a difficult habitat to characterize and quantify, owing to the terminology used by different individuals to identify this habitat type. Often, floodplain forest, riparian forest, and bottomland forest are used interchangeably to describe habitats associated with mountain waterways. While they can refer to the same habitat, they do not necessarily refer to the same habitat. Furthermore, many of the wildlife species associated with mountain floodplain forest are not restricted to floodplains, but will utilize them and a variety of other mountain habitats. Therefore, floodplain forest habitat for the purposes of this plan should be broadly interpreted to include a range of ecological communities defined by Schafale and Weakley (1990), but generally occurring on floodplains or immediately adjacent to waterways.

There is no single estimate of the amount, nor an assessment of the condition of floodplain forest condition in the mountains. Estimates of bottomland hardwood forest for the Southern Appalachian Assessment exceed 450,000 acres (SAMAB 1996), and Partners in Flight estimates 65,000 acres of lowland riparian woodlands in the southern blue ridge (Hunter et al. 1999). However, these estimates were for habitats defined differently, that encompassed different regions of the Southern Appalachians. The fact is, we do not know how much floodplain forest we truly have in western North Carolina. What we do know is that historic development patterns and land uses have taken a disproportionate toll on the availability of floodplain forest in the region, for the simple fact that it is the flattest land around, and therefore most amenable to both agricultural uses as well as development for transportation, housing, and urban development. No matter how it is characterized, floodplain forest is currently in short supply in western North Carolina. There remain a few examples of functional floodplain forest along major rivers in the region primarily upon private lands, and a greater amount of more generalized riparian forest associated with smaller streams upon conservation lands, such as those owned by state and federal government agencies.

B. Problems affecting species and habitats:

In a word, the biggest factor that has had a negative impact upon floodplain forest habitat and consequently the wildlife associated with it is development. There is no question that the river and stream valleys of the Mountain Region have historically supported the bulk of agricultural activities, transportation development, hydroelectric facility development, commerce, and urban development. That has led to a number of different effects upon the habitat that include direct loss, habit fragmentation, altered hydrology, and others. Each of these has affected the entire assemblage of species that utilize floodplain forest to one degree or another. However, most of the species associated with floodplain forest will utilize other habitat types, and have been able to survive even in the face of dramatic loss of habitat.

Floodplain forests, are particularly important habitats for breeding amphibians in the region, mainly due to the inclusion of floodplain pools, and semi-permanent impoundments (i.e. beaver ponds), in our definition of the habitat. These temporarily flooded areas are critical breeding habitat for species such as marbled, mole, four-toed, and spotted salamanders. Likewise they can be critical for breeding to other amphibians such as chorus frogs, wood frogs, etc. Floodplain pools within floodplain forests have been directly impacted by conversion to other land uses, but also indirectly lost due to our development of water control structures (mostly combined with hydroelectric facilities) which have reduced the frequency, duration, and magnitude of flood events. That, in turn has had a number of direct impacts upon the habitat: pools don't get filled or get filled less frequently, vegetation structure and composition changes as a result of lost flood events as well. All of these have impacts upon the entire suite of species which formerly occupied or used floodplain forests.

Often, our approach to managing habitats within floodplains or riparian zones is dictated by other factors which are critically important, such as water quality considerations. However, this combination of management strategies can lead to such situations as floodplain forests becoming homogenous in structure/and composition, partly due to a lack of water quality protection, partly due to historic land use/clearing, and partly due to the diminution of flood regimes.

The result can be a lessening of microhabitat diversity within floodplains, and the concomitant impact on the assemblage of species utilizing floodplain forests.

Other problems affecting particular species that utilize floodplain forests include geographic and genetic isolation (e.g., mole and four-toed salamanders, bog turtles) and small ranges of particular species such as Junaluska and longtail salamanders and mountain chorus frogs. These factors, the limited availability of existing floodplain forest, and others constitute a significant conservation concern for many floodplain forest species.

C. *Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:*

- **Surveys** – The first priority towards developing conservation strategies for floodplain forest wildlife is to enhance our current understanding of the distribution and status of the species which utilize this habitat, as well as the availability of the habitat itself. Status surveys are needed to gather current baseline information on all species, though priority should be given to species that are considered rare, or thought to be declining (e.g., Indiana bat, mole salamander, seepage salamander, Junaluska salamander, longtail salamander, four-toed salamander, mountain chorus frog, bog turtle, timber rattlesnake). Secondary priority for surveys should be concentrated upon species for which we have little current information about status and distribution, though they are thought to be more common (e.g., Swainson's warbler, Kentucky warbler, hooded warbler, Louisiana waterthrush, Baltimore oriole, warbling vireo, smoky shrew, spotted salamander, marbled salamander, three-lined salamander, slimy salamander, eastern hognose snake, eastern kingsnake).
- **Monitoring** – We must begin gathering information about population trends for all priority species associated with floodplain forests (considering new techniques for those that are not adequately sampled through existing methods). Again, we must initially concentrate on perceived rare or declining species, but eventually include all priority species. These forests are often heavily used by migrant birds and should be targeted for establishment of both MAPS and migration banding stations, as well as regular monitoring efforts (e.g., cover boards, egg mass counts, etc) for other priority species groups, such as amphibians. .
- **Research** – Research priorities include many potential topics/questions related to the species themselves, as well as species-habitat relationships. There remain many questions about the genetic status of species ascribed to floodplain forest habitats that need to be addressed such as degree of isolation of populations (e.g., longtail salamanders, mountain chorus frogs, mole and four-toed salamanders). For most of the priority species we do not have a clear understanding of species/habitat relationships to determine how critical maintenance of floodplain forest habitat or its management is to population or species sustainability. The relative importance of floodplain forest habitat compared to other habitats is generally lacking for many of the priority species and needs to be studied, such that conservation measures can be targeted for the species with the most specific requirements for floodplain forest habitat, as opposed to more generalized habitats. Investigations of the impacts and effects of beaver ponds on various floodplain forest species may also be warranted.

D. *Conservation actions necessary to conserve the species and habitat and priorities for implementation:*

Conservation actions that are necessary for both the species and the habitat include more detailed study of status, trends and species specific habitat use, as well as general protection and management measures for floodplain forest habitats. As with most wildlife habitats today, the level of threat to remaining floodplain forests from development or conversion to other land uses remains a significant factor in the future sustainability of wildlife species and populations. Contiguous, unfragmented gradients between floodplain forest and adjacent upland sites are essential to many amphibian and reptile species in providing foraging habitat, hibernation sites, and refugia during high water events (Bailey et al. 2004).

Protection and restoration of the remaining floodplain forest in the region needs to be a high priority for conservation agencies and organizations from numerous perspectives, including both maintenance of water quality, as well as aquatic and floodplain forest wildlife. These priority protection measures include, but are not limited to acquisition of floodplains (through purchase, easement, or other legal means such as management contracts), restoration of floodplain systems, or other legal measures (e.g., buffer rules). The Little Tennessee River valley has good restoration potential in the region, especially with the recent protection of the Needmore Tract (an acquisition made possible through a partnership of the Ecosystem Enhancement Program, the Clean Water Management Trust Fund, the Natural Heritage Trust Fund, the US Fish & Wildlife Service, The Nature Conservancy, the Land Trust for the Little Tennessee, and the Commission).

In addition, we need to place a high priority upon understanding the habitat relationships of floodplain wildlife, such that an active role can be pursued by conservation agencies and organizations in provision of technical guidance related to management of floodplain systems over space and time. We need to better understand the relationships such that we can develop and implement management strategies to mimic natural processes of flooding, which have been altered due to human activities or land use. For example, in the absence of periodic flooding, due to upstream water control, coupled with historic land use and current water quality regulations and recommendations, are we developing homogenous floodplain forests that are not as diverse floristically or spatially to accommodate use by the full array of wildlife that once occurred across the landscape. We need to study both the situation, and the potential remedies, including both our management of the water and surrounding forest to ensure that floodplain forests of the future do in fact provide the full range of requirements to conserve floodplain forest wildlife.

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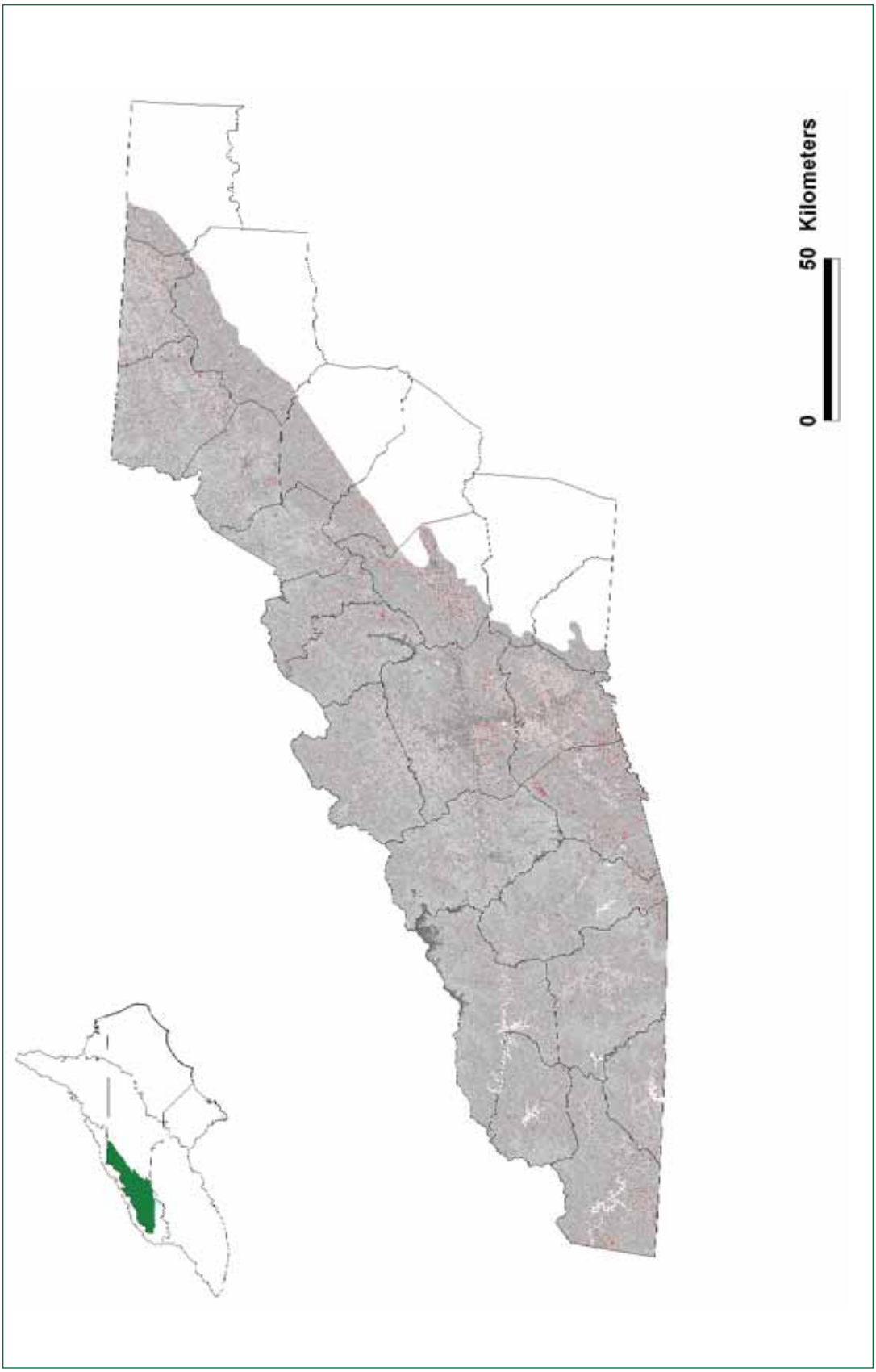

Figure 5A.11. Floodplain forest habitats in the Southern Blue Ridge ecoregion of North Carolina (in red) (data source: NC GAP, 1992).

12. **Riverine aquatic communities** – Riverine aquatic habitat for our purposes encompasses the vast array of mountain rivers and streams from headwater seeps and springs through major waterways, including impoundments upon those waterways. Montane riverine habitats are important for a number of reptiles and amphibians including certain turtles, frogs, and salamanders that utilize aquatic habitats during part or all of their life cycle. These habitats are also important for a variety of mammals that are semi-aquatic and/or that have an aquatic food base (e.g., water shrews, muskrats, beavers, river otters, and certain bats). Selected bird species also rely upon aquatic habitats including rivers and streams to provide habitat or a food base, such as various waterfowl, wading birds, and certain songbirds like the Louisiana waterthrush. Mountain rivers and streams provide a number of important habitat, life cycle, or prey components to a vast assemblage of terrestrial, semi-aquatic, and aquatic wildlife. In addition, the importance of maintaining water quality of riverine habitats cannot be overstated, both in terms of the species that rely upon rivers and streams for habitat, as well as those species which rely indirectly upon the habitat by virtue of provision of habitat for their prey.

    Other fully aquatic taxa (fish, mussels, crayfish, and snails) are referenced in the river basins portion of the report. See the river basin sections (Chapter 5B) for more detailed information on aquatic species and habitats, by basin.

Priority species associated with montane riverine aquatic habitat:

Group	Scientific Name	Common Name	State Status (Federal Status)
Mammals	*Sorex palustris*	Water Shrew	SC
Amphibians	*Cryptobranchus alleganiensis*	Hellbender	SC
	Desmognathus marmoratus	Shovel-nosed Salamander	
	Eurycea guttolineata	Three-lined Salamander	
	Eurycea junaluska	Junaluska Salamander	T
	Eurycea longicauda	Longtail Salamander	SC
	Necturus maculosus	Common Mudpuppy	SC
Reptiles	*Apalone spinifera spinifera*	Eastern Spiny Softshell	SC
	Sternotherus minor	Loggerhead Musk Turtle	SC
	Thamnophis sauritus sauritus	Common Ribbonsnake	

A. Location and condition of habitat[1]:

Human-influenced alterations have affected much of the Mountain Region riverine and flood-plain habitats. Water quality and quantity have been impacted by run-off from municipalities and slope development. Dam construction has altered flows and river hydrology and morphology. Removing woody debris from streams after storm events has influenced in-stream habitat structure. The ecological condition of some mountain rivers is greatly reduced due to these impacts. However, some sections of rivers are designated High Quality Water and Outstanding Resource Water Management Zones and provide excellent opportunities for maintaining relatively pristine waterways. Each of the river basins in North Carolina are described in detail within the 'Aquatics' section of the report, which follows. See the Hiwassee, Little Tennessee, French Broad, Watauga, and New River basin sections in particular.

[1]See the basin maps associated with the Hiwassee, Little Tennessee, Savannah, French Broad, Watauga, New, Catawba, and Broad River basins.

B. *Problems affecting species and habitats:*

Water quality deterioration and loss of habitat are two of the most serious problems affecting wildlife that utilize riverine habitat. Water quality concerns, originating from both point and non-point sources have had, and continue to pose a threat directly to species that occur in riverine habitat, and indirectly through alteration of the food base or habitat. Direct and indirect impacts of decreased water quality upon wildlife associated with riverine habitat are difficult to quantify, and have not been as fully explored as have impacts upon fully aquatic species. However, there is little doubt that clean water is critical to a host of species that live in rivers and streams for a portion of their lives, and that sedimentation, channel scour, and other alterations of the physical habitat can lead to both deterioration of the habitat quality and negative impacts upon aquatic flora and fauna, which form the base of the food web for numerous wildlife species.

A condition with historic roots that still affects riverine habitat and its wildlife is the impoundment of rivers and streams for a variety of purposes including hydroelectric power generation, flood control, water supply, and recreation/aesthetics. There are miles and miles, or acres and acres of lakes and ponds that have converted lentic habitat to lotic. Again, the resultant effects have been both direct and indirect, in that habitat has been lost, and the food web has shifted, at least in portions of former riverine habitat, to species that do not depend upon flowing water. Other than measuring the direct impact of this habitat conversion, we do not know the overall impact upon the wildlife species present from the indirect effects of river or stream impoundment.

Another impact upon riverine habitat that can be construed as habitat loss, at least for some species, is through development of floodplains or riparian areas. River or stream-front development may or may not have a direct negative impact upon water or habitat quality in the stream or river, however in most instances it certainly can and does. The impacts of development adjacent to rivers and streams includes potential problems associated with direct input of contaminants and sediment, alteration of hydrologic patterns and temperature regimes, and loss of critical habitat adjacent to aquatic habitat that may be of equal importance to species that only spend a portion of their lives in the water (e.g., many amphibians).

Several of the priority species associated with riverine habitat face potential problems associated with having very limited distributions, or widely dispersed but small populations (e.g., eastern spiny softshell turtle, loggerhead musk turtle, Junaluska and longtail salamanders). Isolation or fragmentation of particular habitat stretches occupied by those species could have significant long-term affects upon the sustainability of those populations in North Carolina.

C. *Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:*

- **Surveys** – In order to begin to plan conservation strategies for these species, we must have a better understanding of their distribution and status currently. Several of the priority species associated with riverine habitat in western North Carolina are known from only a few localities, and are considered rare or declining. Priority needs to be placed upon the conduct of baseline surveys to determine their current range and distribution (e.g., water shrew, hellbender, Junaluska and longtail salamander, mudpuppy, eastern spiny softshell, and loggerhead musk turtle). Secondary priority should be directed towards gathering better information about the status and distribution of more common species associated with riverine habitats (e.g., shovel-nosed, and three-lined salamanders).
- **Monitoring** – When we have a better understanding of the current distribution of these species, survey efforts should be re-directed into development of long-term monitoring strategies to document population trends, from which conservation strategies can be specifically designed to target those species which are experiencing declines.

- **Research** – Priority research topics related to these species and riverine habitats include investigations into the relationships between water quality and hydrologic regimes and population change of selected species. In particular, research needs to be conducted which will establish whether water quality declines are having a negative impact upon hellbender populations. Potential studies also include efforts to determine specific flow regimes necessary to support microhabitat for particular species (e.g., Junaluska salamander) and investigations to determine the effect that beaver ponds have on downstream movement of toxins and sediment. And finally, better information is needed regarding the specific microhabitat requirements for most of the priority species in order to develop long-term conservation strategies.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

In general the most critical conservation actions necessary to sustain populations of riverine habitat species involve protection of water quality and aquatic habitats. Immediate and continuing efforts need to be undertaken to limit water quality deterioration from point sources of pollution as well as non-point sources. Toxic chemicals and sediment are entering our waterways and having a direct negative impact upon the species in the rivers and streams, but also having significant negative impacts upon the quality of the habitat itself.

Measures to address these issues, some of which are in practice currently, such as regulation of point and non-point sources of pollution, need to be enacted and enforced. Mandatory and incentive based practices to improve water quality need to be actively pursued with cooperation from agencies and organizations at local, state and federal levels. Programs to promote vegetated buffers along rivers and streams need to be supported and intensified. River and stream ecosystem enhancement and restoration efforts and programs need to be enhanced and supported as well. Management of riverine habitats should promote the natural evolution and movement of woody and rocky structures and natural processes like bank dynamics, channel meanders, and flood regimes. And finally, within the frameworks afforded by state, local, federal, and private initiatives, riverine habitats need to be permanently protected from the negative impacts of development through conservation ownership (fee title or easement) of as much habitat as possible, both for long-term water quality protection in our state, as well as the sustainability of wildlife populations dependent upon our rivers and streams. *Also see the appropriate river basin sections for more detailed conservation recommendations by basin.*

Supporting References

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Piedmont Ecoregion

13. **Dry coniferous woodlands** – This habitat type occurs on extremely dry Piedmont sites, including ridgetops and steep slopes. These sites contain rocky, shallow, often extremely acidic soil. Canopy tree species may include table mountain and pitch pine (uncommon), Virginia pine, shortleaf pine, chestnut oak, scarlet oak, post oak, blackjack oak, and some hickories. Hemlocks (especially Carolina hemlock) occur on some rocky areas and exposed bluff slopes in the western Piedmont.

    Piedmont Monadnock Forest is a specific community type (distinguished from other dry oak-pine communities by the dominance of chestnut oak) that can include pine species such as Virginia and shortleaf pine in the canopy, a patchy shrub layer and a sparse herb layer (Schafale and Weakley 1990). Monadnocks are exposed and subject to disturbance by high winds and lightning and can contain old trees. Because of the dryness and disturbance, pines were likely a more important component of Piedmont Monadnock Forests than of other piedmont forests (Schafale and Weakley 1990).

    Piedmont Acidic Cliff communities occur on very steep to vertical slopes on acid soils, stream bluffs, and other slopes. They typically lack a closed tree or shrub canopy due to the rocky, dry sites, but may occur in areas with softer substrate that has been exposed by stream undercutting (Schafale and Weakley 1990). Pine species include Virginia and shortleaf pine, and hemlocks may occur on sites that are more sheltered along with rhododendron. Cliff communities are distinguished from forest communities by having an absent or open canopy and abundant bare substrate due to steepness and rockiness (Schafale and Weakley 1990).

    Pine-Oak Heaths are more typical of the Mountain Region but Piedmont examples occur on high ridges and monadnocks in the western Piedmont (Schafale and Weakley 1990). The typical pines found include Virginia, pitch and table mountain pine. These communities depend on periodic fires, which allow for seeding by shade-intolerant species such as pines, but the natural fire regime that is needed to maintain these areas is not clearly understood.

Priority species associated with piedmont dry coniferous woodlands:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Accipiter cooperii*	Cooper's Hawk	SC
	Accipiter striatus	Sharp-shinned Hawk	SR
	Caprimulgus carolinensis	Chuck-will's-widow	
	Caprimulgus vociferus	Whip-poor-will	
	Colaptes auratus	Northern Flicker	
	Contopus virens	Eastern Wood-pewee	
	Falco sparverius	American Kestrel	
	Melanerpes erythrocephalus	Red-headed Woodpecker	
	Picoides villosus	Hairy Woodpecker	
	Sitta pusilla	Brown-headed Nuthatch	
Mammals	*Lasiurus seminolus*	Seminole Bat	
Reptiles	*Crotalus horridus*	Timber Rattlesnake	SC
	Sistrurus miliarius	Pigmy Rattlesnake	SC
	Tantilla coronata	Southeastern Crowned Snake	

A. Location and condition of habitat (see Map 5A.13):

Dry coniferous woodlands along ridgetops and steep slopes are relatively rare in the Piedmont, occurring mostly in counties that border the mountains. In a 2002 forest inventory (Brown and Sheffield 2003), 8,300 acres were classified as pitch-pine dominated and 1,400 acres as table-mountain pine dominated in the Piedmont. A reduction in fire events in these habitats is impacting species composition. The overall condition of this habitat, however, is comparatively stable but this will change unless fire is used to manage these areas.

Piedmont Monadnock Forests with conifers present occur throughout the Piedmont, but are most common in the western Piedmont and in the Uwharrie Mountains. These areas grade into oak-hickory forests downslope, may grade into Piedmont Acidic Cliff, and may grade into pine-oak heath on sharp high ridges (Schafale and Weakley 1990). Piedmont Acidic Cliff communities occur throughout the Piedmont and generally border floodplain forests or stream channels. There is tremendous variation in plant composition among these sites based on elevation, aspect, and geographic location and in the amount and quality of the conifers present. Pine-Oak Heath occurs mainly in the upper Piedmont. Pilot Mountain, Hanging Rock and Crowders Mountain State Parks all have examples of this community.

B. Problems affecting species and habitats:

- *Fire suppression* – The location of dry coniferous woodlands along ridgetops and well-drained slopes makes this habitat more prone to fire, including occasional catastrophic fires, than more mesic or sheltered habitats. Many of the climax tree species in this habitat depend at least in part upon fire for regeneration.
- *Human disturbance leading to erosion and mass movement of soil* – Construction activities, clear cutting, and other causes of the removal of plant cover can make steep slopes prone to “slides” of mud and/or rock, causing loss of topsoil and potentially causing property damage and threatening human safety, as seen during the hurricanes of 2004.
- *Tree pests and diseases* – There are numerous native and exotic pests that can impact coniferous trees in this habitat (e.g., southern pine beetle, tip moths, pine webworm, Schweinitzii root and bud disease, red heart of pine disease). Localized and non-lethal infestations can be beneficial for wildlife by creating snags, a food source, and habitat diversity. However, extensive lethal outbreaks can dramatically shift the composition of the tree community, with implications for conifer-specialists like brown-headed nuthatch.
- *Development causing habitat loss and fragmentation* – Development projects are impacting dry coniferous woodlands, as with many other habitat types, in the Piedmont. As slopes are a prime location for new housing, development in this habitat can lead to fragmentation and disrupts connectivity between patches for most wildlife except birds. Road crossings can lead to mortalities, especially for reptiles and amphibians.

C. Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:

- **Surveys** – Initial efforts need to be directed towards surveys to determine the current baseline distribution and status of species mainly associated with dry coniferous forest (especially those that are state-listed or believed to be declining). Data is most severely lacking for reptiles, small mammals, and nocturnal birds. Since we lack baseline information about even common species and their distribution and status in this habitat type, we need to direct secondary efforts to conduct surveys to understand current status from which we can then measure future population changes over time.
  - Determine the distribution and status for pigmy rattlesnake, timber rattlesnake, southeastern crowned snake, and other reptiles (especially lizards).
  - Determine the distribution and status for small mammals and bats (e.g., seminole bat).
  - Conduct population status surveys for chuck-will’s-widow, whip-poor-will (nocturnal), brown-headed nuthatch and woodpeckers.

- **Monitoring** – Protocols and procedures developed from baseline surveys should then provide a means to convert from a baseline survey mode to a long-term population monitoring mode. Current monitoring systems and protocols (e.g., MAPS and BBS) may need to be enhanced to better cover species not well covered by current monitoring efforts.
  - Establish MAPS and migration banding stations (although less of a priority than in Piedmont mesic forest, floodplain forest, oak forest and early successional communities).
  - Establish long-term monitoring efforts for small mammals and reptiles in the habitat.
- **Research**

  Population demographics
  - Conduct Seminole bat life history research, as little is known about the life history of this species in the Piedmont.

  Management practices
  - Determine impacts of prescribed fire on these communities and the resulting effects on wildlife communities.
  - Develop logistically and economically effective control strategies for controlling outbreaks of the most damaging insect pests and diseases.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

The highest priority for protecting dry coniferous forest and associated species is to identify the best remaining examples of this habitat in the western Piedmont and then to pursue easements or acquisition. The efforts of land trusts and government agencies should be coordinated to target the highest priority sites. At a larger scale, land use planning is needed to minimize development within large, unfragmented tracts of all woodland types in the western Piedmont.

The greatest habitat management need is the reintroduction of controlled fire on dry ridges to encourage pine regeneration, understory development, and structural diversity. Steep topography and smoke management concerns can make controlled burning a challenge. The NC Forest Service will be a critical partner for promoting an increase in controlled burning in this habitat. Another priority is regulation of human activities on steep slopes that may cause excessive erosion or mud slides, and the development and implementation of best management practices to mitigate erosion. Where feasible, efforts should be made to control large outbreaks of tree-killing insects and diseases.

Supporting References

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Piedmont Ecoregion

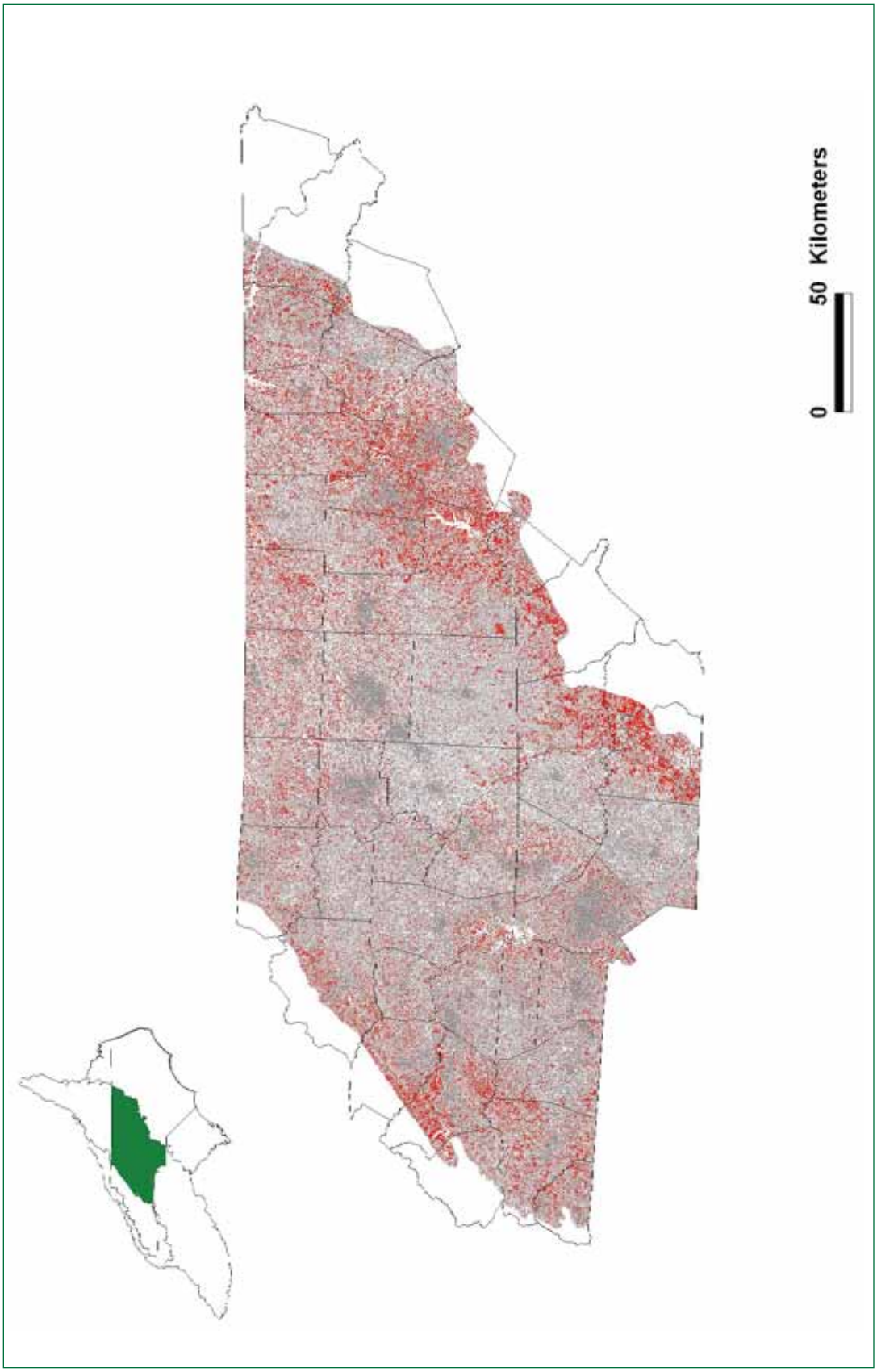

Figure 5A.13. Dry coniferous woodland habitat in the Piedmont ecoregion of North Carolina (in red) (data source: NC GAP, 1992).

14. **Oak forest (including mixed hardwoods and pine)** – This habitat includes all mature Piedmont forests found upslope, or on drier sites, than Mesic Forest and downslope, or on wetter sites, than Dry Coniferous Woodland. Immature forests will be discussed in the Early Succession habitat section. Within this moisture gradient, there is a wide range of composition of the plant community, ranging from pine-dominated to hardwood-dominated forests, depending primarily upon soils and management history.

According to Brown and Sheffield (2003) about 52% (5.4 million acres) of the Piedmont was forested in 2002 (all forest types combined). Seventy four percent (4.0 million acres) of Piedmont forests were classified as hardwood. Within hardwood forests, oak-hickory was the most widespread (2.7 million acres), followed by oak-pine (1.1 million acres) and oak-gum-cypress (151,000 acres). Pine forests accounted for 1.4 million acres, dominated by loblolly pine (798,000 acres), Virginia pine (404,000 acres) and shortleaf pine (132,000 acres). Planted stands comprised 12 percent (640,000 acres) of the total area of timberland in the Piedmont with 473,000 acres in pine plantations and 167,000 acres classified as planted oak-pine stands.

A variety of natural communities recognized by the NC Natural Heritage program have an oak-hickory or mixed hardwood/pine component and occur in the Piedmont on both xeric and mesic sites. The communities with the largest or best examples include Dry Oak-Hickory Forest, Dry-Mesic Oak-Hickory Forest, Basic Oak-Hickory Forest, Xeric Hardpan Forest and Piedmont Monadnock Forest (Schafale and Weakley 1990).

Dry-Mesic Oak-Hickory Forests and Dry Oak-Hickory are the most natural community types of the Piedmont landscape, occurring on ridgetops, upper slopes, south-facing slopes and other dry to mesic upland areas with acidic soils. They are dominated by a variety of oak and hickory tree species, but pines may also be an important component of both communities. Shrub layers are variable in density, but herbs are usually sparse (Schafale and Weakley 1990). Both of these forests are naturally uneven-aged forests with some old trees present. Reproduction typically occurs in canopy gaps and although the historical fire regime is largely unknown, fires (mostly of low intensity) certainly occurred periodically (Schafale and Weakley 1990).

Piedmont Monadnock Forests occur on monadnocks or high ridges and have a canopy dominated by chestnut oak, although other oaks are also present. The Xeric Hardpan community is found at scattered locations throughout the Piedmont, and the canopy is often dominated by post oak and blackjack oak. Basic Oak-Hickory Forest is also found scattered throughout the Piedmont on slopes, ridges and uplands with basic or circumneutral soils (Schafale and Weakley 1990).

In addition to these natural communities, there are a growing number of acres of pine plantations in the Piedmont, primarily of loblolly pine (Brown and Sheffield 2003). While there can be significant variation in the structure and composition of these pine plantations, particularly in the mid-story, the vast majority are even-aged stands with exclusively loblolly pine in the canopy.

A. Location and condition of habitat (see Map 5A.14):

Mature hardwood and pine forests are found throughout the Piedmont, though the total acreage has been declining in recent years. The total forested acres in the Piedmont declined 7%, or by about 400,000 acres, between 1990 and 2002, primarily due to urban development, and secondarily due to agriculture (Brown and Sheffield 2003).

Most Piedmont forests have been logged or cleared at least once within the past 300 years, and many have been cut multiple times. The quality of existing tracts ranges widely across the Piedmont and depends primarily upon the age of the canopy trees, management history, and size of the tract (Godfrey 1997). Some tracts are too small to support viable populations of area-sensitive species or species with large home ranges or dispersal movements. In 2002, only 5.6% of the area of private forests occurred in tracts larger than 500 acres (Brown and Sheffield 2003). Land use conversions in the Piedmont (primarily to suburban and exurban development)

Priority species associated with piedmont oak forests and mixed hardwood/pine stands:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds[1]	*Accipiter cooperii*	Cooper's Hawk	SC
	Caprimulgus vociferus	Whip-poor-will	
	Coccyzus americanus	Yellow-billed Cuckoo	
	Colaptes auratus	Northern Flicker	
	Contopus virens	Eastern Wood-pewee	
	Helmitheros vermivorous	Worm-eating Warbler	
	Hylocichla mustelina	Wood Thrush	
	Melanerpes erythrocephalus	Red-headed Woodpecker	
	Picoides villosus	Hairy Woodpecker	
	Wilsonia citrina	Hooded Warbler	
Mammals	*Mustela frenata*	Long-tailed Weasel	
	Scalopus aquaticus	Eastern Mole	
Amphibians	*Ambystoma maculatum*	Spotted Salamander	
	Ambystoma opacum	Marbled Salamander	
	Hemidactylium scutatum	Four-toed Salamander	SC
	Hyla versicolor	Northern Gray Treefrog	SR
	Plethodon glutinosus sensustricto	Northern Slimy Salamander	
	Scaphiopus holbrookii	Eastern Spadefoot	
Reptiles	*Cemophora coccinea copei*	Northern Scarletsnake	
	Crotalus horridus	Timber Rattlesnake	SC
	Elaphe guttata	Corn Snake	
	Eumeces laticeps	Broad-headed Skink	
	Lampropeltis calligaster rhombomaculata	Mole Kingsnake	
	Lampropeltis triangulum elapsoides	Scarlet Kingsnake	
	Ophisaurus attenuatus longicaudus	Eastern Slender Glass Lizard	
	Sistrurus miliarius	Pigmy Rattlesnake	SC
	Terrapene carolina	Eastern Box Turtle	
	Virginia valeriae valeriae	Eastern Smooth Earthsnake	

contribute significantly to the reduced condition of some tracts. Fire suppression and conversion to pine plantations are two management activities that have most extensively impacted these natural communities.

Disturbed areas in Dry Oak-Hickory and Dry Mesic Oak-Hickory Forests have varying amounts of pines, red maple, tulip poplar and sweetgum depending on the degree of canopy opening and disturbance history. Heavily logged areas or high-graded sites have a mixture of pines and hardwoods and there are several variants present in the Piedmont. Usually these forests are uneven-aged with old tress occasionally present. Disturbances of many types, exotic plants, and fire suppression have undoubtedly changed the species composition and structure of the oak-dominated forests. The best examples of oak forests are found in the central Piedmont and often near rivers or streams (Schafale and Weakley 1990) and several small examples are protected on public lands (e.g., Caswell Game Land, Umstead State Park, Uwharrie National Forest).

[1] In pine-dominated systems under this heading, the brown-headed nuthatch and Chuck-wills-widow could also be included in the list of associated priority species.

B. *Problems affecting species and habitats:*

Many of the problems impacting oak and mixed hardwood/pine forests, including fire suppression and even-aged forest management, result in a loss of habitat complexity and associated wildlife niches (Hunter et al. 2001).

– *Development causing habitat fragmentation* – Development causes direct loss of forest habitat and also fragments remaining forested patches. Fragmentation of forests into smaller contiguous blocks is a concern for forest interior birds (like wood thrush, Cooper's hawk, and worm-eating warbler), which may occur in lower densities or suffer lower productivity or survival in small habitat patches. Animals with large home ranges or dispersal needs may become isolated or absent in small tracts. Fragmentation by roads and development can be particularly problematic for reptiles (particularly timber rattlesnake and box turtle), amphibians, and small mammals that suffer high mortality on roads when traveling between forest patches.

– *Diseases* – Sudden Oak Death disease, which was detected at plant nurseries within North Carolina in 2004, could potentially have devastating impacts on oak forests across the state.

– *Short rotation forestry* – Shorter rotation forestry limits the creation of old-growth forest dynamics, such as creation of canopy gaps, hollow trees, snags, and woody debris. In 2002, less than 1% of both hardwood and pine trees in the Piedmont measured >19 inches diameter at breast height (Brown and Sheffield 2003), indicating that there are few old, large trees that help provide these old growth conditions[2]. Older stands will be more likely to be established and maintained on public land than on commercial forestland, though niche markets for larger timber may entice some landowners to extend cutting rotations.

– *Conversion to pine plantations* – Some native forest stands are being replaced by even-aged pine plantations, resulting in decreased habitat value for forest species that rely on diverse forest composition and structure, such as Kentucky warbler and wood thrush. Pine plantations do, however, provide increased opportunity to provide habitat for brown-headed nuthatch and bobwhite quail, with proper management.

– *Fire suppression leading to reduced or altered understory community and shifting tree species composition* – Historical data suggests that oak communities benefited from periodic fires (Abrams 1992, Close 1996), and many oak species are fire tolerant. In pine stands, fire can play a very important role in reducing the midstory while enhancing structure in the understory. Fire helps to create snags, woody debris, and canopy gaps, and prepares a fertile seed bed, while also improving vegetative structure. The benefit of fire to understory plant development is highly dependent upon the density of canopy trees, with closed-canopy stands suppressing the growth of grasses and forbs following fire. Cavity nesting birds, arboreal mammals, and some frogs, lizards and snakes are impacted by the lack of snags, while reptiles, amphibians and small mammals are impacted by lack of woody debris. Many bird species, such as hooded warbler, red-headed woodpecker, eastern wood-pewee, northern flicker, nightjars, and many post-fledging juvenile birds utilize canopy gaps for cover, or for foraging habitat, as do some bat species. Lack of fire has also allowed some fire-intolerant mesophytic plant species to become quite common in oak dominated communities including American beech (Franklin and Kupfer 2004). The resulting loss of acorn production may be limiting for some wildlife in the future.

– *Exotics* – There are many potential and realized impacts by imported gypsy moths (*Lymantria dispar*) and other non-native insects, kudzu, and other non-native pathogens, plants, and animals. Gypsy moths are the most destructive defoliating insect attacking northern red oak, chestnut oak, and white oak. This insect repeatedly defoliates trees and has killed oaks in a wide area of the northeastern United States. The Asiatic oak weevil (*Cyrtepistomus castaneus*) attacks northern red oak seedlings and has the potential to seriously affect seedling growth because the larvae feed on the fine roots while the adults feed on the foliage.

[2] It should be noted, however, that tree diameter does not always correlate with tree age.

C. Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:

- **Surveys** – Surveys are needed to document the distribution, relative abundance and status of many wildlife species associated with oak or mixed hardwood/pine forests. In general, inventory and trend information is most severely lacking for reptiles, amphibians, and small mammals (bats in particular), while diurnal birds are relatively well surveyed in Piedmont upland forests. Priorities for conducting surveys need to focus on species believed to be declining, at risk, or mainly dependent on oak dominated communities. Secondary priority for surveys should be for species for which current distribution information is already available or for species that are generalists in terms of habitat usage.
  - Document the distribution and status of forest bats. Several priority bat species, including Seminole bat, southeastern bat, hoary bat, northern yellow bat, silver-haired bat, and northern long-eared bat may occur in upland Piedmont forests, but very little work has been done to document these species.
  - Document the distribution and status of priority amphibians (e.g., eastern spadefoot toad, four-toed salamanders) and document non-breeding use of oak forests by spotted and marbled salamanders.
  - Document distribution and status of timber and pigmy rattlesnakes.
  - Conduct nocturnal surveys to determine the status and distribution for whip-poor-will and Chuck-will's widow.
  - Determine the breeding status and distribution of Cooper's hawks.
  - Document status and distribution of priority reptiles (e.g., northern scarlet snake, mole kingsnake, scarlet kingsnake, corn snake, eastern smooth earth snake) and document the extent of eastern box turtle use of oak or hardwood/pine dominated forests.
  - Document the distribution and rate of spread for the most detrimental invasive exotic insects, plants, and diseases.

- **Monitoring** – Monitoring systems need to be expanded and/or targeted to be able to assess current population status and trend information for all wildlife species associated with oak or hardwood/pine forests. Again, the best trend information is available for many birds, while little long-term trend data are available for amphibians, reptiles, and mammals.
  - Monitor tree infestations and diseases to document potentially destructive organisms shortly after they show up, while there is still a chance to contain or eradicate the pest. This effort should include monitoring of potential vectors for the introduction of new pests and diseases, including nursery and forest products.
  - Monitor for exotic species spread; control may be required locally.
  - Develop standardized monitoring programs analogous to the Breeding Bird Survey for reptiles, amphibians and small mammals. Of particular interest is trend information for those species dependent upon snags and woody debris.
  - Establish mist-netting stations for long-term forest bat monitoring.
  - Establish MAPS and migration bird banding stations to monitor population status and trends for birds not adequately sampled under existing monitoring protocols.
  - Establish Migration Monitoring routes and winter surveys for birds in oak dominated forests.

- **Research** – There is a need to develop a greater understanding of the ecological relationships between wildlife species and their habitats, as well as the biological, physical and chemical habitat components, to help better guide management and conservation efforts.

  Predator effects
  - Study predator impacts on nest productivity, especially for ground nesting birds.
  - Examine cowbird parasitism impacts on bird productivity in small versus large habitat patches.
  - Determine the interactions between fire ants and ground nesting birds, small mammals and reptiles in disturbed forests, along edges of forest, and at road/forest interfaces.

Population demographics

- Establish long-term bird nest searching and spot mapping studies on neotropical migrants like worm-eating warbler, wood thrush, hooded warbler and eastern wood-pewee.
- Determine the impacts on native wildlife populations of large-scale applications of pesticides for gypsy moths and other pests.

Habitat use

- Determine the minimum forest patch size needed to support stable populations of forest-interior birds (e.g., wood thrush and scarlet tanager), as well as basic studies of nest success and productivity in habitat patches of different sizes, similar to studies conducted with citizen science volunteers by the Cornell Lab of Ornithology.
- Conduct productivity studies of open woodland woodpeckers (i.e. northern flicker and red-headed woodpecker).

Management practices

- Examine the feasibility of using forestry practices that mimic old growth forest dynamics (e.g., canopy gap, snag, and woody debris creation) in a manner that is compatible with economic goals of private landowners.
- Study the efficacy and wildlife impacts of thinning mature oak stands to encourage understory development.
- Compare oak forests that are managed via prescribed fire and those that are not burned at all, tracking differences in plant, wildlife and invertebrate communities.
- Study the efficacy of wildlife underpasses where habitat is highly fragmented by high volume roads.
- Develop new management techniques that control invasive exotic species while minimizing impacts on non-target species.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

About 5 million acres, or 93%, of the forested land in the Piedmont is owned by non-industrial private landowners (Brown and Sheffield 2003), and thus any effort to conserve species in Piedmont forests must focus on impacting private lands. Privately-owned Piedmont forests are under tremendous developmental pressure, and the highest priority for conservation of this habitat is land use planning and protection of large tracts of land. A secondary priority is controlling the impacts of introduced pests that have the potential to dramatically alter forests, with Sudden Oak Death a very high priority. The third-level conservation priority is promoting management practices that enhance habitat conditions, including selective thinnings and controlled burning.

Policy–based actions

County and state-level land use planning is needed to minimize development within large, unfragmented tracts of forests. Where development will occur, cluster development and other lower impact development approaches are urged. This would be most appropriate and effective in the regions that are, as yet, not heavily developed, including Anson, Montgomery, Stanly, Randolph and Richmond counties in the southern Piedmont, and the northern tier counties of Surry, Stokes, Rockingham, Caswell, Person, and Granville. Planning for future infrastructure (roads, water lines, etc.) should be concentrated closer to existing development and should avoid dissecting larger tracks of unfragmented forest.

Protection actions

The next highest priority for this habitat is direct land protection through easements and land acquisition. Attempts should be made to provide large core areas of forest and to connect isolated patches of forests. As this is the dominant vegetation type in the Piedmont, protection of large tracts (>500 acres) is recommended. Cooper and Demarest (1999) recommend that core areas be at least 16,000 acres in size to produce viable populations of forest-interior birds, like scarlet tanager. Large core areas will be important for reptiles like box turtle and timber

rattlesnake, which suffer high mortality when crossing roads. State and county parks departments, the Commission, the Ecosystem Enhancement Program, The Nature Conservancy, the Piedmont Land Conservancy, the Land Trust for Central North Carolina, and other regional land trusts are all important players in land protection. The Nature Conservancy's Piedmont ecoregional plan (when completed) and the One NC Naturally Initiative will help to prioritize land protection efforts in the Piedmont.

Habitat management and restoration actions

Controlled burning is a beneficial habitat management practice, and should be encouraged in almost all Piedmont forest types, especially those with a pine component or a more open overstory. The greatest limitation on controlled burning is the presence of well-traveled roads, developments and sensitive agriculture operations (like chicken houses) which raise concerns over smoke management and liability. The NC Forest Service is the most important partner in promoting controlled burning. The Forest Service offers a free fire line program for private landowners, helping to dramatically defray the cost of implementing controlled burning.

Invasive and exotic species control should be targeted at ecologically sensitive areas and at new and potentially manageable outbreaks. Rapid response to new outbreaks will be critical.

There are a number of management practices that can be implemented on commercial pine plantations to enhance their habitat value. Many forest managers attempt to control hardwoods in pine stands with chemicals or other means, to reduce competition with pines. Morrison and Meslow (1983) and Santillo et al. (1989 *a*, *b*) found that retaining even small patches of deciduous trees with pine stands maintains a similar songbird community as in stands where hardwoods are not controlled. They recommend retaining these in areas of unstable soil, along roads, and as stream buffer strips. Banded or spot applications of herbicides can be used to maintain vegetation diversity and cover (Isaacson 1999). When selecting herbicides for pine release, Thomas (n.d.) recommends using Arsenal alone because legumes and blackberries are not damaged.

On large timber holdings it will be beneficial to maintain a diversity of habitat types and stand ages across the landscape and to restrict clearcut size, if benefit for forest interior species is the goal. Thinning prior to crown closure (Isaacson 1999), prescribed burning (Perkins 1962), and mid-rotation pine release using Arsenal (Thomas 1993) improve the quality and diversity of plant communities important to many wildlife species. Landowner incentives, technical assistance, and markets that promote extending rotation lengths should also be supported.

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Piedmont Ecoregion

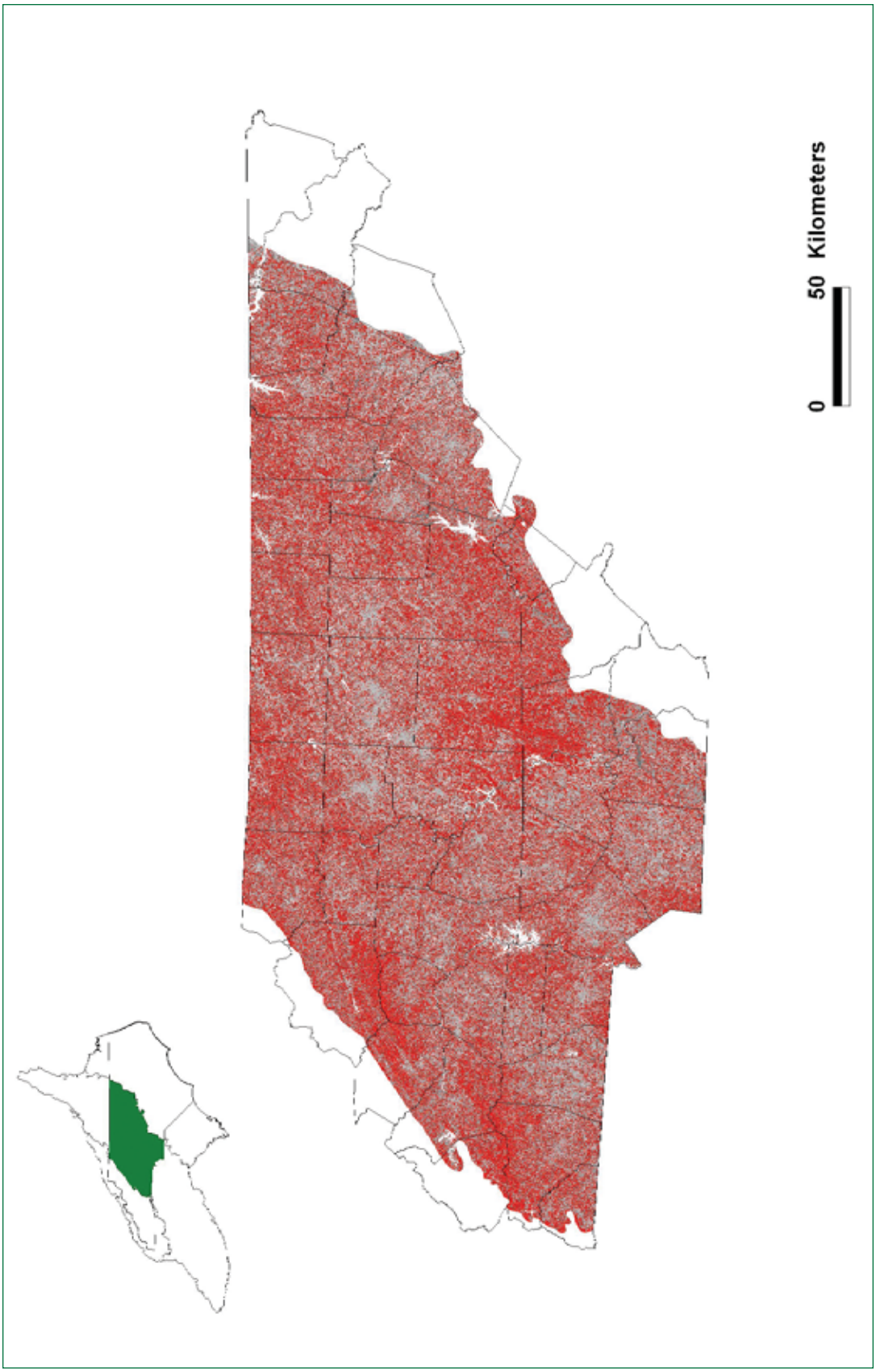

Figure 5A.14. Oak forest and mixed hardwoods/pine habitat in the Piedmont ecoregion of North Carolina (in red) (data source: NC GAP, 1992).

15. **Mesic forest** – Piedmont mesic forests occur on moist portions of upland habitat, steep north-facing slopes, lower slopes, along ravines, high sections of outer floodplains and stream bottoms. The most common subtypes in the Piedmont are Mesic Mixed Hardwood Forest and Basic Mesic Forest (Schafale and Weakley 1990). These habitats have well-developed understory and shrub layers and are characterized by canopy species such as American beech, tulip poplar and red oak, and in the western Piedmont, eastern hemlock.

    Under natural conditions these forests are uneven-aged and often have some old, large trees present. Reproduction occurs mainly in canopy gaps (Schafale and Weakley 1990) and disturbed areas have increased amounts of pines, tulip poplar and sweetgum. Fires most likely occurred periodically but because of the moist and sheltered nature of the sites, they likely did not burn often or with great intensity. Mesic Mixed Hardwood Forests grade into alluvial or bottomland forest or into various upland forest types and can be distinguished from Basic Mesic Forest by more acidic soils, an absence of base-loving plants and lower vegetative diversity in the understory.

    In general, Mesic Mixed Hardwood Forests are quite common and their occurrence on steeper topography has allowed some to escape extensive disturbance until recently. Due to a scarcity of basic rocks in the piedmont, the Basic Mesic Forest subtype is rare. Mesic forests can be distinguished from upland hardwood forests by the canopy composition and from floodplain forests by the lack of bottomland tree species and presence of flood-intolerant trees (Schafale and Weakley 1990).

Priority species associated with piedmont mesic forest:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Accipiter cooperii*	Cooper's Hawk	SC
	Accipiter striatus	Sharp-shinned Hawk	SR
	Coccyzus americanus	Yellow-billed Cuckoo	
	Colaptes auratus	Northern Flicker	
	Contopus virens	Eastern Wood-pewee	
	Helmitheros vermivorus	Worm-eating Warbler	
	Hylocichla mustelina	Wood Thrush	
	Melanerpes erythrocephalus	Red-headed Woodpecker	
	Oporornis formosus	Kentucky Warbler	
	Picoides villosus	Hairy Woodpecker	
	Wilsonia citrina	Hooded Warbler	
Mammals	*Lasionycteris noctivagans*	Silver-haired Bat	SR
	Mustela frenata	Long-tailed Weasel	
	Scalopus aquaticus	Eastern Mole	
Amphibians	*Ambystoma maculatum*	Spotted Salamander	
	Ambystoma opacum	Marbled Salamander	
	Ambystoma talpoideum	Mole Salamander	SC
	Hemidactylium scutatum	Four-toed Salamander	SC
	Hyla gratiosa	Barking Treefrog	
	Hyla versicolor	Northern Gray Treefrog	SR
	Plethodon glutinosus sensustricto	Northern Slimy Salamander	
Reptiles	*Clemmys guttata*	Spotted Turtle	
	Crotalus horridus	Timber Rattlesnake	SC
	Elaphe guttata	Corn Snake	
	Eumeces laticeps	Broadhead Skink	
	Lampropeltis calligaster rhombomaculata	Mole Kingsnake	
	Terrapene carolina	Eastern Box Turtle	
	Virginia valeriae valeriae	Eastern Smooth Earthsnake	

A. *Location and condition of habitat (see Map 5A.15):*

Mesic habitats in the Piedmont have experienced less direct habitat destruction and fragmentation as compared to other upland habitats, but more recent logging has reduced the extent of old growth canopy in most places. Also, the extent of intact natural landscapes with a mesic forest component (often amidst other upland forest types and bottomland communities) has been reduced by development and forest clearing for agriculture, especially in oak forest types immediately above the mesic forest slopes.

There are still good examples of this mesic forest in the Piedmont at Umstead State Park, Duke Forest, Hill Demonstration Forest, Raven Rock State Park and at Eno River State Park in the central Piedmont, and also examples in parts of Uwharrie National Forest. The Basic Mesic Forest subtype often has rare and disjunct plant species.

B. *Problems affecting species and habitats:*

- *Development causing habitat fragmentation* – Housing subdivisions are often built adjacent to mesic slopes and floodplain forests in central North Carolina. As with all Piedmont forested habitats, fragmentation of mesic forests into smaller or narrower contiguous blocks is a concern for forest interior birds (like wood thrush, Cooper's hawk, and worm-eating warbler), which may occur in lower densities or suffer lower productivity or survival in small habitat patches. Fragmentation by roads and development can be particularly problematic for reptiles (particularly timber rattlesnake and box turtle), amphibians, and small mammals (particularly eastern mole) that suffer high mortality on roads when traveling between forest patches or between mesic forest and other habitats.
- *Conversion to loblolly pine monoculture* – After logging, some mesic forest habitats are replanted to even-aged loblolly pine plantations, reducing species and structural diversity.
- *Shorter rotation logging* – When forests are cut for timber as soon as they are economically viable, they are not able to develop old-growth structural characteristics such as canopy gaps and standing and fallen snags. A lack of canopy gaps in this habitat type has probably lead to a reduced number of some avifauna such as the eastern wood-pewee, red-headed woodpecker, northern flicker, hooded warbler and Kentucky warbler. This reduction in canopy gaps has also caused a decline in midstory and understory vegetation, which has impacted species such as the Swainson's warbler, Kentucky warbler, hooded warbler and wood thrush. The reduction in standing snags negatively impacts primary and secondary cavity nesting species, and the lack of dead wood on the forest floor impacts herpetofauna and small mammals.
- *Exotic plants* – Plants such as autumn olive, Japanese grass, Japanese honeysuckle, and privet have taken resources from native vegetation and altered habitat structure and species composition. The extent of negative (and positive) impacts of exotic species on populations of native fauna is largely unknown.

C. *Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:*

- **Surveys** – Initial efforts need to be directed towards surveys to determine the current baseline distribution and status of species mainly associated with mesic forests (especially those that are state-listed or believed to be declining) for which that information is lacking. Since we lack baseline information about even common species and their distribution and status in this habitat type, we need to direct secondary efforts to conduct surveys to understand current status from which we can then measure future population changes over time.
  - Determine the breeding distribution and status of Cooper's and sharp-shinned hawks. Because of their secretive nature, traditional bird surveys do not adequately track these populations. Targeted tape "play-back" surveys will be needed.
  - Conduct nest-searching and spot-mapping bird surveys to determine limiting factors in productivity.
  - Determine the distribution and population status of mole salamander, four-toed salamander, northern two-lined salamander.

- Determine the status and distribution of timber rattlesnake.
- Determine the status and distribution of spotted and box turtles, particularly in more urbanized and rapidly urbanizing counties.
- Determine the status and distribution of small mammals and bats in Piedmont mesic forest.

- **Monitoring** – Protocols and procedures developed from baseline surveys should then provide a means to convert from a baseline survey mode to a long-term population monitoring mode. Current monitoring systems and protocols (e.g., MAPS and BBS) may need to be enhanced to better cover species not well covered by current monitoring efforts.
  - Establish MAPS and migration banding stations.
  - Conduct herpetofauna monitoring to track population trends for species of concern. Particular attention should be paid to mole salamanders and four-toed salamanders.
  - Establish monitoring systems and protocols for small mammals, bats and reptiles and amphibians to follow population trends

- **Research**

  Population demographics
  - Conduct life history studies on priority bat species, as well as investigations into specific habitat needs, particularly for silver-haired bats.
  - Conduct research on the effects of the loss of old-growth characteristics on herpetofauna populations.

  Predator effects
  - Examine impacts of cowbird parasitism and predation on neotropical migrant nesting productivity (e.g., hooded warbler, Kentucky warbler, eastern wood-pewee and worm-eating warbler).

  Habitat use
  - Study the impacts of habitat fragmentation and roads on reptile and amphibian survival and productivity.

  Other
  - Conduct economic and human dimensions research to determine how to encourage commercial forestry practices that promote multi-age stands with structural diversity.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

Within Piedmont mesic forest there are three major conservation needs. The highest priority is land use planning to minimize development within large, unfragmented tracts of mesic forest. This would be most appropriate and effective in the regions that are, as yet, not heavily developed, including Anson, Montgomery, Stanly, Randolph and Richmond counties in the southern Piedmont, and the northern tier counties of Surry, Stokes, Rockingham, Caswell, Person, and Granville. Planning for future infrastructure (roads, water lines, etc.) should be concentrated closer to existing development and should avoid dissecting larger tracks of unfragmented forest.

The next highest priority for this habitat is direct land protection through easements and land acquisition. Attempts should be made to connect mesic stands to adjacent patches of upland hardwoods or floodplain forests to establish larger core areas for wildlife. State and county parks departments, the Commission, the Ecosystem Enhancement Program, The Nature Conservancy, the Piedmont Land Conservancy, the Land Trust for Central North Carolina, and other regional land trusts are all important players in land protection. The Nature Conservancy's Piedmont Ecoregional Plan (when completed) and the One NC *Naturally* Initiative will help to prioritize

land protection efforts in the Piedmont.

The third major conservation need is habitat management and forestry practices that will encourage structural and species diversity. Possibly the greatest habitat management need is an increased focus on allowing longer forestry rotations and the development of older-growth forest characteristics. After timber harvest, landowners could consider establishing multi-tree species or multi-age stands. Also, allowing or encouraging periodic habitat disturbance will help to create tree-fall gaps and snags that will promote understory development and increase vegetative and structural diversity. The Forest Landbird Legacy Program can help provide technical guidance and cost share for management practices that promote late succession forest bird habitat.

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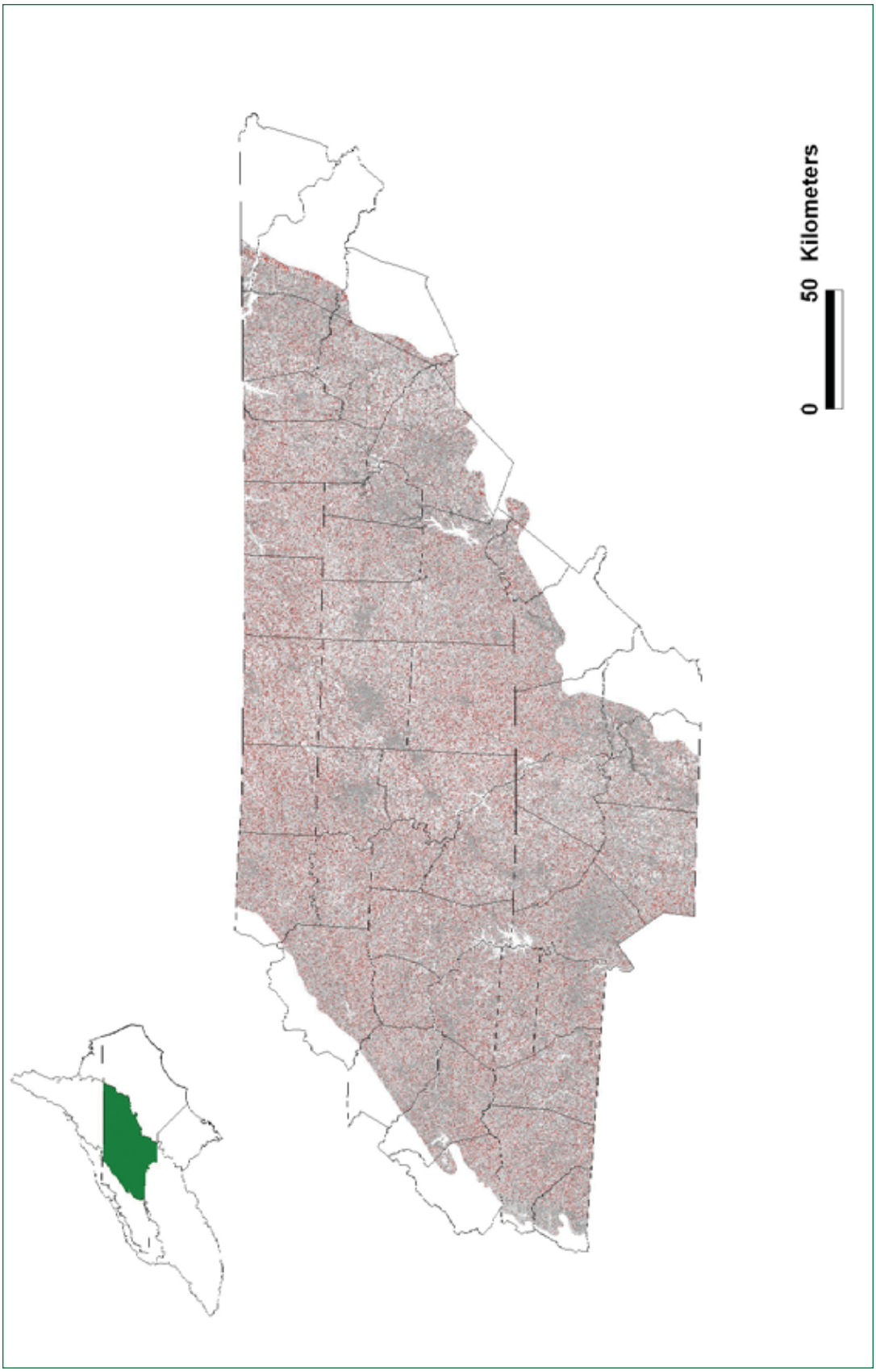

Figure 5A.15. Mesic forest habitat in the Piedmont ecoregion of North Carolina (in red) (data source: NC GAP, 1992).

16. **Early successional habitats** – Piedmont early succession and scrub-shrub habitats, characterized by low woody vegetation and herbaceous plants, are often found associated with agricultural or forestry activities. This habitat includes grasslands, shrublands, clearcuts and regenerating forests, large canopy gaps, hayfields, pasture, row crops and field borders. For the purposes of this Plan, this habitat category will also include open savannas, or any habitat where dense understory vegetation is maintained through periodic disturbance. These habitats are created and maintained by disturbances like discing, clearcutting or burning.
To a lesser extent, extreme weather events or tree pests (insects and diseases) can also create early succession habitats. Historically, large herbivores and Native American land uses likely contributed to the creation and maintenance of these habitats.

By their nature, early succession habitats are ephemeral and will have a limited longevity without repeated disturbance. The habitat structure changes as succession progresses, and many wildlife and plant species are adapted to different stages within the early succession continuum, from bare earth through pole-stage woodland. Managing for species dependent upon early succession habitats presents several management challenges, including the need to identify which successional stage is most appropriate for the species or assemblage of interest and the need for repeated management actions to maintain suitable habitat.

Early succession habitats can contain a diverse assemblage of plants, with Piedmont prairies being a notable example of this (Davis et al. 2002). However, intensively managed habitats such as large lawns, golf courses, high production agricultural fields, monoculture hayfields, and intensively managed commercial timber stands often have low species and structural diversity, and thus have limited habitat value for wildlife. They may, however, play a role in the overall landscape scale habitat selection process of certain early successional species, provide transitional habitats, or provide habitat for a limited number of other species. Therefore, in a general sense or at a large scale, they can be included as part of the overall early successional habitat matrix, though most of the priority early successional species require a more diverse plant community than is often provided at these kinds of sites.

The landscape context can be critical for success of maintaining populations of early succession species, as many of these species depend on the ability to rapidly colonize new areas as succession renders other areas unsuitable, and many of the species in this group are "area sensitive," requiring a minimum contiguous habitat patch size before they will colonize an area or successfully reproduce. Many early succession habitats with otherwise suitable habitat structure may have limited wildlife value if the habitat patch is too small or isolated from other similar habitats.

Historically, the Piedmont contained some prairie-type habitats (Barden 1997) with high plant and, presumably, insect diversity. Around the time of colonization, these Piedmont prairies were maintained through fire and herbivore grazing. Today, remnant tracts of prairie are found primarily along powerline rights-of-way and sites managed specifically for prairie restoration and maintenance.

A. Location and condition of habitat (see Map 5A.16):

Ephemeral by definition, the distribution and location of early succession habitats across the Piedmont can change dramatically within a decade. Currently, most early succession habitats are found on private lands in farmland, recently harvested timberland, powerline rights-of-way, roadsides, and managed Piedmont prairies. The extent and quality of early succession habitats has been greatly dependent upon human land use patterns. While there is some uncertainty of the extent of early succession habitats prior to European settlement, it is likely that many early succession species' populations peaked in the early 1900s with extensive clearing of forests and low-intensity agricultural operations. In the second half of the 20th century, the quantity and quality of early succession habitats have diminished due to reduction of the use of fire, increasing development, encroachment of exotic vegetation, changing agricultural and forestry practices, and fragmentation of habitat patches into small isolated units (Cobb et al. 2002, Johnson and Igl 2001, Thompson and DeGraaf 2001, Warner 1994). Populations of many species that depend on these habitats have also declined during this time period (e.g., Hunter et al. 2001, Litvaitis 2001).

Priority species associated with piedmont early successional habitats:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Aimophila aestivalis*	Bachman's Sparrow	SC
	Ammodramus henslowii	Henslow's Sparrow	SR
	Ammodramus savannarum	Grasshopper Sparrow	
	Caprimulgus carolinensis	Chuck-will's-widow	
	Caprimulgus vociferus	Whip-poor-will	
	Chordeiles minor	Common Nighthawk	
	Colinus virginianus	Northern Bobwhite	
	Dendroica discolor	Prairie Warbler	
	Dolichonyx oryzivorus	Bobolink	
	Empidonax traillii	Willow Flycatcher	
	Falco sparverius	American Kestrel	
	Icterus spurius	Orchard Oriole	
	Lanius ludovicianus	Loggerhead Shrike	SC
	Scolopax minor	American Woodcock	
	Spiza americana	Dickcissel	
	Spizella pusilla	Field Sparrow	
	Sturnella magna	Eastern Meadowlark	
	Tyrannus tyrannus	Eastern Kingbird	
	Tyto alba	Barn Owl	
Mammals	*Cryptotis parva*	Least Shrew	
	Microtus pennsylvanicus	Meadow Vole	
	Mustela frenata	Long-tailed Weasel	
	Peromyscus polionotus	Old-field Mouse	SR
	Scalopus aquaticus	Eastern Mole	
	Zapus hudsonius	Meadow Jumping Mouse	
Reptiles	*Lampropeltis calligaster rhombomaculata*	Mole Kingsnake	
	Lampropeltis getula getula	Eastern Kingsnake	
	Ophisaurus attenuatus longicaudus	Eastern Slender Glass Lizard	
	Terrapene carolina	Eastern Box Turtle	

B. *Problems affecting species and habitats:*

– *Agricultural practices* – The routine land disturbance by agricultural operations provides the best opportunities for early succession habitat creation and maintenance in North Carolina. However, the value of modern farmland for early succession wildlife has been reduced as economic pressures, improvements in equipment and herbicides, and social factors have all led to larger, more uniformly shaped rowcrop fields, as well as "cleaner" fields with fewer weeds in the fields and less weedy edge. Few rowcrop fields are managed to include a fallow rotation. Some beneficial practices, such as no-till planting, have had mixed success in being adopted. In pastureland, the extensive use of exotic cool-season grasses has reduced habitat quality for wildlife. Cutting hay in mid-summer and overgrazing can adversely affect nesting grassland birds.

– *Forestry practices* – Commercial forestry operations create much of the early succession habitat available in the Piedmont. In 2002, about 1.1 million acres (10% of the total land area in the Piedmont) were classified as timber stands <10 years old (Brown and Sheffield 2003). Clear-cutting timber typically results in the creation of early succession habitat for a short period of time. Most of the understory grass, forb, and shrub layers are typically reduced or lost once a newly planted commercial timber stand "canopies out", which occurs typically

7–15 years after timber clearing and planting. Heavily stocked, even-aged pine monocultures typically retain very little understory structure after canopy closure. Economic pressures, improvements in equipment and herbicides, and fast-growing genetic strains of trees have all reduced the amount of time to canopy closure, contributing to loss of early succession habitat. In addition, intensive site-prep techniques can reduce the quality and quantity of herbaceous cover during the early phases of stand establishment. Conversion of longleaf to loblolly pine hampers the ability of foresters to conduct controlled burns during the early years of tree growth. Thinning of mature trees creates another opportunity for understory habitat development, but most commercial operations leave too high a basal area after thinning for much benefit to be realized. "High grading" of mature timber stands, instead of clear-cutting, reduces the potential for early succession habitat creation.

- *Fire suppression* – Suppression of wildfires and lack of controlled burning eliminates an important source of early succession habitat creation and maintenance within many forested habitats. Concerns about uncontrolled fire, liability, air quality, social acceptance, and smoke management, and lack of landowners with the experience and equipment to conduct controlled burns have limited the use of fire on private lands.
- *Habitat loss and fragmentation* – Grass/shrub habitat is lost through the natural process of succession and also through conversion to other land uses. Human development in rural areas of the Piedmont is causing loss and fragmentation of agriculture and forest lands (U.S. Department of Commerce 1992), and hinders the use of prescribed fire. While some early succession species, such as northern mockingbird, song sparrow and black rat snake, have adapted well to human development, most of the priority species for this habitat are harmed by the encroachment of development. While most birds can rapidly find and colonize early succession habitat patches, some bird species (and grassland birds in particular) are area sensitive and will not use small patches of habitat surrounded by forest or developed areas. Bobwhite quail may require large (>5,000 acres) areas of contiguous habitat for long-term population viability (based on Guthery et al. 2000). The isolation of suitable early succession habitats may be most problematic for mammals and herptiles which have limited dispersal ability and may suffer high mortality when traveling through unsuitable habitats. Forest managers can increase connectivity of early succession habitats by planning forestry operations in adjacent stands or creating corridors between timber harvests.
- *Excessive mowing* – Early succession cover in powerline rights-of-way and roadsides is often adversely affected by too frequent or poorly timed mowing. In addition, many areas of fallow ground near houses or businesses are frequently mowed to maintain a neat appearance, while opportunities exist to convert some of these areas to suitable wildlife cover.
- *Public perception* — Fallow or un-mowed areas are seen by many as "messy" and "weedy," and an indicator of a lack of caring or effort by a landowner. This widespread public perception is partially responsible for fallow habitats being reduced in habitat quality or eliminated.
- *Loss of historical Piedmont prairie* – Piedmont prairies contain highly diverse and specialized plant and insect communities. Currently, only small remnant tracts remain. Fire and/or low intensity agricultural operations are necessary to maintain prairie communities. Current restoration efforts are focused on plant conservation and have been implemented on small acreages that have limited value for area-sensitive grassland species such as grasshopper sparrow and eastern meadowlark. Grasslands of >20 acres should be pursued to benefit these species.
- *Exotic species* – The effects of exotic plants, insects, and animals on early succession habitat and native wildlife populations are poorly understood. Impacts are likely to vary widely depending on the species involved, environmental conditions, and management activities. Fire ants are a species of particular concern, especially regarding their potential impact on herpetofauna, small mammals, and ground nesting birds.
- *Collecting for the pet trade* – The impacts of commercial collecting of box turtles on local populations are unknown.

C. Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:

- **Surveys** – Surveys are needed to document the distribution, relative abundance and status of many wildlife species associated with early successional habitats. This need is particularly acute for mammals and reptiles.
  - Survey small mammals to determine the composition of the early succession mammal community in the Piedmont.
  - Determine the distribution of the least shrew, meadow jumping mouse and old-field mouse surveys (especially in Rutherford Co.).
  - Document the status and distribution of mole kingsnake, eastern kingsnake and eastern slender glass lizard and survey for more common amphibians and reptiles using early succesional habitats.
  - Determine the importance of early succession habitats for foraging bats.
  - Implement winter surveys for birds (and other taxa) to measure populations at the time of the year when early succession habitat may be most limiting.
  - Survey for grassland birds that are considered to be steeply declining, are not tracked well by typical survey methods, or have poorly understood distribution and status in the region (e.g., barn owl, grasshopper sparrow, Bachman's sparrow, eastern meadowlark and eastern kingbird).
  - Conduct nocturnal surveys for Chuck-will's-widow and whip-poor-wills, concentrating on foraging areas.
  - Determine vesper sparrow breeding status and loggerhead shrike status and distribution.
  - Conduct migration surveys to determine the extent of use of early succession habitats by post-breeding and migratory birds.

- **Monitoring** – We are aware of few long-term monitoring programs in the Piedmont that are focused on early succession habitats. The best information currently exists for birds (primarily through the Breeding Bird Survey and Christmas Bird Count, though also through Commission and Mecklenburg County Department of Parks and Recreation monitoring programs), while very little population status and trend information is available for mammals and herptiles. High priority should be given to developing monitoring systems for these taxa. The identification of "surrogate species" (those species who may be representative of the habitat needs of a particular guild of species and are widespread enough to allow population monitoring) will facilitate monitoring efforts. For birds we suggest the following surrogate species—Grasslands: eastern meadowlark, northern bobwhite and grasshopper sparrow; Shrublands: field sparrow, indigo bunting, blue grosbeak, prairie warbler, and yellow-breasted chat; Open Woodlands: red-headed woodpecker and brown-headed nuthatch. Surrogate species should be identified for mammal, amphibian, and reptile communities.
  - Develop monitoring systems to determine population trend information for grassland-dependent small mammals.
  - Establish MAPS, winter, and migration bird banding stations—especially in grasslands and hay fields.
  - Continue and expand long-term monitoring of grassland and scrub-shrub birds on Piedmont Game Lands and other public lands.

- **Research** – Research priorities should include understanding the factors that limit populations of at-risk species, and the development and refinement of habitat and population management strategies. Particular effort should be made to find habitat management strategies that are easy and cost-effective to implement on "working" lands. NC State University and other research colleges and universities in the state will be important partners in accomplishing some of these research goals.

Habitat use

- Examine the habitat requirements of habitat specialists and ways to integrate management for these species into commercial agriculture and forestry operations.
- Examine the minimum habitat patch and habitat complex size required to sustain populations of shrub-scrub and grassland birds and mammals. Some studies suggest that patch size may be an important factor affecting both birds (Lanham and Guynn 1998) and mammals (Yates et al. 1997).
- Evaluate the landscape context (amount of suitable habitat in surrounding landscape) for sites where rare species are found.
- Study the responses of bird communities to early successional habitat in managed landscapes and unmanaged landscapes.
- Evaluate the habitat requirements and management needs of grassland-dependent herpetofauna.
- Identify factors limiting populations of loggerhead shrike.

Populations and communities

- Examine impacts of cowbird parasitism and predation on neotropical migrant nesting productivity (e.g., hooded warbler, Kentucky warbler, eastern wood-pewee and worm-eating warbler).

Predator effects

- Identify predators of field sparrow nests, and other species with high nest depredation rates.
- Determine if cowbirds are negatively impacting bird productivity in portions of the western Piedmont with higher densities of livestock and cowbirds.
- Examine the impacts of fire ants on herpetofauna, small mammals, and ground nesting birds, in addition to large scale management actions that could be used to control fire ants.

Other

- Conduct economics and human dimensions research to determine how to make early succession habitat creation and maintenance more financially and socially acceptable for private landowners.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

With a convergence of interest in the conservation of early succession habitats by both game and non-game communities, there is a great opportunity to bring a lot of resources to bear on problems facing this habitat. Both the Northern Bobwhite Conservation Initiative (Dimmick et al. 2002) and the Partners in Flight Southern Piedmont Bird Conservation Plan (Cooper and Demarest 1999) call for similar actions to promote early succession habitat, and both game and non-game objectives have been incorporated into the Commission's early succession habitat initiative, the Cooperative Upland habitat Restoration and Enhancement (CURE) program.

Since the greatest opportunities for creating and maintaining early succession habitat in the Piedmont exists on private "working" lands, the highest priority for conservation actions should be to forge and expand partnerships and programs to promote early succession habitat management on agriculture and forestry lands. Many financial incentive programs are currently in place to facilitate management of private lands (particularly through the Farm Bill), including the Wildlife Habitat Incentives Program, the "bobwhite buffers" (CP-33) program, and CURE, which are designed explicitly to enhance early succession wildlife populations. The most limiting factor for implementation of these programs seems to be technical guidance manpower to solicit and work with private landowners. Potential partners for implementing conservation practices on private lands include but are not limited to the Natural Resources Conservation Service, Farm Services Agency, Soil and Water Conservation districts, Cooperative Extension, consulting foresters, land trusts, sportsman groups (like Quail Unlimited), US Fish & Wildlife Service Partners program, and the Commission.

The Commission has identified "focal areas" for early succession habitat work within the Piedmont and upper coastal plain for the CURE program (see Howell et al. 2002). These focal areas contain landscapes that are considered to provide the greatest potential for early succession habitat management on private lands. These focal areas should be used to prioritize and focus other early succession habitat initiatives. Furthermore, conservation efforts should be geographically clustered, to the extent possible, to create larger areas of contiguous early succession habitat.

Habitat management and restoration actions

- The greatest need and opportunity within private agricultural lands in the Piedmont is to increase the habitat value of pasture and hayfields. Conservation programs should promote the integration of native warm season grasses into livestock operations, and discourage haying or overgrazing during the nesting season.
- On row crop farms conservation actions should focus on using technical guidance and outreach to help promote establishment of field borders, no-till agriculture, fallow rotations, hedgerows, and native herbaceous and shrub plantings. We should proactively encourage the establishment of large blocks of habitat and increasing the connectivity of existing habitats by encourage neighboring landowners to work together to create larger-scale habitat areas. The Commission's CURE program provides one example of how such an effort could be implemented.
- Cooperative agreements and incentive programs should be forged with industrial timber companies to promote best management practices to enhance early succession habitat structure, maintenance and connectivity. An example of such an agreement is the Upper Tar River Memorandum of Understanding signed between International Paper and several North Carolina conservation organizations in 2004. While this agreement focused primarily on riparian habitats, it provides a framework and precedent for the type of voluntary conservation agreement that can be reached with timber companies. Successful promotion of early succession habitat enhancement on industrial timberlands will require an understanding of the financial costs of implementing those practices. The Wildlife and Industry Together (WAIT) program may help with this endeavor. Timber companies, Partners in Flight, Partners in Amphibian and Reptile Conservation, the NC Forest Service, and the Commission will all be important players.
- An effort should be made to encourage the use of controlled burning, including promoting the training of certified burners and addressing liability concerns and air quality concerns. A critical partner in this endeavor will be the NC Forest Service.
- An effort should be made to promote best management practices among non-industrial private timber managers. Practices that should be promoted include pre-commercial thinning, thinning to lower basal areas, controlled burning, minimizing the linear edge of harvest units, and planting longleaf pine where appropriate. Practices that should be discouraged include "high-grade" timber thinnings. Critical partners in this effort include private consulting foresters and the NC Forest Service.
- Sites with potential for restoration of Piedmont prairies should be identified and beneficial management should be proactively promoted. Sources of local-ecotype native seed should be developed for use in restoration projects. The Piedmont Prairie Partnership is providing a framework for those interested in prairie restoration.

Policy-based actions

- The current NC Use Value Assessment Program for assigning land taxes charges higher land taxes for land managed exclusively for wildlife than for land in agricultural or forestry production. This creates a financial disincentive for landowners to convert working lands into permanent wildlife cover. This tax code [including N.C.G.S. 105-160A-49(fl), 105-277.2 through 105-277.7, 105-289(a)(5) and (6), 105-296(j), and 106A-37(fl)] should be amended to include managed wildlife habitat in the same land valuation category as agriculture and forestry (Cobb et al. 2002).

– Land use planning should be promoted to minimize development within large, unfragmented tracts of farm and forestland, particularly within the CURE focal areas and in regions that are not yet experiencing heavy development pressure. Critical partners in this endeavor include county commissions and zoning boards, developers, the NC Department of Transportation, land trusts, and the American Farmland Trust.

Protection actions

– Conservation organizations should consider acquisition of upland agricultural habitats, which could be subsequently leased to tenant farmers with stipulations for favorable early succession habitat management practices. A high priority should be placed on acquiring sites with potential for restoration of Piedmont prairies.
– Easement programs that protect farm and forestland from development should be promoted, particularly within the CURE focal areas. Land trusts and the Natural Resources Conservation Service will be important partners.
– Educate the public on the value of early succession habitats and on the beneficial role of controlled burning. Teachers, nature centers, Cooperative Extension agents, foresters, and the Commission's Division of Conservation Education are among the educators who can help in this endeavor.

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Piedmont Ecoregion

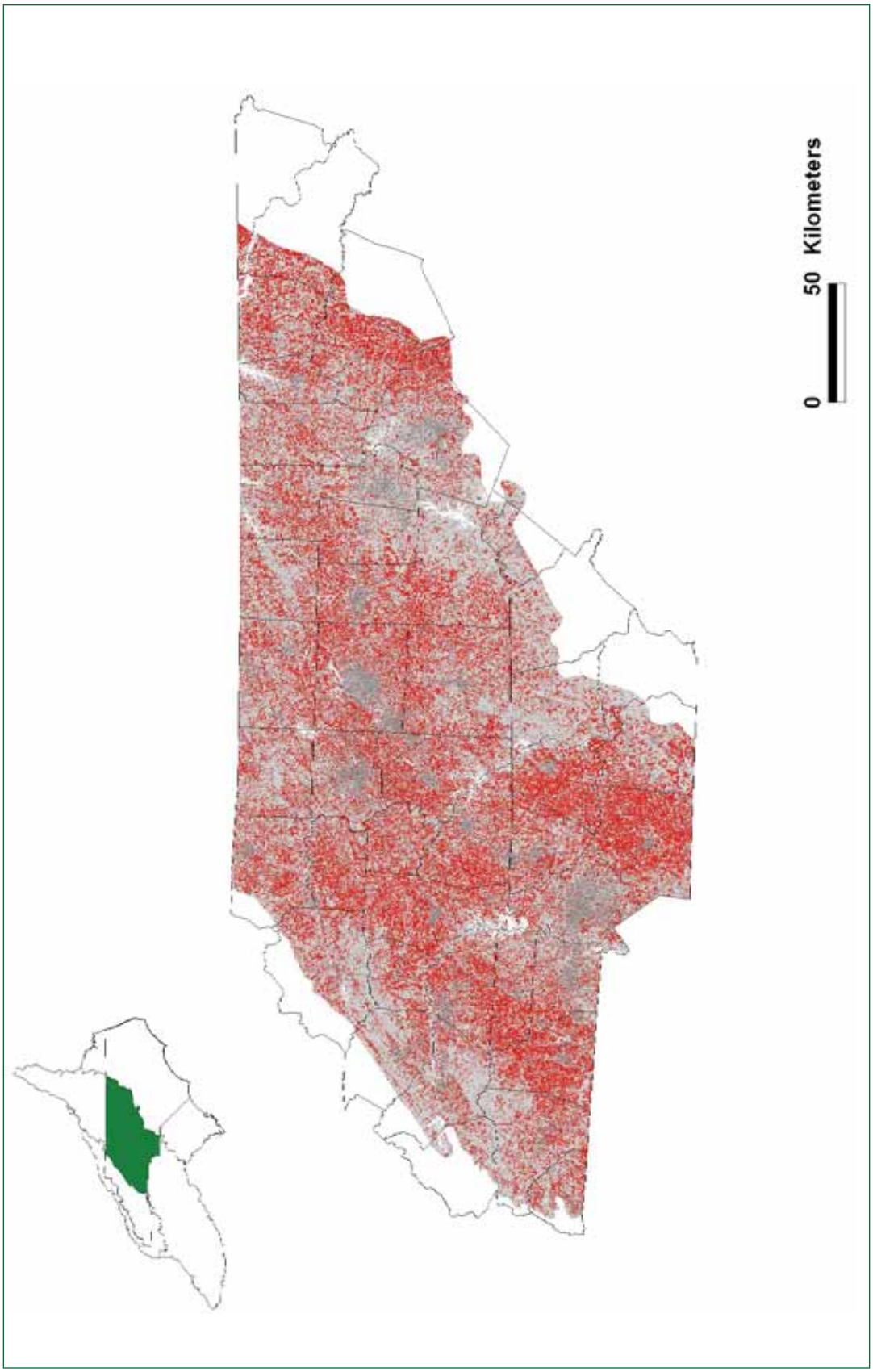

Figure 5A.16. Early successional habitats (including agricultural areas) in the Piedmont ecoregion of North Carolina (in red) (data source: NC GAP, 1992). *Note: Due to the ephemeral nature of these habitats, this coverage may not be entirely accurate as of 2005. However, it should still give readers an indication of the extent of these habitats across the region.*

17. **Floodplain forest** – Piedmont floodplain forests generally do not contain significant recognizable elevation differences easily seen in the larger coastal floodplain systems. In these smaller floodplains, the relief and size of the fluvial landforms (levees, sloughs and ridges), which differentiate the communities in large floodplains, become smaller and harder to find (Schafale and Weakley 1990). In larger and more expansive examples of these floodplains, the forest canopy contains a good mixture of bottomland and mesophytic (moderately moisture tolerant) plant species, such as green ash, red maple, swamp chestnut oak, willow oak, and American elm. In areas where floodplain landforms are apparent, levees may contain sycamore, river birch and box elder. Floodplain areas that have been farmed or clearcut recently are usually dominated by tulip poplar or sweetgum.

    Piedmont floodplain communities include Piedmont Levee Forest, Piedmont Swamp Forest, Piedmont Bottomland Forest, Floodplain Pool, Piedmont Semipermanent Impoundment and Piedmont Alluvial Forest (Schafale and Weakley 1990). Piedmont Alluvial Forest is quite common as a habitat type although the vegetative buffers surrounding them can be quite small or fragmented. Some of the best remaing examples of Piedmont Bottomland Forest and associated large floodplain communities are at New Hope Creek Bottomland in Durham County, Pee Dee National Wildlife Refuge in Anson and Richmond Counties, and along the Dan River. The widest floodplains are located within Triassic Basins, which contain more easily erodable sedimentary rock than are found elsewhere (metamorphic rock).

    Piedmont Alluvial Forests are distinguished from larger floodplain communities by the absence or poor development of the depositional fluvial landforms, which determine vegetation (Schafale and Weakley 1990). Levees, sloughs and ridges may be visible in alluvial forest communities but are usually small. Variation in these sites is likely related to frequency and recentness of large-scale flood events.

    Historically, many floodplains were maintained in switch cane (*Arundinaria gigantea*) and herbaceous plants through fire and other periodic disturbance. Small remnants of "canebrake" communities still exist throughout the Piedmont, but management strategies to maintain this feature are almost non-existent. Migratory landbirds that use switch cane areas for breeding include hooded warbler, Kentucky warbler and Swainson's warbler.

    Floodplain pools that occur in small depressions and are flooded for a portion of the year generally have few or no trees and are especially important sites for breeding amphibians such as spotted salamander, marbled salamander, four-toed salamander and many frogs. Piedmont floodplains are also important as movement corridors for mammals, reptiles, and amphibians. Birds use riparian corridors at all times of the year and these areas are especially important to neotropical migrants during the migration periods. Indeed, floodplain forests generally have the highest nesting bird concentrations in the state and they are arguably the most important habitats for birds. In general, our knowledge about how wildlife use altered or fragmented habitat is lacking especially for animals other than birds or bats (Ellis et al. 2002) and we need to develop more accurate and usable protocols for sampling many species using floodplains such as amphibians to better understand status, distribution and life histories (Taylor and Jones 2002).

A. Location and condition of habitat (see Map 5A.17):

Floodplain forests of some type are found beside most rivers and streams in the Piedmont. They are of varying widths, depending upon the topography of land adjacent to the river, and the transition between floodplain and upland forest is often gradual. In 2002, 150,900 acres in the Piedmont were classified as oak-gum-cypress and 97,000 acres as elm-ash-cottonwood for a total of 247,900 acres of bottomland-related trees, or a little over 2% of the land area in the Piedmont (Brown and Sheffield 2003).

Human-influenced alterations have affected much of the Piedmont's riverine and floodplain habitats. Logging, clearing land for agriculture, development, recreational use, and reservoir construction all cause direct loss and alteration of floodplain forests. In the past half century, an estimated 52% of bottomland forests in the south have been cleared for agriculture or development (Smith et al. 2001). Land clearing activities conducted adjacent to, and up and

Priority species associated with piedmont floodplain forest:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Caprimulgus vociferus*	Whip-poor-will	
	Coccyzus americanus	Yellow-billed Cuckoo	
	Colaptes auratus	Northern Flicker	
	Contopus virens	Eastern Wood-pewee	
	Haliaeetus leucocephalus	Bald Eagle	T (T)
	Helmitheros vermivorous	Worm-eating Warbler	
	Hylocichla mustelina	Wood Thrush	
	Limnothlypis swainsonii	Swainson's Warbler	
	Melanerpes erythrocephalus	Red-headed Woodpecker	
	Nyctanassa violacea	Yellow-crowned Night-heron	
	Oporornis formosus	Kentucky Warbler	
	Picoides villosus	Hairy Woodpecker	
	Scolopax minor	American Woodcock	
	Wilsonia citrina	Hooded Warbler	
Mammals	*Corynorhinus rafinesquii*	Rafinesque's Big-eared Bat	T
	Lasiurus seminolus	Seminole Bat	
	Myotis austroriparius	Southeastern Bat	SC
Amphibians	*Ambystoma maculatum*	Spotted Salamander	
	Ambystoma opacum	Marbled Salamander	
	Ambystoma talpoideum	Mole Salamander	SC
	Eurycea guttolineata	Three-lined Salamander	
	Hemidactylium scutatum	Four-toed Salamander	SC
	Hyla versicolor	Northern Gray Treefrog	SR
	Plethodon glutinosus sensustricto	Northern Slimy Salamander	
Reptiles	*Clemmys guttata*	Spotted Turtle	
	Clemmys muhlenbergii	Bog Turtle	T (T)
	Crotalus horridus	Timber Rattlesnake	SC
	Elaphe guttata	Corn Snake	
	Eumeces laticeps	Broad-headed Skink	
	Heterodon platirhinos	Eastern Hog-nosed Snake	
	Lampropeltis getula getula	Eastern Kingsnake	
	Terrapene carolina	Eastern Box Turtle	
	Thamnophis sauritus sauritus	Common Ribbonsnake	

down-stream of floodplain forests can cause indirect impacts to the floodplains, particularly related to hydrology. Areas adjacent to floodplains are often prime targets for general development and subdivisions, and buffer size is often inadequate to provide any protection from a variety of anthropomorphic disturbances over time. For instance, flooding events may occur with greater frequency in some areas due to increased upstream impervious surfaces and clearing of vegetation near buffers.

Managed river flows from dams have altered the natural flow regime, and in particular have impacted the timing and intensity of overbank flow into the floodplain, altering both water and sediment deposition. The input of nutrients from flood events makes levee sites along streams and rivers very fertile, and overbank flows help to recharge vernal pools in the wetland. Changes in flow regimes may eventually lead to changes in the floodplain plant and animal communities (Schafale and Weakley 1990).

Sediment pollution is a major concern in most stream and river systems in the Piedmont. The condition of some Piedmont floodplain forests is greatly degraded by these impacts. The Pee Dee and Dan River basins contain some of the larger tracts of intact floodplain forest left in the Piedmont and offer some of the best opportunities for large-scale habitat conservation. Beaver activity and the creation of beaver ponds in floodplain forest can have substantial impacts on trapping sediment and associated pollutants.

Exotic plant species such as Japanese honeysuckle, Japanese grass and Chinese privet are frequent invaders in small floodplain systems, especially if these areas have been logged in the past. The reduction in overall plant diversity is often extensive due to these invasive non-native plants and may cause problems for native fauna, though the extent of wildlife impacts is largely unknown.

Floodplain sites are often prime candidates for farmlands, and few bottomlands of any large size remain. Intact Bottomland Forests, especially without exotic species invasion, are among the rarest of natural communities in North Carolina (Schafale and Weakley 1990). Floodplain Pools are widespread in the Piedmont but are generally small in size. Pools that dry out less frequently (or seldom dry out) can develop permanent aquatic communities (with fish) that are often unsuitable for breeding amphibians. Sediment pollution is now a major problem for many floodplain pools in the Piedmont.

B. Problems affecting species and habitats:

- *Direct habitat loss* – Riparian forests have become scarce in the Piedmont because many of these areas are now used for food and fiber production. Additionally, many riparian areas were lost to create reservoirs, and some have been cleared for development. Many are damaged by construction of sewerlines, which are built almost exclusively in floodplains.
- *Altered hydrology* – The most significant source of habitat alteration is altered hydrology. Altered hydrology changes plant communities and also affects the availability of ephemeral wetlands for breeding amphibians. Building ditches and canals in floodplains dramatically alters hydrology and is often done to prepare a floodplain for agriculture, forestry, or development. Even in abandoned sites, ditches will continue to alter the hydrology for many decades. Bank stabilization efforts can alter riverine dynamics that create oxbow lakes and some ephemeral wetland habitats important to amphibians. Controlled flows downstream of dams and the construction of levees can reduce overbank flood events which are important for recharging ephemeral wetlands and spreading nutrients in the floodplain. However, excessive flooding can also be problematic. Increased severe flooding can be caused by reduction of vegetated floodplains and increases in impervious surfaces in the uplands. Dams can alter the timing and duration of flood events. Flooding for long periods of time during the breeding season can harm plant and animal reproduction and severe floods also threaten human safety and property.
- *Habitat fragmentation* – As floodplain forests are lost or altered, the remaining tracts of forest become smaller and more isolated. New highways and other corridors are often constructed across floodplains, fragmenting the floodplain forest. Floodplains are used as travel corridors by many species and fragmentation may alter dispersal and migration patterns. Reptiles and amphibians may be particularly vulnerable to reduced movement when the matrix surrounding the forest becomes unsuitable. The reduced size of remaining forest patches may impact area sensitive birds (Kilgo et al. 1998) and small mammals (Yates et al. 1997). Clearing of adjacent uplands can increase edge effects and limit the effective size of floodplain forest habitat.
- *Lack of old growth dynamic* – Old growth floodplain forests contain large diameter trees, snags, dead wood, and canopy gaps that support dense undergrowth. Some younger riparian forests and those that lack periodic habitat disturbance can have a reduced number of snags. Snags play a very important role in providing nesting, foraging, and roosting areas for many cavity nesting birds, bats, arboreal mammals, reptiles and amphibians. Lack of snags and den trees is often a limiting factor for several species of wildlife, especially secondary cavity users (McComb et al. 1986). Younger riparian forests can also lack dead wood on the ground,

which is important for some songbirds (e.g., Kentucky warbler), many reptiles, amphibians, and some small mammals. Habitat disturbance can be important for creating canopy gaps which create small pockets of dense, low growth (valuable for nesting for Swainson's warbler, hooded warbler, Kentucky warbler and wood thrush), provide cover for American woodcock, and are valuable foraging areas for many juvenile birds. Stream snagging (clearing woody debris within stream channels) after storms can reduce habitat structure, particularly for reptiles and amphibians among terrestrial creatures (*aquatic organisms are covered under the river basin sections in this Plan*). Snagging can also alter river hydrology and morphology. "High grade" logging operations removes the larger trees that provide important habitat structure for wildlife, while the low-quality trees that are left can often hamper the regeneration of more wildlife-favorable trees.

– *Water quality* – Poor water quality due to nutrient inputs, reduced dissolved oxygen levels, sedimentation, and chemical contamination (among others) can have a strong impact on amphibians, turtles, and other animals associated with floodplain forests that forage or breed in aquatic areas, in addition to the direct impacts on fully aquatic species. Sediment pollution is a major problem in the Piedmont of North Carolina. (*See river basin sections for further discussion of water quality issues within specific basins*).

– *Exotic plants* – Japanese grass (*Microstegium vimineum*) can suppress the growth of other plants, alter habitat structure, and has little wildlife value. Other common invasive plants that impact floodplain community structure include Chinese Privet and Japanese honeysuckle, though these plants have some limited wildlife value. In general, the density of exotic, invasive plants in small to medium sized floodplain forests in the Piedmont is significant though the resulting impact on wildlife populations is largely unknown.

– *Loss of canebrake communities* – Historical data indicate that extensive stands of switch cane (*Arundinaria gigantea*) have been drastically reduced throughout the Piedmont. Cane communities are maintained through fire or other periodic disturbance. While fires would likely not burn very hot or well through many floodplains due to the moist soils, floodplains with extensive canebrakes historically burned periodically, which helped to maintain and expand these canebrakes. Canebrakes benefit Swainson's warbler, Kentucky warbler, hooded warbler, wood thrush, American woodcock, and timber rattlesnake, among others. Fire suppression and development adjacent to floodplains has contributed to a loss of large canebrakes, which have been replaced primarily by other woody vegetation.

– *Commercial collecting of turtles* – The extent of commercial collecting of bog turtle and spotted turtle for the pet trade, and its impact on local populations is unknown, but potentially a problem.

C. *Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:*

- **Surveys** – Priorities for conducting surveys need to focus on species believed to be declining, at risk or mainly dependent on floodplain communities. Bat surveys and amphibian surveys are considered high priorities for this habitat. Secondary priority for surveys should be for species for which current distribution information is already available, or for species that are generalists in terms of habitat usage.
  – Determine the breeding distribution and status of floodplain associated bird species (e.g., Swainson's warbler and Louisiana waterthrush).
  – Conduct nocturnal surveys to determine the population status and distribution of Chuck-wills-widow and Whip-poor-will.
  – Inventory heron and egret rookeries.
  – Determine the distribution and population status of bats in Piedmont floodplain forests. Few systemic surveys have been conducted throughout the Piedmont region; most of these surveys have been conducted or coordinated by the NC Museum of Natural Sciences. In addition to Rafinesque's big-eared bat, Seminole bat, and southeastern bat, it is possible that other priority bats may be found in the Piedmont. Northern yellow bats may occur in the eastern Piedmont, and northern long-eared bats may occur in the western Piedmont. Hoary bats have been detected in acoustical surveys along the Pee Dee river.

- Determine the distribution and population status of terrestrial small mammals, like golden mouse and shrews, in Piedmont floodplain forests.
- Determine the status and distribution of mole salamander, four-toed salamander, gray treefrog, and timber rattlesnake (and conduct surveys to determine the distribution and status of many common reptiles and amphibians).
- Identify both breeding sites and travel corridors for bog turtle in the northwestern Piedmont.

- **Monitoring** – Few of the existing monitoring efforts adequately cover floodplains (e.g., the Breeding Bird Survey does not adequately sample floodplains).
  - Establish selective monitoring systems for bird species that are difficult to detect by conventional survey protocols (e.g., Swainson's warbler, Kentucky warbler and other floodplain bird species). (A monitoring program for birds in floodplain forests on Caswell Game Land, Caswell County, was initiated by the Commission in 2004).
  - Establish more MAPS and migration-period bird banding stations.
  - Conduct long-term monitoring of heron and egret rookeries.
  - Continue monitoring of bald eagle nesting territories.
  - Initiate long-term bat population monitoring.
  - Initiate long-term reptile and amphibian monitoring in floodplain pools in particular.

- **Research**

  Predator effects
  - Conduct studies about nesting success, productivity and survival of floodplain birds in buffers of different widths; this could provide some insight into population declines and help to guide management recommendations for buffer width.

  Habitat use
  - Identify those reptile and amphibian species that are most vulnerable to direct mortality and isolation from roads. Strategies to mitigate the impacts of roads should be devised and tested.
  - Determine the extent of the use of floodplains as travel corridors for bog turtle in the western Piedmont; determine any management actions that are needed to facilitate use by bog turtles.
  - Determine the extent and timing of use of riparian corridors by birds during the migration period.

  Management practices
  - Evaluate the distribution, impacts on native wildlife, and feasibility of control of feral hogs, which are very common at inner coastal sites along major rivers adjacent to the Piedmont (e.g., Howell Woods in Johnston County), and are found sporadically throughout the Piedmont.
  - Examine ways to effectively restore canebrake communities, and determine the response of birds, mammals, amphibians and reptiles to the reestablishment of switch cane stands.
  - Study the effects of various river flow regimes on ephemeral pool habitat in floodplains, to help develop management recommendations for dam releases. This research will be particularly critical to help guide management recommendations in the Federal Energy Regulatory Commission relicensing process for dams along the Yadkin, Pee Dee, and Catawba rivers.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

Conservation of floodplains is complicated by the fact that many conservation actions also require protection of associated uplands and upstream riparian systems. However, floodplains are the highest priority habitat for conservation in the Piedmont because of their importance to birds (Cooper and Demarest 1999), bats, and herpetofauna. Intact floodplains are equally important for protecting aquatics habitats.

Habitat management and restoration actions

- Restoration projects are needed to create oxbow lakes, shallow wetlands, snags, and canopy gaps in appropriate locations. Smith et al. (2001) indicate that small openings (<0.26ha) comprising <22% of the total area of old-growth bottomland forest may help enhance bird species diversity. Incentive programs for landowners (like the Forest Landbird Legacy Program) could encourage reforestation or structural improvement of floodplain forests.
- In managed rivers, restore stream flows that promote controlled overbank flows and hydrological connectivity between the river and the floodplain.
- Opportunities to restore cane break communities should be sought, through controlled burning or other management.
- Large trees should be maintained around reservoirs for potential eagle nests, and forest cover should be maintained in the tailrace below dams for eagle foraging.
- Population control of feral hogs may be necessary in some areas in the near future.
- Greenways maintained for public recreation should be created and managed to reduce the width of pedestrian paths so that the overhead tree canopy is not broken, and native plant communities are not degraded (Novotny 2003, Hull 2003).

Policy-based actions

- Land use planning and zoning laws are needed to limit development, land clearing, and hydrology alterations within floodplains (e.g., route highways and other corridors that cross floodplains as closely as possible to existing corridors to avoid fragmenting an extensive corridor of forest; try to avoid routing sewerlines through high quality floodplain).
- Promote stormwater management regulations and efforts to control point source pollution.

Protection actions

- Land acquisition and/or conservation easements are key to maintaining or restoring connectivity between forest stands. Land protection efforts should be targeted to enhance the size and connectivity of existing protected areas.
- Establishment and conservation of large riparian buffers and land in the adjacent uplands could benefit many neotropical migrants, as well as other taxa. Riparian buffers should be at least 100m wide to benefit breeding area-sensitive forest birds (Keller et al. 1993, Hodges and Krementz 1996). For private lands, Cooper and Demarest (1999) recommend buffers of 30m per side on order 1–2 streams, 100m per side on order >3 streams, and 500m per side on all rivers.
- Minimize land clearing and disturbance around eagle nests and heron rookeries.

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Piedmont Ecoregion

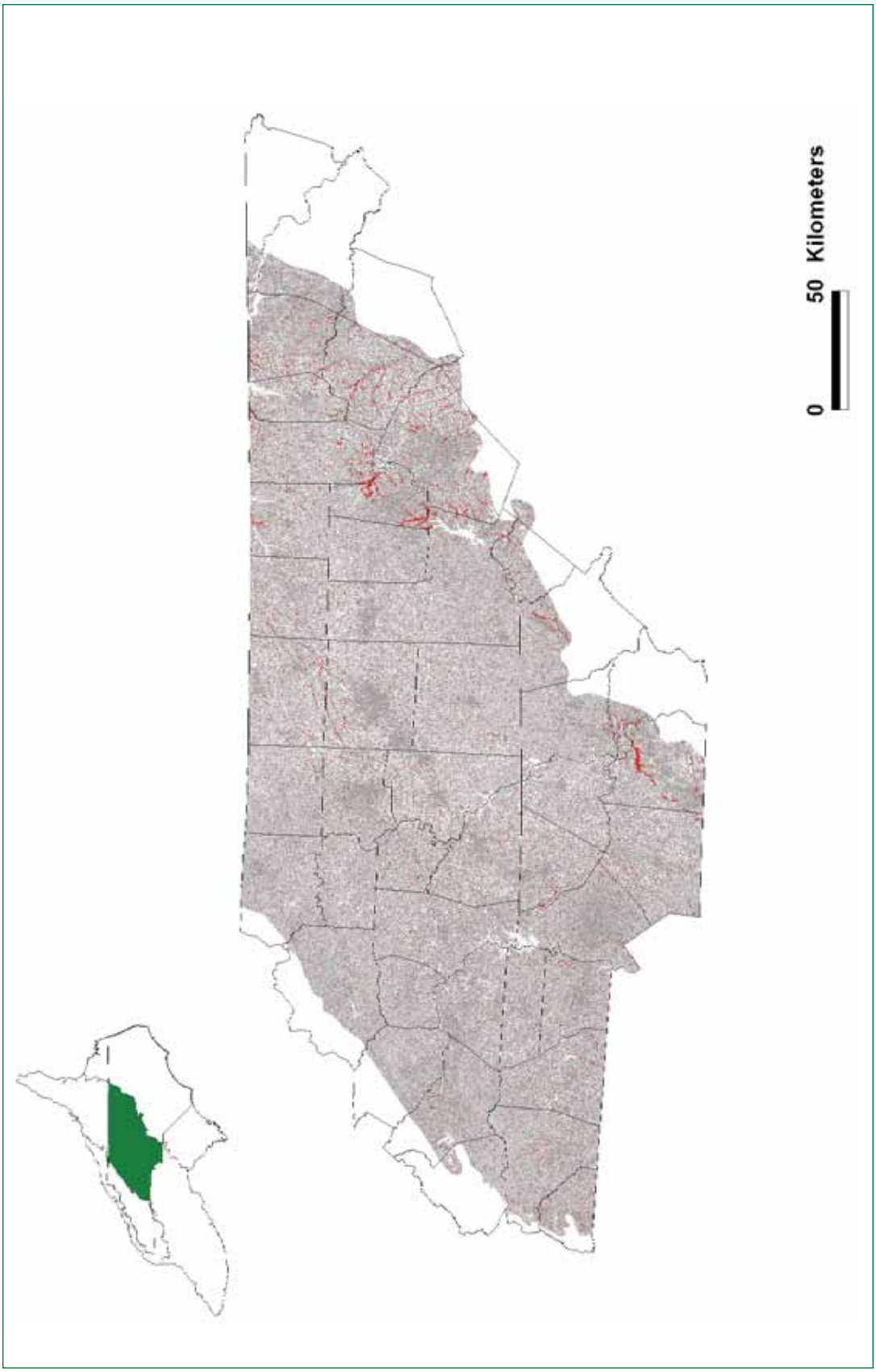

Figure 5A.17. Floodplain forest habitat in the Piedmont ecoregion of North Carolina (in red) (data source: NC GAP, 1992).

18. **Small wetland communities** – This habitat type can include vernal pools, seeps, small depression ponds, ephemeral wetlands and beaver ponds. Some depressions may hold water for a significant portion of the year; others may be saturated for only a few months. All Piedmont wetland habitats are especially important as breeding sites for amphibian species. Small wetlands can also be important breeding habitat for crayfishes (*for more about crayfishes and other aquatic taxa, see the individual river basin sections*). Wading birds, waterfowl, and songbirds, too, may also use small wetland communities for nesting and feeding areas. (*Note: western Piedmont bog habitats are covered under the "Bogs and associated wetlands" section in the Southern Blue Ridge portion*).

    Piedmont communities in this category include Upland Pool, Upland Depression Swamp Forest, and Low Elevation Seep (Schafale and Weakley 1990). Upland Pools are a rare habitat type in the Piedmont, dominated by wetland shrubs and herbs and are small depressions where water is ponded by an impermeable substrate. Tree species along the edge of these habitats may include black gum, water oak, red maple, and sweet gum. Shrubs may include buttonbush, blueberries, and swamp doghobble. Royal ferns, sedges, sphagnum, and other mosses are found in the herb layer. Upland Depression Swamp Forest occurs on poorly drained upland flats or depressions scattered throughout the Piedmont. These communities often have several tree species present (e.g., willow oak, red maple, sweet gum) with a sparse shrub layer such as blueberry, black haw, or arrowwood (Schafale and Weakley 1990). Low Elevation Seeps are found at the edge of floodplains or the base of slopes and are generally covered in a variety of herbaceous species (though usually lacking in sphagnum moss).

Priority species associated with piedmont small wetland communities:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Melanerpes erythrocephalus*	Red-headed Woodpecker	
	Nyctanassa violacea	Yellow-crowned Night-heron	
Amphibians	*Ambystoma maculatum*	Spotted Salamander	
	Ambystoma opacum	Marbled Salamander	
	Ambystoma talpoideum	Mole Salamander	SC
	Ambystoma tigrinum	Eastern Tiger Salamander	T
	Eurycea guttolineata	Three-lined Salamander	
	Eurycea quadridigitata	Dwarf Salamander	SC
	Hemidactylium scutatum	Four-toed Salamander	SC
	Hyla gratiosa	Barking Treefrog	
	Hyla versicolor	Northern Gray Treefrog	SR
	Scaphiopus holbrookii	Eastern Spadefoot	
Reptiles	*Clemmys guttata*	Spotted Turtle	
	Thamnophis sauritus sauritus	Common Ribbonsnake	

A. Location and condition of habitat[1]:

Piedmont wetland habitats are heavily impacted, and have been greatly reduced, by development, roads and drainage throughout the region. While often small in size, cumulatively these habitats provide critical breeding habitat for many amphibian species. The loss of ephemeral wetland communities in the Piedmont has strong ramifications for future amphibian populations.

[1]A map of this habitat is not provided, due to scale and sensitivity issues.

Beaver ponds are a natural community, but result from modification of other community types. Beavers were extirpated in North Carolina by the late 1800s, due to the high demand for beaver pelts, but were reintroduced in 1939. Since that time, beaver recovery has been wildly successful, resulting in an increase in wetland habitat, but also an increase in complaints about beaver-caused damage to private property (e.g., flooding in agricultural areas). With stable beaver populations, beaver ponds can be maintained for decades. However, beaver-caused damage to trees and property has resulted in the destruction of many beaver dams. A reduction of beaver ponds will place more importance on man-made ponds as the primary habitat for many lentic aquatic species. Dead trees in beaver ponds are important foraging and nesting habitat for woodpeckers, such as the red-headed woodpecker, and for wood duck nesting.

B. Problems affecting species and habitats:

- *Roads* – Increased road densities are correlated with declines in amphibian diversity and abundance (Vos and Chardon 1998, Findlay et al. 2001, Fahrig et al. 1995). Roads can cause heavy mortality for reptiles and amphibians and can effectively isolate breeding populations, or separate wetland habitats from upland habitats that are used during non-breeding portions of amphibian and reptile life cycles.
- *Water quality* – Increases in impervious surfaces causes excess stormwater runoff and pollution from point and non-point sources, which degrades water quality. Most amphibians are highly sensitive to changes in water quality.
- *Drainage* – Some wetland communities are drained for agriculture or development, causing direct habitat loss. Loss of ephemeral wetland habitats severely impacts amphibians (Bailey et al. 2004).
- *Alteration of hydrology* – Cutting ditches through wetlands can alter their hydrology and habitat quality. Excess stormwater runoff can also change wetland hydrology.
- *Introduction of fish, bullfrogs, and other predatory species* – Ephemeral and isolated wetlands are very valuable to amphibians because they typically do not support fish and other predators of amphibian eggs. The introduction of fish, bullfrogs, and other predatory species can devastate the breeding effort of amphibians in small wetlands.
- *Timber harvest* – Clearcutting near ephemeral wetlands causes higher solar radiation and an increase in probability of wetlands drying out; also, timber harvest may introduce weedy plant invasions of wetlands.
- *All Terrain Vehicles* – The excessive use of all terrain vehicles (ATVs) and other recreational vehicles can cause significant damage around wetland communities. ATVs can cause soil disturbance, increase erosion and sedimentation, elevate vehicle related mortality rates, and cause noise-related disruptions of faunal activities (Bailey et al. 2004).

C. Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:

- **Surveys**
  - Identify the location of key small wetland communities in the Piedmont.
  - Initiate distribution surveys for all amphibian species associated with small wetland communities, but especially the mole salamander, eastern tiger salamander, dwarf salamander, and four-toed salamander.
  - Gather better information about the status and distribution of more common species associated with Piedmont wetland habitats (e.g., three-lined salamander, common ribbonsnake).
  - Determine woodpecker use of dead trees in beaver ponds.
- **Monitoring**
  - Determine population trends and persistence of small wetland breeding amphibian populations, particularly mole salamander, eastern tiger salamander, dwarf salamander, and four-toed salamander.

- **Research**
  - Focus habitat use studies on bats and small mammals to clarify how small mammals and bats use these wetlands; little is known about the value of small wetland communities in the Piedmont for those groups.
  - Study the efficacy and practicality of "toad tunnels" and other wildlife crossings that allow passage under roadways and help maintain connectivity between wetland metapopulations.
  - Determine minimum upland buffers required to sustain at-risk amphibian populations.
  - Explore management strategies to eradicate undesirable species, such as bullfrogs, from wetlands..

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

A high priority should be placed on protecting wetlands and adjacent uplands through acquisition or easement. Seasonal wetlands must have sufficient surrounding habitat in order to support the life history requirements of amphibian and reptile populations. Every effort should made to maintain continuous gradients between wetland and upland sites; roads, agriculture, or forestry operations between complimentary sites may render them ineffective at supporting amphibian and reptile populations (Bailey et al. 2004). Land trusts can be a valuable partner in this effort.

Wetland restoration efforts should focus on restoring the natural hydrology, water quality, and plant communities of degraded wetlands, and on creating new ephemeral wetlands in suitable locations. The Natural Resources Conservation Service's Wetlands Reserve Program provides a good tool for promoting wetland conservation on private lands. Several sources of information are available (Biebighauser 2002, Thompson and Luthin 2004, EPA 1993) to assist in constructing and restoring wetlands. The Ecosystem Enhancement Program will likely play a key role in wetland protection and restoration in North Carolina.

There is great need to promote the adoption of agricultural and forestry best management practices that reduce run-off, erosion, and pollution. The federal Farm Bill and other cost share programs provide incentives for land stewards to adopt these practices. Technical guidance manpower is needed to proactively promote and facilitate participation in these programs.

Beaver ponds can be a nuisance to landowners when they flood farm fields or commercial timber. Several techniques have been developed to minimize beaver damage while maintaining some benefit from impounded waters. The Beaver Management Assistance Program administered by US Department of Agriculture Wildlife Services offers assistance with lethal and non-lethal beaver management. Perhaps an even more effective way to mitigate beaver damage suffered by landowners is through property tax incentives. Strategies to promote techniques for managing beaver damage that minimize the loss of quantity and quality of beaver ponds should be explored.

Strategies for the effective removal of introduced aquatic predators must also be developed, and a mechanism for identifying and prioritizing sites for removals worked out.

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19. **Riverine aquatic communities** – Piedmont riverine habitats are important for a number of wildlife species that utilize aquatic habitats during part or all of their life cycle. Terrestrial species that are dependent upon riverine aquatic communities are often also intimately tied to floodplain forest habitats. Many of the issues from the floodplain forest section will also have relevance for these taxa. Examples for birds that utilize river and streams include the Louisiana waterthrush, some waterfowl, wading birds and some shorebirds. Piedmont riverine habitats are important for a number of reptiles and amphibians including certain turtles, frogs, and salamanders that utilize aquatic habitats during part or all of their life cycle. These habitats are also important for a variety of mammals that are semi-aquatic and/or that have an aquatic food base (e.g., muskrats, beavers, river otters, and certain bats).

    Piedmont rivers and streams provide a number of important habitat, life cycle, or prey components to a vast assemblage of terrestrial, semi-aquatic, and aquatic wildlife. In addition, the importance of maintaining water quality of riverine habitats cannot be overstated, both in terms of the species that rely upon rivers and streams for habitat, as well as those species which rely indirectly upon the habitat by virtue of provision of habitat for their prey.

    Other fully aquatic taxa (fish, mussels, crayfish, and snails) are referenced in the river basin portion of the report. See the river basin sections (Chapter 5B) for more detailed information on aquatic species and habitats, by basin.

Priority species associated with piedmont riverine aquatic habitat:

Group	Scientific Name	Common Name	State Status (Federal Status)
Amphibians	*Eurycea guttolineata*	Three-lined Salamander	
Reptiles	*Apalone spinifera aspera*	Gulf Coast Spiny Softshell	
	Farancia abacura abacura	Eastern Mudsnake	
	Kinosternon baurii	Striped Mud Turtle	
	Thamnophis sauritus sauritus	Common Ribbonsnake	

A. Location and condition of habitat[1]:

Riverine aquatic communities are found alongside and within all Piedmont rivers. Human-influenced alterations have affected much of the Piedmont's riverine and floodplain habitats. Water quality and quantity have been impacted by run-off from municipalities, some poorly managed agricultural operations and especially sediment pollution from construction and road building. Dam construction has altered flows and river hydrology and morphology. Removing woody debris from streams after storm events has influenced in-stream habitat structure. The ecological condition of some Piedmont rivers is greatly reduced due to these impacts. However, some sections of Piedmont rivers are designated High Quality Water and Outstanding Resource Water Management Zones and provide excellent opportunities for maintaining relatively pristine waterways (*see Broad, Catawba, Yadkin-PeeDee, Roanoke, Cape Fear, Neuse, and Tar-Pamlico River Basin sections*).

B. Problems affecting species and habitats:

Water quality deterioration, and changes in river morphology and hydrology are the most serious problems affecting wildlife that utilize riverine habitat. Water pollution, originating from both point and non-point sources, continues to pose a threat directly to species that occur in riverine habitat, and also impacts these species indirectly through alteration of the food base or habitat.

[1]See the basin maps associated with the Broad, Catawba, Yadkin-PeeDee, Roanoke, Cape Fear, Neuse, and Tar-Pamlico River basins.

– *Urban runoff* – A high priority concern is runoff from impervious surfaces. As more of a watershed is paved, flooding after storm events can become more severe, causing scouring and sedimentation in rivers. Scouring flows can strip salamander eggs from river banks and vegetation, reducing reproductive success. Lawn pesticides, road oil, and other pollutants are also carried into waterways. Direct and indirect impacts of decreased water quality upon wildlife associated with riverine habitat are difficult to quantify, and have not been as fully explored as have impacts upon fully aquatic species. However, there is little doubt that clean water is critical to a host of species that live in rivers and streams for a portion of their lives, and that sedimentation, channel scour, and other alterations of the physical habitat can lead to both deterioration of the habitat quality and negative impacts upon aquatic flora and fauna, which form the base of the food web for numerous wildlife species.

– *Agricultural runoff* – Another potential source of pollution is runoff of pesticides, fertilizers, and sediment from agricultural row crop fields. These problems are most severe where there are not sufficient vegetated buffers between agricultural fields and waterways. The presence of drainage tiles can circumvent the benefit of vegetated borders by carrying runoff directly to waterways.

– *Livestock operations* – Cattle that water in rivers and streams can cause bank erosion and increase sedimentation downstream. To alleviate this problem, cattle should be fenced out of natural waterways and provided with alternative water access.

– *Impoundments* – River and stream impoundments exist along most major (and many minor) waterways in the Piedmont. These impoundments serve a variety of purposes including hydroelectric power generation, flood control, water supply, and recreation/aesthetics. Impoundments convert lotic habitat to lentic, causing a shift in the food base and both direct and indirect effects on wildlife communities. We do not know the overall impact upon the presence of wildlife species from the indirect effects of river or stream impoundment. Alteration of hydrology, geomorphology, and connectivity (both within river systems and between river and floodplain) through artificial levees, rip rap, or dams can also impact in-stream habitat structure.

– *Development* – Human development in floodplains or riparian areas can degrade riverine habitat. River or stream-front development without sufficient buffers may impact water or habitat quality in the stream or river. The impacts of development includes potential problems associated with direct input of contaminants and sediment, alteration of hydrologic patterns and processes, temperature regimes, and loss of critical habitat adjacent to aquatic habitat that may be of equal importance to species that only spend a portion of their lives in the water, like some amphibians. Development can also lead to disturbance for birds nesting or foraging along rivers, such as bald eagle.

– *Habitat fragmentation* – Some priority species associated with riverine habitats may be dramatically affected by isolation or fragmentation of particular habitat stretches, due to limited distributions, unknown distributions or widely dispersed but small populations.

– *Exotic species* – The introduction of exotic plant and animal species (e.g., *Corbicula*) can have negative impacts on aquatic communities that provide the prey base for the terrestrial animals in this group. Some introduced exotics, like flathead catfish, may directly prey upon native species. The individual and collective impacts of exotic species on high-priority native fauna are not well known.

– *Stream snagging* – Clearing woody debris within stream channels after storms can reduce habitat structure, particularly for reptiles and amphibians, though the impact of this practice on wildlife populations is unknown.

C. *Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:*

In order to begin to plan conservation strategies for these species, we must have a better understanding of their current distribution and status. Some of the priority species associated with riverine habitat in the Piedmont of North Carolina are known from few Piedmont localities, and are considered uncommon or rare. Priority needs to be placed on conducting baseline surveys to determine the current range and status of those species (e.g., gulf coast spiny

softshell, striped mud turtle, eastern mudsnake). Secondary priority should be directed towards gathering better information about the status and distribution of more common species associated with riverine habitats (e.g., three-lined salamander, common ribbonsnake). Collaboration between aquatic and terrestrial biologists will be beneficial for recording ancillary data on riverine species.

- **Monitoring** – When we have a better understanding of the current distribution of these species, survey efforts should be re-directed into development of long-term monitoring strategies to document population trends, from which conservation strategies can be specifically designed to target those species.
- **Research**
  - Gain information regarding the specific microhabitat needs of priority species to develop long term conservation strategies.
  - Study the extent and impact of exotic species introductions, as well as effective control measures for the most problematic exotics.
  - Determine the impacts of "snagging" (removing woody debris after storms) on wildlife populations.
  - Determine the effect beaver ponds have on downstream movement of pollutants (toxins and sediments).

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

In general the most critical conservation actions necessary to sustain populations of riverine habitat species involve protection of water quality and aquatic habitats. Immediate and continuing efforts need to be undertaken to limit water quality deterioration from point sources of pollution as well as non-point sources though enacting new laws, better enforcement of existing laws, or through the development of voluntary incentive programs to reduce water pollution. The NC Citizens for Clean Water is one private organization that is working toward these goals. Regulatory agencies should be encouraged to protect wide buffers for riparian areas and adopt strict rules for stormwater and wastewater management. Cooperation from agencies and organizations at local, state and federal levels, in addition to public support and pressure on elected officials will be critical for improving water quality.

Land-use planning at the watershed scale will help to mitigate the cumulative and secondary impacts of impervious surfaces. Counties should be encouraged to adopt growth management plans that steer development away from riparian areas and other important habitats. This effort will require the coordination and collaboration of many stakeholder, including local, county, and state planning boards and natural resources agencies, and it will require the support of landowners and the general public.

Many farm bill programs, and the Environmental Quality Incentives Program (EQIP) in particular, provide an excellent opportunity to reduce sediment, fertilizer and pesticide runoff by subsidizing vegetated filter strips, reduced tillage farming, fencing to keep livestock out of streams, and other conservation practices. EQIP and other programs can also provide assistance for improving animal waste management. Closing abandoned and sub-standard waste lagoons should be one of the top priorities for protecting riparian ecosystems, particularly for eastern North Carolina. The conservation community should support the research and implementation of new generation animal waste management systems that reduce the risk of animal waste pollution entering the waterways.

River and stream ecosystem enhancement and restoration efforts and programs need to be enhanced and supported as well. And finally, within the frameworks afforded by state, local, federal, and private initiatives, riverine habitats need to be permanently protected from the negative impacts of development through conservation ownership (fee title or easement) of as much habitat as possible.

Protection actions

– Protect habitat along riverine systems through acquisition and easements. Eno River State Park could be used as a model for protecting a length of river. The state wide Greenways initiative provides an opportunity to protect riparian corridors.

Habitat management and restoration actions

– Promote the adoption of agricultural and forestry best management practices that reduce run-off and erosion, including fencing livestock out of streams and leaving wide buffers between development, agriculture, and some forestry practices (e.g., clearcutting) and riparian areas. The federal Farm Bill and other cost share programs provide incentives for land stewards to adopt these practices. Technical guidance manpower is needed to proactively promote and facilitate participation in these programs.

– Work with power companies to restore or simulate natural river ecological functions. The Federal Energy Regulatory Commission relicensing process offers and excellent opportunity to work towards this goal on the Yadkin, Pee Dee, and Catawba rivers.

– Manage riverine habitats to allow natural movement of woody and rocky structures; work to restore processes like bank dynamics, channel meanders, and flood regimes.

Policy-based actions

– Land use planning and zoning laws needed to limit development, land clearing, and hydrology alterations within floodplains.

– Work with municipalities to reduce stormwater runoff and wastewater discharges.

– Work to identify and promote the designation of Outstanding Resource Waters.

Also see the appropriate river basin sections for more detailed conservation recommendations regarding fully aquatic species.

Supporting References

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20. **Lakes and reservoirs** – There are no natural lakes in the Piedmont. However, reservoirs, mill ponds, farm ponds and other water bodies provide habitat for a variety of fully- and semi-aquatic species. These areas are also important areas for many bird species (nesting, roosting, and feeding sites) and provide habitat for fish, reptiles, amphibians, and aquatic mammals. In addition, these water bodies are popular destinations for human recreation. *Beaver ponds are discussed in the 'Small wetland communities' section.*

    Other fully aquatic taxa (fish, mussels, crayfish, and snails) are referenced in the river basin portion of the report. See the river basin sections (Chapter 5B) for more detailed information on aquatic species and habitats, by basin.

Priority species associated with piedmont lakes and reservoirs:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Haliaeetus leucocephalus*	Bald Eagle	T (T)
	Melanerpes erythrocephalus	Red-headed Woodpecker	
	Nyctanassa violacea	Yellow-crowned Night-heron	
Reptiles	*Apalone spinifera aspera*	Gulf Coast Spiny Softshell	
	Thamnophis sauritus sauritus	Common Ribbonsnake	

A. Location and condition of habitat (see Map 5A.20):

The major impoundments in the Piedmont include W. Kerr Scott Reservoir, High Rock Lake, Tuckertown Reservoir, Badin Lake, Lake Tillery, and Blewett Falls Lake along the Yadkin/Pee Dee rivers; Lake James, Lake Rhodhiss, Lake Hickory, Lookout Shoals Lake, Lake Norman, Mountain Island Lake, and Lake Wylie along the Catawba River; Belews Lake, Townsend Lake, Farmer Lake, Hyco Lake, and Mayo Reservoir along the Dan River drainage; John H. Kerr Reservoir and Lake Gaston on the Roanoke River; B. Everett Jordan Lake and Harris Reservoir along the Haw/Cape Fear rivers; Falls Lake along the Neuse River; as well as Oak Hollow Lake, Kings Mountain Reservoir, and Coddle Creek Reservoir.

In addition, many smaller reservoirs and farm ponds are scattered throughout the Piedmont. All of these sites provide key habitat for many species of waterfowl, wading birds and other waterbirds throughout the year. Impoundments vary with age, water depth and disturbance history; the isolation of these ponds may be an important factors in the flora and fauna present (Schafale and Weakley 1990).

B. Problems affecting species and habitats:

– *Human development and use* – Development of lake shores causes loss and fragmentation of riparian habitat. Excessive human use of lake shores can cause disturbance for nesting bald eagles, and in some areas may cause vegetation trampling and erosion problems.

– *Water quality* – Pollution can cause problems for many aquatic organisms and their predators. Heavy metals can be a particular concern because of their ability to bioaccumulate. Smaller water bodies near agricultural or residential areas can suffer from excess nutrient run-off, leading to algal blooms and low dissolved oxygen levels.

– *Sedimentation* – Sediments build up behind an impoundment and over time can cause a degradation of underwater habitat quality above the dam. Plant diversity suffers due to sediment pollution.

– *Exotic species* – *Hydrilla sp.*, *Corbicula malinensis*, *Ludwigia uruguayensis* and carp are among the exotics that can cause problems in water bodies.

– *Mowing of shoreline vegetation* – Reduction in submergent, emergent, and shoreline vegetation can lead to increased trampling and erosion. Many species associated with lakes and aquatic habitats rely on shoreline vegetation for shelter, foraging, breeding, and nesting.

C. Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:

- **Surveys**
  - Determine the status and distribution of reservoir-associated birds (e.g., osprey, herons, swallows, possibly rails) and help identify threats to populations.
  - Survey for shorebird migration activity on large reservoirs (e.g., Falls Lake, Kerr Lake) in spring, summer and fall.
  - Initiate volunteer frog call surveys (a frog call CD is currently being developed by the Commission and NC Partners in Amphibian and Reptile Conservation, 2005).
- **Monitoring**
  - Continue bald eagle breeding activity monitoring.
  - Establish long-term surveys for waterbirds and rails to help determine population trends.
  - Monitor pond turtles and common ribbonsnake to track population trends.
- **Research**
  - Track and identify problems associated with avian vacuolar myelinopathy that cause mortality in American coots, other waterfowl and bald eagles (following up on recent research; Augspurger et al. 2003).
  - Assess the impacts of Federal Energy Regulatory Commission-mandated changes in water releases at hydro electric dams on high priority species.
  - Study the impacts of commercial collecting of turtles on population dynamics, and the impact that the 2004 turtle law may have on the trade.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

When considering conservation actions for large reservoirs, the conservation needs of flowing river habitat and floodplain forest habitat should generally trump the needs of reservoir habitat.

Needed conservation actions for lakes, reservoirs, and other impoundments include:

- Maintain natural shoreline vegetation and structure of adjacent terrestrial habitats if possible (many wetland-related amphibian and reptile species rely on both aquatic and drier upland sites for their life history and seasonal migrations).
- Retain or create snags, logs, rocks and other structures used by basking reptiles.
- Reduce disturbance and development along raceways and near bald eagle nest trees.
- Identify invasive and exotic species, their impacts on native wildlife, and practical methods for removal or control.
- Limit lakeshore development at sites where there is not protected buffer land.
- Acquire lakeshore buffer lands (e.g., as was done at Jordan and Falls reservoirs so as to exclude development).

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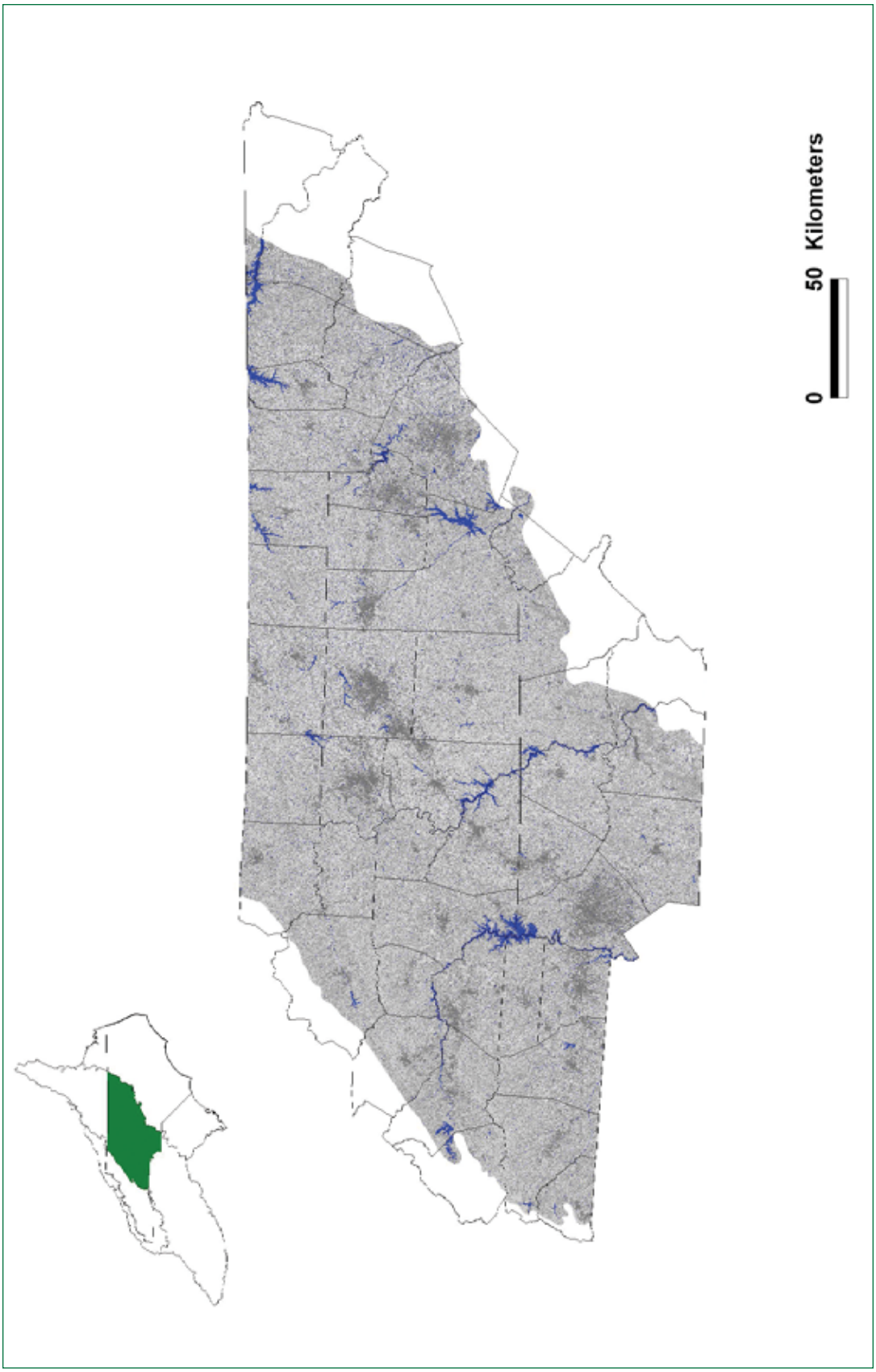

Figure 5A.20. Lakes and reservoirs in the Piedmont ecoregion of North Carolina (in blue) (data source: NC GAP, 1992).

Mid-Atlantic Coastal Plain Ecoregion

21. **Oak forest (including mixed hardwoods and pine)** – This habitat includes the traditional "oak-hickory" forest type, but may also contain large concentrations of tulip poplar, red maple, sweet gum and/or pine species in disturbed sites. In very dry settings, post oak and blackjack oak may dominate. This habitat category also includes sites that may have been longleaf pine stands at one time, but without fire have regenerated into closed canopy mixed hardwood/pine stands with crowded midstory development and low understory species diversity.

    In the Coastal Plain, two examples of oak dominated natural communities include Dry Oak-Hickory Forest and Dry-Mesic Oak-Hickory Forest (Schafale and Weakley 1990). Dry Oak-Hickory Forest is typically a more upland community and was once one of the predominant community types in the Piedmont, and although not as common in the Coastal Plain it was clearly widespread before European settlement and land clearing (Schafale and Weakley 1990). Dry-Mesic Oak-Hickory Forest was historically found throughout the Piedmont and Coastal Plain but much of this area in the Coastal Plain is now in agriculture or pine plantations (Schafale and Weakley 1990).

Priority species associated with coastal plain oak forest (& mixed hardwoods/pine):

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Accipiter cooperii*	Cooper's Hawk	SC
	Caprimulgus carolinensis	Chuck-will's-widow	
	Caprimulgus vociferus	Whip-poor-will	
	Coccyzus americanus	Yellow-billed Cuckoo	
	Colaptes auratus	Northern Flicker	
	Contopus virens	Eastern Wood-pewee	
	Hylocichla mustelina	Wood Thrush	
	Melanerpes erythrocephalus	Red-headed Woodpecker	
	Picoides villosus	Hairy Woodpecker	
	Wilsonia citrina	Hooded Warbler	
Mammals	*Mustela frenata*	Long-tailed Weasel	
	Scalopus aquaticus	Eastern Mole	
	Sciurus niger	Eastern Fox Squirrel	SR
Amphibians	*Ambystoma maculatum*	Spotted Salamander	
	Ambystoma opacum	Marbled Salamander	
	Hemidactylium scutatum	Four-toed Salamander	SC
	Plethodon glutinosus sensustricto	Northern Slimy Salamander	
	Scaphiopus holbrookii	Eastern Spadefoot	
Reptiles	*Cemophora coccinea copei*	Northern Scarletsnake	
	Crotalus horridus	Timber (Canebrake) Rattlesnake	SC
	Elaphe guttata	Corn Snake	
	Eumeces laticeps	Broad-headed Skink	
	Heterodon platirhinos	Eastern Hog-nosed Snake	
	Lampropeltis calligaster rhombomaculata	Mole Kingsnake	
	Terrapene carolina	Eastern Box Turtle	
	Virginia valeriae valeriae	Eastern Smooth Earthsnake	

A. Location and condition of habitat (see Map 5A.21):

Oak dominated forest communities are located throughout the Coastal Plain but are no longer common except in small patches. Most of these forests have been logged or cleared at least once within the past 300 years, and many have been cleared multiple times. The quality of remaining tracts ranges widely across the Coastal Plain and depends primarily upon the age of the canopy trees, management history, and degree of fragmentation of the tract. The condition of many oak forests and mixed hardwood/pine stands in the Coastal Plain has degraded over the last century due to development, habitat fragmentation, fire suppression, high-grading of stands, and the resultant lack of understory and crowded midstory development, although the quality of some stands has improved with age.

Disturbed areas in Dry Oak-Hickory and Dry Mesic Oak-Hickory Forests have varying amounts of pines, red maple, tulip poplar and sweetgum depending on the degree of canopy opening and disturbance history. Heavily logged areas or high-graded sites have a mixture of pines and hardwoods. Usually these forests are uneven-aged with old trees occasionally present. Disturbance of many types, exotic plants and fire suppression has undoubtedly changed the species composition and structure of the Coastal Plain natural oak dominated forests. In turn, due to less frequent fires many areas once dominated by longleaf pine have been invaded oaks, hickories and other hardwoods. However, many of these areas have a high percentage of the total habitat patches dominated by weedy hardwood species such as sweetgum, tulip poplar and red maple if the areas are disturbed frequently.

B. Problems affecting species and habitats:

Microhabitat loss, lack of woody debris, and roads have impacted amphibians, reptiles and small mammals in oak/mixed hardwood stands in the Coastal Plain. Acquisition can be problematic in upland habitats since fewer options are available for grants. Conversion to single-aged loblolly pine stands is a threat; stands have also been high-graded, leaving the trees' form and functions altered. A lack of canopy gaps, affecting bird species that rely on those gaps for foraging areas (e.g., nightjars, eastern wood-pewee, northern flicker, red-headed woodpecker) is also a problem. Development and roads have caused habitat fragmentation, and amphibian species have been impacted by a loss of ephemeral habitats found within the matrix habitat of oak/mixed hardwoods. Lastly, the potential and realized impacts by gypsy moths and other non-native plants and animals are becoming a growing concern throughout hardwood dominated communities. Examples of large size and good quality oak dominated communities are now lacking in the Coastal Plain and habitat fragmentation presents a major problem for many wildlife species.

C. Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:

- **Surveys** – Initial efforts need to be directed towards surveys to determine the current baseline distribution and status of species mainly associated with oak and mixed hardwood/pine forests (especially those that are state-listed or believed to be declining) for which that information is lacking. Since we lack baseline information about even common species and their distribution and status in this habitat type, we need to direct secondary efforts to conduct surveys to understand current status from which we can then measure future population changes over time.
  - Document the status and distribution of neotropical migrant birds not adequately sampled by BBS (e.g., hooded warbler, Kentucky warbler, yellow-billed cuckoo, red-headed woodpecker, northern flicker, hairy woodpecker).
  - Conduct nocturnal surveys for chuck-will's-widow and whip-poor-will to determine status and distribution, especially in areas with open patches of habitat mixed with mature trees.
  - Determine the status and distribution of all bats using hardwood and hardwood/pine forests.
  - Determine the status and distribution of long-tailed weasel and other small mammals using the habitat.

- Determine the status and distribution of eastern spadefoot and four-toed salamander.
- Determine the status of amphibians (mainly salamanders such as marbled, spotted, redback and slimy salamander) that key on woody debris for part or all of their life cycle.
- Determine the status and distribution of secretive, hard to survey reptiles (e.g., canebrake rattlesnake, mole kingsnake, northern scarletsnake and eastern smooth earthsnake) (in conjunction with surveys for more common reptiles).

- **Monitoring** – Protocols and procedures developed from baseline surveys should then provide a means to convert from a baseline survey mode to a long-term population monitoring mode. Current monitoring systems and protocols (e.g., MAPS and BBS) may need to be enhanced to better cover certain species not well covered by current monitoring efforts.
  - Establish MAPS and migration banding stations and migration monitoring surveys.
  - Initiate long-term monitoring for breeding neotropical migrants (especially ground-nesters and cavity nesters).
  - Initiate long-term monitoring for bats and small mammals (e.g., moles, shrews, rodents) following initial survey efforts.
  - Initiate long-term monitoring for amphibians that use woody debris as a microhabitat following initial survey efforts.
  - Initiate long-term monitoring needed for canebrake rattlesnakes and other secretive reptiles following initial survey efforts.

- **Research** – Research studies targeting birds need to be long-term and large-scale, replicated studies that have controlled experimental approaches and focus on population demographics and the response of species to habitat manipulations where appropriate as outlined by the National Partners in Flight Research working group (Donovan et al. 2002). Similar research priorities are needed for other oak/mixed hardwoods forest taxa including bats, small mammals, amphibians and reptiles.

  Population demographics
  - Conduct long-term life history studies for many birds, bats, small mammals, amphibians and reptiles, starting with those of highest conservation priority (Yates et al. 1997, Holmes and Sherry 2001, Ellis et al. 2002, Osbourne and Anderson 2002, Taylor and Jones 2002).

  Predator effects
  - Study predator effects on nest productivity (especially for shrub and ground nesters) via nest search and spot mapping studies.
  - Examine productivity of canopy and cavity nesting birds.

  Habitat use
  - Examine habitat use patterns on raptors and nightjars using telemetry (Mills 1986 and Lake et al. 2002).
  - Determine how large scale floods affect reptile and amphibian populations.

  Management practices
  - Determine the effects of management to improve vegetative structure (canopy gaps, prescribed fire, etc.) on habitat use patterns of birds, small mammals, bats, amphibians and reptiles (Blake and Hoppes 1986, Lanham and Guynn 1998, Osbourne and Anderson 2002).

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

Acquisition whenever possible and proper management of these areas is key. Conservation of existing oak forest patches is imperative. As oak forests typically occur in small stands, it may be difficult to specifically target these stands for acquisition. However, acquisitions of large tracts (>500 acres) is recommended where some stands of oak forest are present.

Use of infrequent prescribed fire and canopy gap management may be needed to improve forest structural heterogeneity (frequent fire will limit shrub and understory development necessary to breeding bird species). Management and protection of mixed hardwoods/pine to promote future large, unfragmented tracts is especially important for amphibians, reptiles, small mammals and bats. Landowner incentives to promote extending rotation lengths may be another management option.

A portion of these lands should be dedicated to old growth habitat. Within the oak-mixed hardwoods/pine habitat, we must attempt to retain as many of the embedded habitats (e.g., seasonal wetlands) as possible. Some mixed hardwood stands should be considered for conversion back to longleaf pine habitat where appropriate. Long-term studies focusing on the habitat-use needs of many species in oak and hardwood/pine forests, as well as the response of wildlife species to habitat fragmentation, patch size and habitat management are needed.

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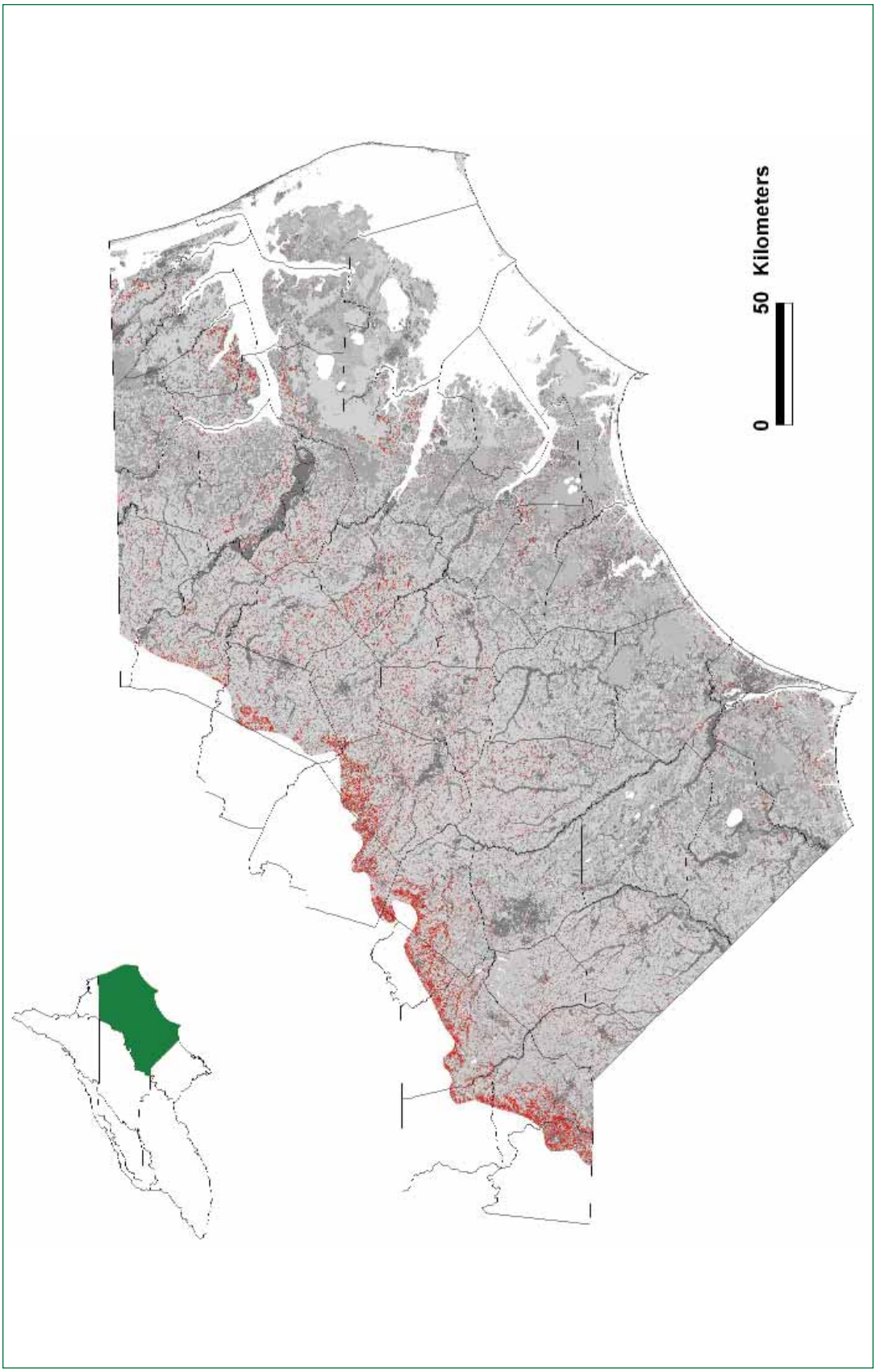

Figure 5A.21. Oak forest and mixed hardwoods habitats in the Mid-Atlantic Coastal Plain ecoregion of North Carolina (in red) (data source: NC GAP, 1992).

22. **Mesic forest** – Coastal Plain mesic forest occurs on moist portions of upland habitat protected from fire, north-facing slopes, high sections of outer floodplains and less commonly on upland flats surrounded by peatland. They may also be found on island ridges surrounded by swamps. These habitats can have well-developed understory and shrub layers, and are characterized by mesophytic canopy species such as American beech, tulip poplar, sweetgum, bitternut hickory, shagbark hickory, American elm, black walnut, white oak, swamp chestnut oak and red oak.

    Coastal Plain subtypes include Mesic Mixed Hardwood Forest (found throughout the Coastal Plain) and Basic Mesic Forest, scattered and found primarily in the area of marl outcrop in the eastern Coastal Plain south of the Neuse River but also on basic alluvial traces along the Roanoke River (Schafale and Weakley 1990). Mixed Mesic Hardwood Forests are distinguished from Basic Mesic Forests by having acidic rather than circumneutral to basic soils, a less well developed herb layer, lower floristic diversity and no or few basic indicator species (Schafale and Weakley 1990).

    Mesic forests usually occur on sites that are sheltered from fire by topography and moisture. Fires in these systems were likely much less frequent and intense than in uplands. Under natural conditions, mesic forests are uneven-aged, with some old trees present. Reproduction occurs primarily in canopy gaps, and disturbed areas have increased amounts of pines and weedy hardwoods such as tulip poplar and sweetgum, as well as exotics such as Japanese honeysuckle (Schafale and Weakley 1990).

A. Location and condition of habitat (see Map 5A.22):

Examples of the Mesic Mixed Hardwood Forest bluff/slope variant are found in Croatan National Forest, Merchant's Millpond State Park and Cliffs of the Neuse State Park. Examples of the swamp island variant are found in the Dismal Swamp National Wildlife Refuge and along the Waccamaw River in Columbus County and examples of the upland flat variant are found in Perquimans and Bertie County. Both variants of Basic Mesic Forest (marl outcrop and terrace slope) are rare because of the rarity of basic substrates on the Coastal Plain (Schafale and Weakley 1990).

The condition of coastal plain mesic forest is relatively poor due to almost complete fire suppression (infrequent fires helped control the extent of mesic vegetation), high-grading of stands, exotic species, and habitat fragmentation.

B. Problems affecting species and habitats:

Due to the relatively flat topography, coastal plain mesic forests are scarce compared to the Piedmont. Most sites are quite narrow bands on the landscape. In many cases, the flat land above these slopes has been converted to agriculture or loblolly pine plantations, compromising the quality of the mesic forest habitat. Development has fragmented the habitat and high-grading has changed the forest condition and composition. Although fires would have naturally swept through these sites relatively infrequently, even these infrequent fires have been suppressed, which affects community composition related to mesic plant species and likely exotics. Logging has depleted the amount of dead and downed material as well as other old growth characteristics such as tree cavities, hollow trees, vine tangles, etc. Exotic plants such as autumn olive, Japanese grass, Japanese honeysuckle, and privet have taken resources from native vegetation. A lack of canopy gaps in this habitat type has probably lead to a reduced number of some avifauna such as the eastern wood-pewee, red-headed woodpecker, northern flicker, hooded warbler, worm-eating warbler and Kentucky warbler. This reduction in canopy gaps has also caused a decline in midstory and understory vegetation which has impacted species such as the Swainson's warbler, Kentucky warbler, hooded warbler and wood thrush, as well as many small mammals and reptiles.

Priority species associated with coastal plain mesic forest:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Coccyzus americanus*	Yellow-billed Cuckoo	
	Colaptes auratus	Northern Flicker	
	Contopus virens	Eastern Wood-pewee	
	Helmitheros vermivorous	Worm-eating Warbler	
	Hylocichla mustelina	Wood Thrush	
	Limnothlypis swainsonii	Swainson's Warbler	
	Melanerpes erythrocephalus	Red-headed Woodpecker	
	Oporornis formosus	Kentucky Warbler	
	Picoides villosus	Hairy Woodpecker	
	Wilsonia citrina	Hooded Warbler	
Mammals	*Lasionycteris noctivagans*	Silver-haired Bat	SR
	Lasiurus intermedius	Northern Yellow Bat	SR
	Mustela frenata	Long-tailed Weasel	
	Peromyscus gossypinus	Cotton Mouse	
	Scalopus aquaticus	Eastern Mole	
Amphibians	*Ambystoma mabeei*	Mabee's Salamander	SR
	Ambystoma maculatum	Spotted Salamander	
	Ambystoma opacum	Marbled Salamander	
	Hemidactylium scutatum	Four-toed Salamander	SC
	Hyla gratiosa	Barking Treefrog	
	Plethodon glutinosus sensustricto	Northern Slimy Salamander	
	Pseudacris brimleyi	Brimley's Chorus Frog	
	Pseudacris nigrita nigrita	Striped Southern Chorus Frog	
	Pseudacris ornate	Ornate Chorus Frog	SR
	Rana capito	Carolina Gopher Frog	T
	Scaphiopus holbrookii	Eastern Spadefoot	
Reptiles	*Clemmys guttata*	SpottedTurtle	
	Crotalus horridus	Canebrake Rattlesnake	SC
	Elaphe guttata	Corn Snake	
	Eumeces laticeps	Broad-headed Skink	
	Lampropeltis calligaster rhombomaculata	Mole Kingsnake	
	Rhadinaea flavilata	Pine Woods Littersnake	
	Terrapene carolina	Eastern Box Turtle	
	Virginia valeriae valeriae	Eastern Smooth Earthsnake	

C. Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:

- **Surveys** – Initial efforts need to be directed towards surveys to determine the current baseline distribution and status of species mainly associated with mesic forests (especially those that are state-listed or believed to be declining) for which that information is lacking. Since we lack baseline information about even common species and their distribution and status in this habitat type, we need to direct secondary efforts to conduct surveys to understand current status from which we can then measure future population changes over time.
  - Conduct selective surveys to determine the status and distribution of birds hard to track by BBS (e.g., Swainson's warbler, worm-eating warbler, Kentucky warbler, hooded warbler, yellow-billed cuckoo) as well as more common breeding birds.
  - Determine distribution and status information for all bat species and many other mammals, especially for long-tailed weasel and cotton mouse.

- Survey amphibians for which we have little information on status and distribution (e.g., Mabee's salamander, four-toed salamander, Brimley's chorus frog, ornate chorus frog) as well as other more common amphibians.
- Determine the status and distribution of canebrake rattlesnake.
- Determine the status and distribution of hard to track snakes such as mole kingsnake, pine woods littersnake and eastern smooth earthsnake.

- **Monitoring** – Protocols and procedures developed from baseline surveys should then provide a means to convert from a baseline survey mode to a long-term population monitoring mode. Current monitoring systems and protocols (e.g., MAPS and BBS) may need to be enhanced to better cover certain species not well covered by current monitoring efforts.
  - Expand MAPS and migration banding stations to better identify breeding bird and migratory bird productivity and other demographic information.
  - Establish long-term monitoring for small mammals and bats following initial surveys.
  - Conduct general long-term herpetofauna monitoring to track the effects of the loss of old growth characteristics in this habitat type.

- **Research**

  Productivity
  - Conduct bird nest productivity studies, including nest-searching and spot mapping, and studies of predator effects on bird nest productivity.

  Genetics
  - Examine the possibility of a sub-species for the coastal worm-eating warbler.

  Population demographics
  - Collect demographic information on all bat species; investigate specific habitat needs and conduct life history studies.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

Conservation actions will need to include land acquisition, easements and protection to promote remaining large, unfragmented tracts as well as management to maintain and re-establish mesic forest.

Land acquisition and easements should be the top priority for conservation actions; Land Trusts will serve as a major partner in these efforts. This is a relatively rare forest type and great effort should be made to protect mesic forest and their species assemblages.

We must continue to work with non-industrial foresters to promote and increase silvicultural practices that benefit birds of conservation concern (e.g., promote canopy gap management, longer rotations, introduction of fire) as well as small mammals, bats and reptiles and amphibians.

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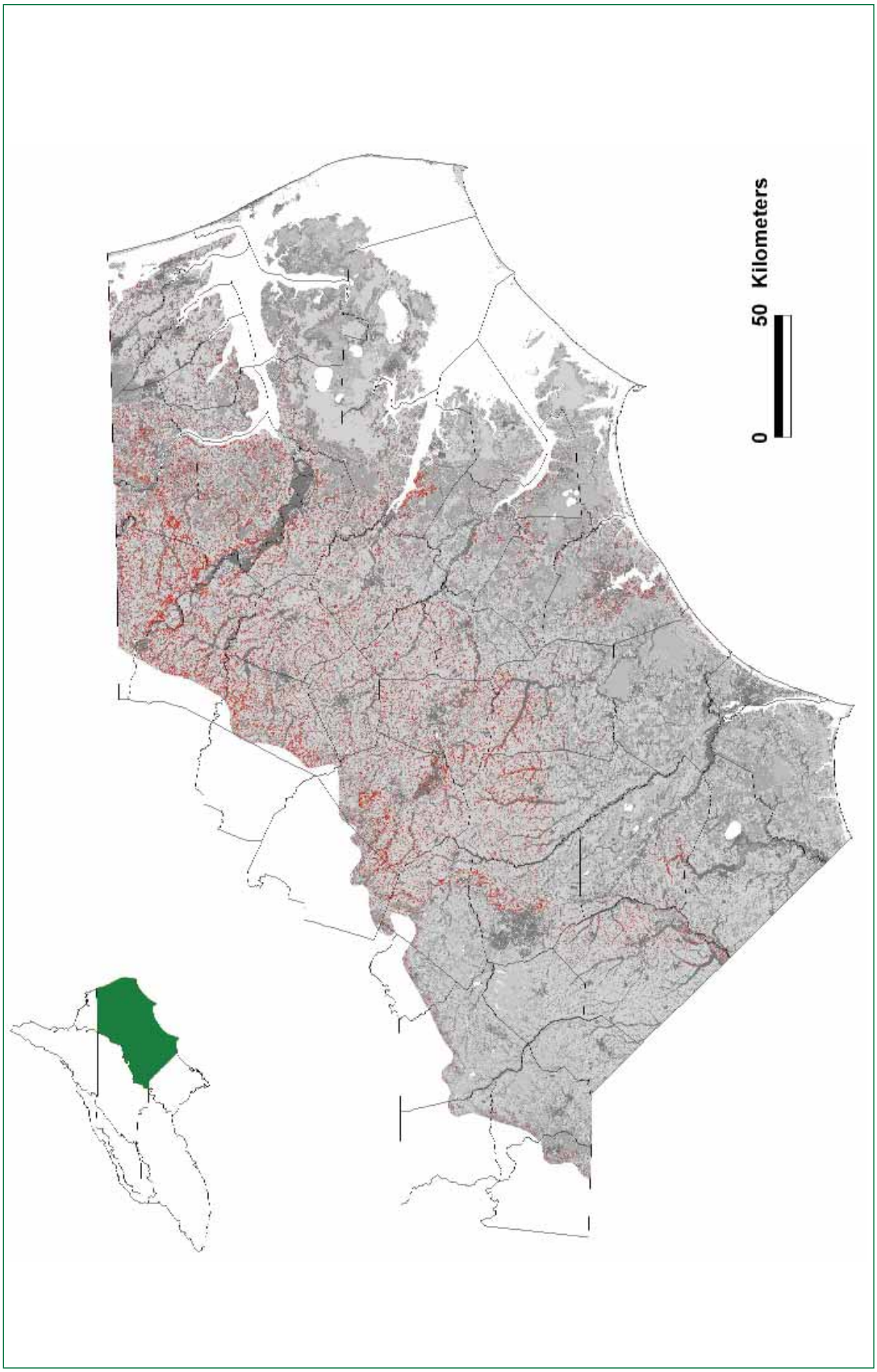

Figure 5A.22. Mesic forest habitats in the Mid-Atlantic Coastal Plain ecoregion of North Carolina (in red) (data source: NC GAP, 1992).

23. **Early successional habitats** – Coastal Plain early successional and scrub-shrub habitats, characterized by low woody vegetation and herbaceous plants, are often found at the transition between agricultural fields and nearby woodlands, created by disturbances like clearcutting, disking or burning. This habitat also includes agricultural hayfields, pastures, and field borders. Early successional habitats can also be mimicked in the understory of very open pine stands. Historically, these habitats were created by catastrophic natural fires, anthropogenic fires, large-scale wind events, insect pests, or pathogens such as fungal diseases. Early successional habitats are found throughout the region.

This habitat category can contain a diverse assemblage of plants, and nearly always features some combination of human activity. That does not mean that environmental factors such as weather events, climate, and natural fires have not played a role in creation and maintenance of some areas. The theoretic role of beavers, historic herbivores, Native American uses and other factors point to additional mechanisms for creation and maintenance of at least some early succession habitats, at least historically; however, in the past century nearly all early successional habitats have been human-created. Natural succession will limit the longevity of many of these habitats, unless they are actively managed.

There are numerous examples and types of communities that provide early successional habitat for an assortment of wildlife species. However, a number of them provide little benefit to a significant array of plant and animal species, especially those patches of small size, and thus could only be considered marginal wildlife habitat at best. These kinds of places generally reflect human use and activity as the primary goals of their management and include a number of places such as large lawns, monoculture hayfields, golf courses, airports, residential development and even urban and suburban development.

High quality early successional wildlife habitats include a variety of pastures, croplands, recent clearcuts, and field borders. Pastures and other grasslands provide year-round habitat for several priority bird species. Croplands such as corn fields and soybean fields provide food (especially where the harvest was poor) for many game species, sparrows, and other wildlife in fall and winter.

In the Coastal Plain, the quantity of early successional habitat is not lacking but the quality is often questionable for most species of wildlife. There are, however, excellent opportunities for quality early sucessional habitat of large patch sizes for wildlife on industrial forestland in the Coastal Plain. Partnerships with timber companies (and other large-scale landowners) featuring external cooperators that focus on creating management plans and strategies that benefit a diverse suite of wildlife species absolutely needs to continue, expand and be refined over time.

A. Location and condition of habitat (see Map 5A.23):

Quality early successional habitats have declined considerably over the past half-century, due to reduction of fire, increasing development, and changing agricultural practices. Management of these habitats, especially through fire, is essential for their continued existence and to benefit early successional wildlife. Ephemeral by definition, the distribution and location of early succession habitats across the Coastal Plain can change dramatically within a decade. Currently, most early successional habitats on private lands are located on farmland, recently harvested timberland, powerline right-of-ways and roadsides.

Regardless of how it is measured, high quality early successional wildlife habitat in the Coastal Plain of North Carolina is limited (other than industrial timberlands) and may be declining as a percentage of the landscape due to numerous factors.

The declines of grassland bird species, for example, is attributed to not only actual loss of habitat but also degradation of remaining tracts because of improper or inadequate management and encroachment of exotic vegetation, as well as fragmentation of habitat patches into small isolated units (Johnson and Igl 2001). We must determine if agricultural landscapes can indeed support healthy bird populations (Peterjohn 2003) and decide on the future direction of research related to grassland birds (Vickery and Herkert 2001). Many shrub-scrub birds are also declining according to the best information we have (Hunter et al. 2001), and further

Priority species associated with coastal plain early successional habitat:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Aimophila aestivalis*	Bachman's Sparrow	SC
	Ammodramus henslowii	Henslow's Sparrow	SR
	Ammodramus savannarum	Grasshopper Sparrow	
	Asio flammeus	Short-eared Owl	
	Caprimulgus carolinensis	Chuck-will's-widow	
	Caprimulgus vociferus	Whip-poor-will	
	Chondestes grammacus	Lark Sparrow	SR
	Chordeiles minor	Common Nighthawk	
	Circus cyaneus	Northern Harrier	SR
	Cistothorus platensis	Sedge Wren	
	Colinus virginianus	Northern Bobwhite	
	Dendroica discolor	Prairie Warbler	
	Falco sparverius	American Kestrel	
	Icterus spurius	Orchard Oriole	
	Lanius ludovicianus	Loggerhead Shrike	SC
	Passerina ciris	Eastern Painted Bunting	
	Scolopax minor	American Woodcock	
	Spizella pusilla	Field Sparrow	
	Sturnella magna	Eastern Meadowlark	
	Tyrannus tyrannus	Eastern Kingbird	
	Tyto alba	Barn Owl	
Mammals	*Condylura cristata*	Star-nosed Mole	SC
	Cryptotis parva	Least Shrew	
	Microtus pennsylvanicus	Meadow Vole	
	Mustela frenata	Long-tailed Weasel	
	Scalopus aquaticus	Eastern Mole	
	Synaptomys cooperi helaletes	Southern Bog Lemming	
Reptiles	*Crotalus adamanteus*	Eastern Diamond-backed Rattlesnake	E
	Lampropeltis calligaster rhombomaculata	Mole Kingsnake	
	Lampropeltis getula getula	Eastern Kingsnake	
	Masticophis flagellum	Eastern Coachwhip	SR
	Ophisaurus attenuatus longicaudus	Eastern Slender Glass Lizard	
	Pituophis melanoleucus melanoleucus	Northern Pinesnake	SC
	Terrapene carolina	Eastern Box Turtle	

information is badly needed on how they relate to reduced patch size of early successional habitat (Lanham and Guynn, Jr. 1998).

B. *Problems affecting species and habitats:*

Development and large-scale mono-agricultural operations causing a shortage of quality habitat in large patches (except on industrial forestland) is a major concern, along with fire suppression. Modern agricultural practices (frequent mowing, lack of field borders, pesticide use, and non-native plants like kudzu and fescue) are also a problem for wildlife that use early successional habitat around farmland. Exotic species have caused particular problems in early successional habitats. Fire ants kill newly hatched ground nesting birds and reptiles as well as newly born mammals. Brown-headed cowbirds parasitize bird nests, and many exotic plant species take advantage of the light conditions in early successional habitats.

Human development is causing loss and fragmentation of early successional wildlife habitat, and hinders the use of prescribed fire. Suppression of wildfires and lack of controlled burning eliminates an important source of early succession habitat creation and maintenance. Understanding the way that people perceive, use and value early successional landscapes (human dimensions) needs more attention (Askins 2001 and Gobster 2001).

Some species, such as northern bobwhite, may require large areas of contiguous habitat for long-term population viability. Current restoration efforts often focus on small acreages that have limited value for area-sensitive grassland species such as grasshopper sparrow and eastern meadowlark. Grasslands of >50 acres should be pursued to benefit these species. Some research has suggested that grasslands of at least 500 acres or may be needed to support a diverse grassland bird fauna or rare species (Vickery et al. 1994 and Perkins et al. 2003). In addition roads have become a primary mortality factor for many birds, mammals and particularly reptiles and amphibians.

Early succession cover in powerline right-of-ways and roadsides can be adversely affected by too frequent or poorly timed mowing, as well as herbicide treatments (Bramble et al. 1992). In addition, many areas of fallow ground near houses or businesses are frequently mowed to maintain a neat appearance, while opportunities exist to convert these areas to suitable wildlife cover.

Most of the understory grass, forb, and shrub layers are lost once a newly planted timber stand "canopies out," which occurs typically 7-15 years after timber clearing and planting. Economic pressures, improvements in equipment and herbicides, and fast-growing genetic strains of trees have all reduced the amount of time to canopy closure, contributing to loss of early succession habitat. In addition, intensive site-prep techniques can reduce the quality and quantity of herbaceous cover during the early phases of timber planting (Morrison and Meslow 1984). "High grading" of mature timber stands, instead of clearcutting or thinning, also eliminates the potential for early succession habitat creation over the life of stands. Many researchers suggest that silviculture will play an important role in providing habitat for many early successional wildlife species (Askins 1998; Thompson and DeGraaf 2001) so wildlife biologists need to maintain open lines of communication with foresters, and especially with large industrial timber companies. Tremendous opportunities exist on industrial forestland in the Coastal Plain of North Carolina to meet the needs of shrub-scrub birds of high conservation concern.

Powerlines, fields and field borders are usually devoid of any dead and downed logs for herpetofauna. Even clearcuts that supply some dead and down material don't have near as much as what would have been available under natural conditions created by wildfires or hurricanes.

Economic pressures, improvements in equipment and herbicides, and social factors have all lead to larger, more uniformly shaped rowcrop fields, as well as "cleaner" fields with less weedy edge (Marcus et al. 2000). Few rowcrop fields are managed to include a fallow rotation. Some beneficial practices, such as no-till planting, have had mixed success in being adopted. In pastureland, the extensive use of exotic cool-season grasses have reduced habitat quality for wildlife. Cutting hay in mid-summer and overgrazing can adversely affect nesting grassland birds.

C. *Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:*

- **Surveys** – Surveys are needed to document the distribution, relative abundance and status of many wildlife species associated with early successional habitats. Priorities for conducting surveys need to focus on species believed to be declining, at risk or mainly dependent on early successional communities. Secondary priority for surveys should be for species for which current distribution information is already available or for species that are considered common.

- Determine the status of high priority birds (e.g., Henslow's sparrow, eastern painted bunting, Bachman's sparrow, grasshopper sparow, loggerhead shrike, field sparrow, American woodcock, northern bobwhite, and barn owl) and secondarily for other more widely distributed early successional birds that seem to be declining, such as eastern meadowlark, orchard oriole, eastern kingbird.
- Determine the status, distribution, and extent of breeding by short-eared owl, northern harrier, and American kestrel.
- Conduct nocturnal surveys for chuck-will's-widow and whip-poor-will.
- Determine the status and distribution of hard to detect species such as dickcissel, bobolink and lark sparrow.
- Determine the status and distribution of small mammals that are rare or difficult to detect (e.g., star-nosed mole, shrews, long-tailed weasel, southern bog lemming) and secondarily for other small mammals using early successional habitats.
- Survey for bats foraging in early successional habitats.
- Survey for uncommon and/or hard to detect reptiles (e.g., eastern diamond-backed rattlesnake, mole kingsnake, eastern coachwhip, eastern slender glass lizard and northern pinesnake) in early successional habitats.

• **Monitoring** – Monitoring systems need to be expanded and/or targeted to be able to assess current population status and trend information for all wildlife species associated with early successional habitats. Many early successional bird species require monitoring attention, due to documented BBS declines, but BBS does not adequately sample irregularly distributed or clumped species. Declines for grassland species (grasshopper sparrow, Henslow's sparrow, eastern meadowlark) have been documented as being especially high, but birds that utilize shrub-scrub such as prairie warbler and common yellowthroat have also seen declines and are in need of additional long-term monitoring.
  - Establish MAPS and migration banding stations, especially in shrublands, grasslands, hay fields, and pastures.
  - Initiate long-term monitoring for Henslow's sparrow (and other grassland breeding and wintering birds) at the Voice of America (VOA) sites in Pitt and Beaufort Counties (Mangun and Kolb 2000).
  - Establish long-term monitoring for declining (according to our best information) early successional bird species in appropriate habitat at all seasons, like Bachman's sparrow (Stober and Krementz 2000).
  - Continue long-term monitoring of early successional birds needed on Game Lands, National and State Forests and National Wildlife Refuges.
  - Initiate long-term monitoring of mammal species of early successional habitats on habitat patches of varying sizes (Yates et al. 1997 and Litvaitis 2001).
  - Establish long-term monitoring of eastern diamond-backed rattlesnake and northern pinesnake (Woodward and Barthalmus 1996).

• **Research** – Research studies targeting birds need to be long-term and large-scale, replicated studies that have controlled experimental approaches and focus on population demographics and the response of species to habitat manipulations where appropriate as outlined by the National Partners in Flight Research working group (Donovan et al. 2002). Similar research priorities are needed for other early successional taxa including bats, small mammals, amphibians and reptiles.

  Genetics
  - Conduct genetics studies of the breeding sub-species of American kestrel in the lower Coastal Plain.
  - Conduct genetics studies on Henslow's sparrows at the VOA sites.
  - Conduct genetics studies on Coastal Plain shrew species.

Habitat use

- Examine Chuck-will's-widow and whip-poor-will foraging areas on industrial and non-industrial forestland.
- Study the effects of patch size and vegetative structure on nesting success of early successional birds (Burhans and Thompson 1999; Ricketts and Ritchison 2000).
- Study the effects of patch size on small mammal populations (Yates et al. 1997).
- Conduct movement studies on northern pinesnake and eastern diamond-backed rattlesnake (using telemetry).

Population demographics

- Conduct bird nest search and spot mapping studies on public land and on industrial forestland on various patch sizes.
- Examine loggerhead shrike productivity, especially near farms and Cooperative Upland habitat Restoration and Enhancement Program cooperatives.
- Examine nightjar productivity on industrial forestland compared to non-industrial forestland.
- Examine prairie warbler productivity on industrial forestland compared to non-industrial forestland.
- Expand bat research on industrial forestland (e.g., Weyerhaeuser and International Paper lands).

Predator effects

- Examine predators effects on nest productivity of ground- and shrub- nesting birds (Yahner and Wright 1985 and Davison and Bollinger 2000).
- Determine the effects of cowbirds on early successional bird productivity.
- Study the impacts of fire ants on bird nests, small mammals and reptiles in disturbed sites (Smith et al. 2004).

Management practices

- Determine the effects of clearcut stand size on shrubland birds (Krementz and Christie 2001).
- Examine the responses of bird communities to early successional habitat in a managed landscape (Wilson and Watts 2000, Yahner 2003).
- Determine the effects of silvicultural procedures on breeding, wintering and migrating birds on managed forests (Woodward et al. 2001, Easton and Martin 2002)
- Determine the effects of clearcut stand size on small mammals and reptiles (Yates et al. 1997).

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

The use of native grasses, shrubs, and herbaceous plantings to support breeding birds, small mammals and herpetofauna should be encouraged. Prescribed burning should be conducted to restore and improve field borders, and the training of certified burners should become a priority. Liability and air quality concerns need to be addressed.

Management of large blocks (50 acres or greater) of shrub-scrub and grassland habitat is needed to restore ample suitable habitat and to serve as breeding sites for area-sensitive shrub-scrub and grassland species. Patches of early successional habitat should be connected whenever possible to form larger blocks by working with neighboring landowners to cooperate and create large-scale habitat areas. A better understanding of the predator community in early successional sites and their interactions with nesting birds and other wildlife at various habitat patch sizes are needed.

Establishment of field border systems may be an effective way to increase densities of some birds (especially wintering sparrows) on farms at certain times of the year (Marcus et al. 2000). Work needs to continue with private landowners to improve hayfield management (e.g., avoid cutting during prime bird nesting season: May – July). Biologists need to continue to work with private

landowners to establish no-till agriculture, fallow rotations and hedgerows on agricultural lands. Work is also needed to educate the public on the value of early successional habitats and the benefits of controlled burns (Gobster 2001).

Support is needed to help with implementation of federal Farm Bill programs, North Carolina's Cooperative Upland habitat Restoration and Enhancement program, and other programs that encourage the establishment and management of early succession habitats on private lands. We must also continue efforts to work in cooperation with species-specific initiatives such as the Eastern Painted Bunting Working Group and the Northern Bobwhite Conservation Initiative (Dimmick et al. 2002), and to follow prescriptions recommended by those groups. Biologists and researchers need to work with timber companies and private foresters to encourage best management practices that maintain early succession habitat for as long as possible in a timber rotation and reduce the amount of linear edge on some harvest units. Effort needs to be made to encourage early successional areas with dead and downed material present. Retention of snags within clearcuts will help with this effort. Finally, land use planning needs to be encouraged to minimize development within large, unfragmented tracts of farm and forestland that has habitat components that benefit early successional wildlife.

As nearly all early successional habitats are now created by humans, there is little need for outright acquisition of such habitats. For that matter, there may be increasing public pressure to minimize early successional acreage (e.g., return abandoned farmland to natural systems over time). Thus, it is important for biologists to creatively work to provide the best foraging, nesting, and roosting habitat for priority species in the remaining early successional habitats.

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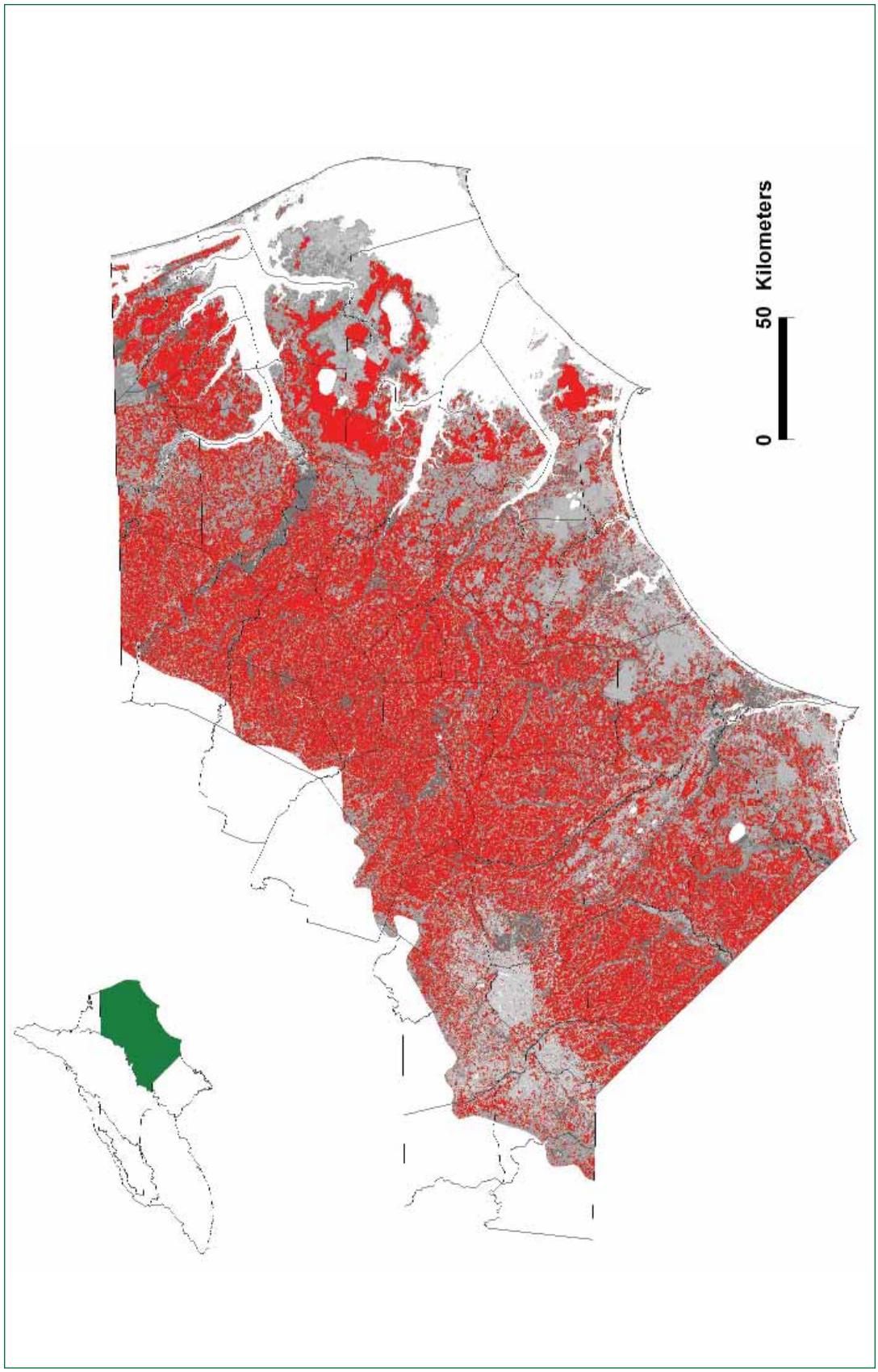

Figure 5A.23. Early successional habitats (including agricultural areas) in the Mid-Atlantic Coastal Plain ecoregion of North Carolina (in red) (data source: NC GAP, 1992). *Note: Due to the ephemeral nature of these habitats, this coverage may not be entirely accurate as of 2005. However, it should still give readers an indication of the extent of these habitats across the region.*

24. **Dry coniferous woodlands (Loblolly/slash pine forest)** – Non-longleaf pine coniferous woodlands occur throughout the Coastal Plain in areas planted in upland loblolly pine or slash pine. This habitat might also include sites that, due to lack of fire, lost their original longleaf component and naturally regenerated in other pine species. The understory and midstory in these areas may be dominated by dense growing pocosin shrubs (e.g., wax myrtle), and hardwood tree species such as oaks, hickories, sweetgum or red maple. The exact midstory and understory species composition and structural diversity in plantations will be influenced by past management strategies and rotation schedules. This in turn determines the wildlife species present at various stages in the history of the stands.

Priority species associated with coastal plain loblolly/slash pine woodlands:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Accipiter cooperii*	Cooper's Hawk	SC
	Aimophila aestivalis	Bachman's Sparrow	SC
	Caprimulgus carolinensis	Chuck-will's-widow	
	Caprimulgus vociferus	Whip-poor-will	
	Chordeiles minor	Common Nighthawk	
	Colaptes auratus	Northern Flicker	
	Colinus virginianus	Northern Bobwhite	
	Contopus virens	Eastern Wood-pewee	
	Falco sparverius	American Kestrel	
	Helmitheros vermivorous	Worm-eating Warbler	
	Melanerpes erythrocephalus	Red-headed Woodpecker	
	Picoides borealis	Red-cockaded Woodpecker	E (E)
	Sitta pusilla	Brown-headed Nuthatch	
Mammals	*Lasiurus seminolus*	Seminole Bat	
	Sciurus niger	Eastern Fox Squirrel	SR
Reptiles	*Crotalus horridus*	Timber (Canebrake) Rattlesnake	SC
	Heterodon platirhinos	Eastern Hog-nosed Snake	
	Sistrurus miliarius	Pigmy Rattlesnake	SC
	Tantilla coronata	Southeastern Crowned Snake	

A. Location and condition of habitat (see Map 5A.24):

There are over 1 million acres of pine plantations (mainly loblolly pine) in the Coastal Plain owned by industrial timber companies that provide a variety of age classes and conditions of stands. Most of this habitat is found in the upper coastal plain since drainage is better there, but it can be found throughout. Most stands are harvested between 18 and 33 years of age, but there are some exceptions. Generally the harvest strategies provide exceptional habitat on a landscape scale for a variety of early successional wildlife species, pine specialists and even forest species for some periods of time over the life of many stands and adjacent areas. (*Also see the coastal plain Early Successional Habitat section*). Silvicultural strategies (e.g., thinnings, herbicide treatments, fertilization, pruning of pines, and prescribed fire) used determine the species composition and structure of the midstory and understory. Areas that were most likely dominated by longleaf have evolved to a loblolly component due to lack of fire are scattered throughout the Coastal Plain and are generally in poor structural condition with dense a midstory and sparse to moderate understory.

B. Problems affecting species and habitats:

In former longleaf pine stands now dominated by loblolly pine, fire suppression is the single most important factor causing deterioration in these woodlands. It has greatly increased the hardwood component of these stands, changed the structure of the stands as well as the vegetative species in both the understory and overstory. Acquisition can be problematic in these upland habitats since fewer grant options are available. The Natural Heritage Trust Fund and Recovery Land Acquisition Grants are good possibilities.

Habitat fragmentation has also occurred in some areas, although many former hardwood stands and pond pine pocosins have been converted to loblolly or slash pine plantations for timber production. Site suitability for commercial and residential development is one factor contributing to the habitat fragmentation threat and complicating management of remaining stands. These plantations are well suited for some fauna (prairie warbler, worm-eating warbler) but are not suitable to others (eastern fox squirrel, red-cockaded woodpecker) due to the lack of an open canopy layer, high stocking rate, and short rotation age. These highly managed pine plantations also lack age diversity within stands and few old growth stands are available. High grading of stands, lack of gap management and overstocked stands are leading to a lack of structural diversity for many species. Roads cause particularly high mortality to reptiles and amphibians.

C. Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:

- **Surveys** – Initial efforts need to be directed towards surveys to determine the current baseline distribution and status of species associated with loblolly/slash pine stands (especially those that are state-listed or believed to be declining) for which that information is lacking. Since we lack baseline information about even common species and their distribution and status in this habitat type, we need to direct secondary efforts to conduct surveys to understand current status from which we can then measure future population changes over time.
  - Identify locations of red-cockaded woodpecker colonies around and between designated recovery populations.
  - Determine breeding status/distribution of Cooper's hawk.
  - Conduct status/distribution surveys for the brown-headed nuthatch, red-headed woodpecker, worm-eating warbler, American kestrel, chuck-will's-widow, whip-poor-will, and common nighthawk.
  - Conduct status/distribution surveys of neotropical migrant landbirds on industrial forestland.
  - Conduct species specific surveys for bird species not well tracked by BBS.
  - Determine the status of Bachman's sparrow in stands with the appropriate structure and basal area (e.g., some industrial forestland stands).
  - Conduct distribution and population surveys for eastern fox squirrel.
  - Determine the status and distribution of timber and pigmy rattlesnakes.
  - Determine the status and distribution of priority small mammals, bats, reptiles and amphibians on industrial forestland.
- **Monitoring** – Protocols and procedures developed from baseline surveys should then provide a means to convert from baseline surveys to long-term population monitoring. Current monitoring systems and protocols (e.g., MAPS and BBS) may need to be enhanced to better cover certain species not well covered by current monitoring efforts.
  - Expand MAPS and migration bird banding stations, especially on industrial forestland.
  - Conduct long-term monitoring of winter birds, small mammals, bats, reptiles and amphibians on industrial forestland (compare results in older pine forests to those of typical industrial forestland).

- **Research**

  Population demographics
  - Examine causes of declines among nightjars on industrial forestland (Weyerhaeuser has conducted some of this research already on pine plantations).
  - Conduct life history studies on priority bat species.
  - Conduct life history and activity patterns of eastern fox squirrel.

  Genetics
  - Explore possibility of a sub-species for the coastal worm-eating warbler.

  Predator effects
  - Study predator effects (and cowbird parasitism) on bird nest productivity.

  Genetics
  - Document timber (canebrake) rattlesnake activity patterns on industrial forestland (using telemetry).

  Management practices
  - Explore the impacts of various silvicultural practices on industrial forestland on neotropical migrants, cavity nesters and ground nesting birds.
  - Examine the effects of habitat enhancement in Cooperative Upland Habitat Restoration and Enhancement (CURE) project sites on bats and herpetofauna.

  Habitat use
  - Explore habitat-area relationships of shrub-scrub birds on industrial forestland (Lanham and Guynn 1998).
  - Examine the effects of large scale floods on herpetofauna.
  - Examine the response of small mammal and herpetofauna to pine management strategies (Hood et al. 2002 and Yates et al. 1997).
  - Explore bat habitat use of managed pine stands (Ellis et al. 2002).

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

Unlike nearly all other forest types mentioned in this Plan, the loblolly/slash pine forest is mostly non-natural (either through fire suppression of longleaf pine stands or conversion of other types to pine plantations). Thus, there is a need to decrease this habitat type and return acreage to natural types. Management and protection of non-longleaf pine woodlands to promote large, unfragmented tracts along with land and easement acquisition on non-industrial forestland should be considered. Fire should be re-introduced, and the fire frequency should be increased to at least once every three years on most tracts when possible. This will necessarily involve resolving smoke management issues, negative public sentiment and liability concerns associated with prescribed burning. Restoration of natural fire frequency, intensity, and seasonality is critical for pine-related reptiles, amphibians, and their prey (Bailey et al. 2004). Restoration of dry longleaf communities should be the primary goal. Additional older aged pine acreage is needed, or management to mimic the characteristics of older stands (e.g., provide canopy gaps, leave dead and downed material, leave cavity trees). Specific management will need to be implemented/continued to manage for red-cockaded woodpecker populations (banding efforts, population monitoring).

Cooperative efforts related to management activities need to continue and expand with large-scale industrial forest landowners to continue to try and improve habitat conditions at the landscape and stand level for a variety of wildlife species (Measells et al. 2002). In addition continued cooperative efforts with red-cockaded woodpecker working groups (for translocation, or to manage the Sandhills and coastal populations of red-cockaded woodpeckers) is needed.

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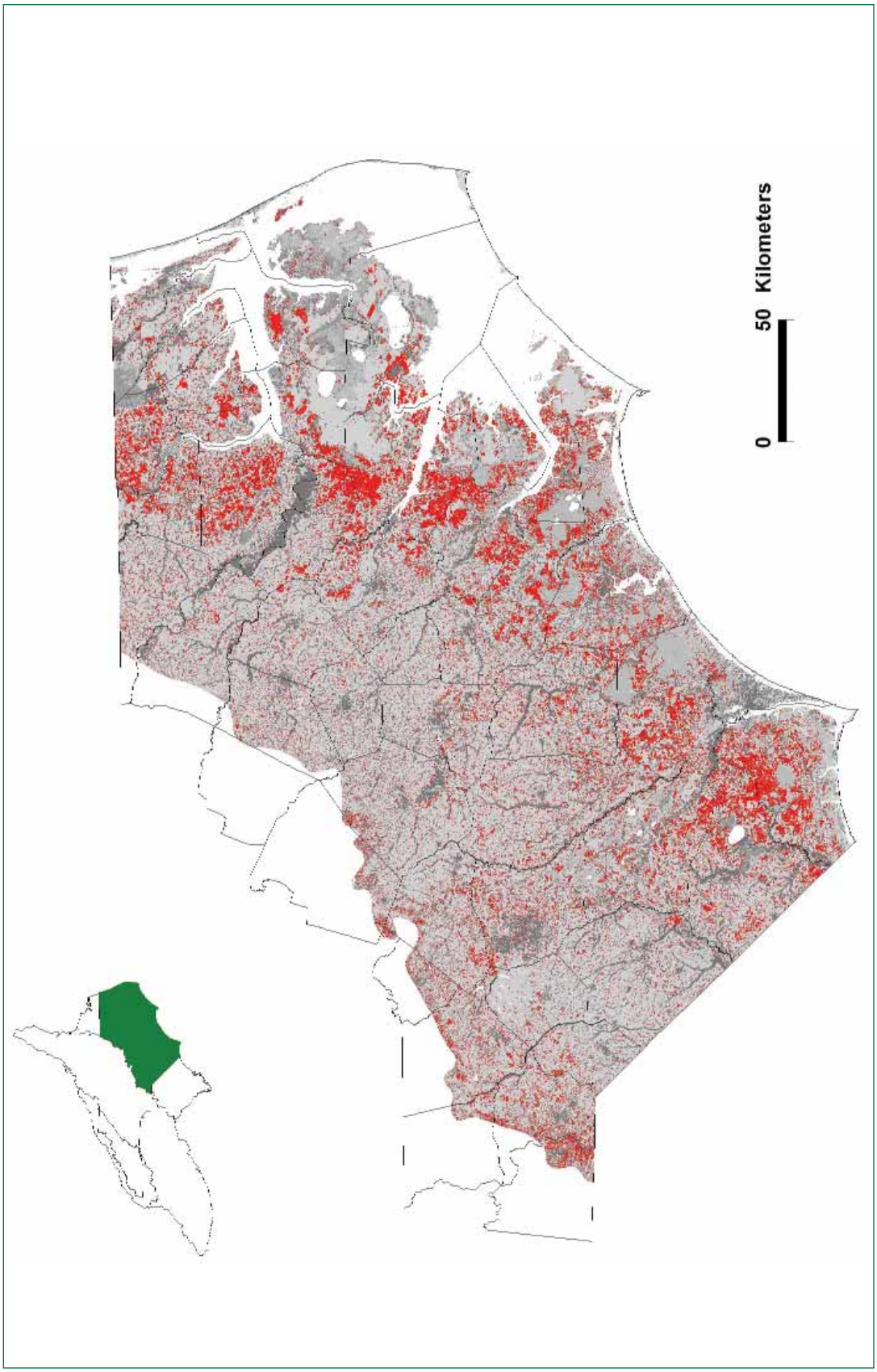

Figure 5A.24. Dry coniferous woodland habitats in the Mid-Atlantic Coastal Plain ecoregion of North Carolina (in red) (data source: NC GAP, 1992).

25. **Dry longleaf pine** – Longleaf pine habitats can range from moist to very well drained sites, including Mesic Pine Flatwoods, Pine/Scrub Oak Sandhill, Xeric Sandhill Scrub, and Coastal Fringe Sandhill. These types often grade into each other or occur as a mosaic on the landscape. Frequent fire maintains a canopy dominated by longleaf pine, an open midstory, and an understory dominated by wiregrass or other grass/herb ground cover. When fire is absent or infrequent, scrub oaks, other hardwoods, and shrubs become common in the midstory and shade out native grasses and forbs. The historical expanse of longleaf pine habitats likely supported stable populations of many early seral species without the understory of a mature or old growth pine forest. Longleaf pine is a very long lived species, so the old growth component of this habitat type was very significant. Prescribed growing season fire needs to increase dramatically in these systems and midstory reduction is essential.

    Coastal Fringe Sandhill communities typically occur within a few miles of the coast on the central and southern Coastal Plain. They have an open to sparse canopy of longleaf pine, scattered scrub oaks, abundant lichens and bare sand, and like sandhill communities naturally experienced frequent low intensity fire except in areas with to little herb cover to carry a fire (Schafale and Weakley 1990). Without fire, oaks and shrubs increase in dominance, leading to litter buildup and shading that reduces herb diversity. With long-term fire suppression the litter buildup and changes in the microenvironment can allow invasion by more mesic species (Schafale and Weakley 1990).

    Mesic Pine Flatwood sites occur on mesic (non-wetland) sites, range throughout the Coastal Plain and Sandhills and have a closed to open canopy of longleaf pine occasionally mixed with loblolly pine (Schafale and Weakley 1990). The low shrub layer can be dense and the herb layer is dominated by wiregrass in frequently burned areas. These communities naturally experience frequent low to moderate intensity surface fires that maintained a rather open canopy, open to sparse shrub layer and thick diverse herb layer (Schafale and Weakley 1990). Many of these sites were cleared for agriculture due to high fertility, whereas others are rapidly in transition to pine-hardwood forests or to loblolly pine forests with a well developed hardwood midstory due to lack of fire.

    Pine/Scrub Oak Sandhill communities are found on rolling to more steeply sloping sites with Coastal Plain sediments with a clay layer near the surface, or sandy to loamy well-drained soils primarily in the Sandhills region but also in the Coastal Plain in sandy areas (Schafale and Weakley 1990). Longleaf pine typically dominates the open canopy with open to dense understory dominated by scrub oaks like turkey oak, blackjack oak and bluejack oak. These communities naturally experienced frequent low intensity surface fires and in the absence of fire the scrub oaks become denser and larger, forming a closed or almost closed subcanopy (Schafale and Weakley 1990). This is the dominant upland community in the 'Sandhills' region of the state.

    Xeric Sandhill Scrub sites occur on deep sand ridges and swale systems. Relict aeolian sand deposits, Carolina bay rims and sandy uplands in mainly the Sandhills region and southern Coastal Plain (Schafale and Weakley 1990). Longleaf pine dominates the open canopy with open to dense understory of turkey oak. Although the least productive, most barren sites produce too little fuel to sustain frequent fires, most of these communities naturally experienced frequent low intensity surface fires with the peak fire season believed to be in early summer (Schafale and Weakley 1990). In absence of fire the scrub oaks become denser and larger and in turn reduce the herb layer and possibility of surface fires.

A. Location and condition of habitat (see Map 5A.25):

Longleaf pine communities, once the most abundant Coastal Plain habitat, now exist in just 3% of their previous range throughout the southeast (Frost 1995). Longleaf pine forest and savanna is one of the most endangered habitats in the country today (Noss and Peters 1995). Urban development and a lack of fire continue to threaten many of these forests. Frost (1993) states that "Of 352 longleaf pine remnants examined in North Carolina, only 91 stands (26%) were being maintained by fire, while the rest (74%) were fire-suppressed and in transition to other forests types." Longleaf pine forests presently occur in the following North Carolina counties, with number of acres in parentheses: Moore (30,200) Hoke (28,300), Richmond (25,800),

Priority species associated with coastal plain dry longleaf pine habitats:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Aimophila aestivalis*	Bachman's Sparrow	SC
	Ammodramus henslowii	Henslow's Sparrow	SR
	Caprimulgus carolinensis	Chuck-will's-widow	
	Caprimulgus vociferus	Whip-poor-will	
	Colaptes auratus	Northern Flicker	
	Colinus virginianus	Northern Bobwhite	
	Contopus virens	Eastern Wood-pewee	
	Dendroica discolor	Prairie Warbler	
	Falco sparverius	American Kestrel	
	Melanerpes erythrocephalus	Red-headed Woodpecker	
	Picoides borealis	Red-cockaded Woodpecker	E (E)
	Sitta pusilla	Brown-headed Nuthatch	
Mammals	*Lasiurus seminolus*	Seminole Bat	
	Sciurus niger	Eastern Fox Squirrel	SR
Amphibians	*Ambystoma tigrinum*	Eastern Tiger Salamander	T
	Bufo quercicus	Oak Toad	SR
	Hyla andersonii	Pine Barrens Treefrog	
	Hyla gratiosa	Barking Treefrog	
	Plethodon glutinosus sensustricto	Northern Slimy Salamander	
	Pseudacris ornata	Ornate Chorus Frog	SR
	Rana capito	Carolina Gopher Frog	T
	Scaphiopus holbrookii	Eastern Spadefoot	
Reptiles	*Cemophora coccinea copei*	Northern Scarletsnake	
	Crotalus adamanteus	Eastern Diamondback Rattlesnake	E
	Crotalus horridus	Timber (Canebrake) Rattlesnake	SC
	Elaphe guttata	Corn Snake	
	Heterodon platirhinos	Eastern Hog-nosed Snake	
	Heterodon simus	Southern Hog-nosed Snake	SC
	Lampropeltis calligaster rhombomaculata	Mole Kingsnake	
	Lampropeltis triangulum elapsoides	Scarlet Kingsnake	
	Masticophis flagellum	Eastern Coachwhip	SR
	Micrurus fulvius	Eastern Coral Snake	E
	Ophisaurus attenuatus longicaudus	Eastern Slender Glass Lizard	
	Pituophis melanoleucus melanoleucus	Northern Pinesnake	SC
	Sistrurus miliarius	Pigmy Rattlesnake	SC
	Tantilla coronata	Southeastern Crowned Snake	

Bladen (25,400), Brunswick (25,200), Cumberland (22,600), Pender (18,600), Scotland (17,900), Onslow (17,800), Carteret (10,800), New Hanover (8,100), Sampson (5,800), Craven (5,200), Pitt (3,100), Columbus (2,800), Harnett (2,800), Robeson (2,500), Jones (2,200), and Lenoir (400).

The best remaining examples of the dry longleaf pine habitat in the Coastal Plain are on the military bases of Fort Bragg, Camp Lejeune, Sonny Point, and Cherry Point, the Croatan National Forest, Holly Shelter Game Land, and Sandhills Game Land. Most of the acreages on the above sites are in fair to good condition, due to regular prescribed burning. There are many other sites on both public and private lands where little to no burning has depleted the value of the habitat; these sites are considered to be in poor condition.

B. Problems affecting species and habitats:

The majority of the loss of this habitat type has been due to urbanization, agriculture, and regeneration of other timber types. Longleaf is considerably more difficult to get established than loblolly, and many foresters do not have the training in order to feel comfortable making recommendations to plant longleaf. Pine production on the Coastal Plain is typically high intensity with short rotations, resulting in densely stocked, closed canopy plantations of loblolly or slash pine with very little herbaceous understory.

Other threats to dry longleaf pine communities are lack of fire, urban development, and intensive pine straw raking. Fire suppression (or only cool season fires) has caused the deterioration of many additional sites, particularly on private lands and around urban areas where smoke management issues create problems for managers and landowners. In absence of fire, scrub oaks (or mesic trees) become larger and more dense and form closed canopies that reduce understory vigor. The loss of understory grass and the presence of oak leaf litter (less flammability) reduces the likelihood and effectiveness of future surface fires (Schafale and Weakley 1990). Designated Wilderness Areas are a good example of where longleaf is being lost to a lack of fire. Longleaf cannot regenerate itself without fire to control competing vegetation. Remaining stands are often fragmented.

Urban development continues to be a problem and can be excessive on these sites. Dry longleaf pine communities occur on sandy, loamy, or other fine textured soils that are moderately to excessively drained, making them ideas sites for residential and commercial development. In addition, the scenic quality of longleaf pines, coupled with the white sands, make longleaf sand-hills ideal sites for golf courses and associated development; many thousands of acres have been developed, particularly around Southern Pines and Pinehurst, North Carolina, for these purposes.

Pine straw raking has tremendously impacted understory habitat by removing understory grasses and forbs, preventing their growth, and somtimes creating an almost bare sandy forest floor.

Old growth characteristics (canopy gaps, red-heart fungus, cavities, snags, hollow trees) are lacking throughout, except where red-cockaded woodpeckers are managed, impacting both primary (e.g., woodpeckers) and secondary (e.g., rodents, bats and other birds) cavity users. Habitat loss and lack of fire affects bird species that rely on a grass-dominant understory and open pine ecosystems (red-cockaded woodpecker, Bachman's sparrow, brown-headed nuthatch, Henslow's sparrow, and northern bobwhite). Microhabitat features such as large woody debris have been lost, impacting reptiles and small mammals (Loeb 1999). Fire ant impacts are also a growing threat.

C. Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:

- **Surveys** – Surveys are needed to document the distribution, relative abundance and status of many wildlife species associated with dry longleaf pine habitats. Priorities for conducting surveys need to focus on species believed to be declining, at risk or mainly dependent on dry longleaf pine communities. Secondary priority for surveys should be for species for which current distribution information is already available or for species that are considered common.
  - Focus avian status and distribution surveys on Bachman's sparrow, brown-headed nuthatch, red-headed woodpecker, American kestrel, Henslow's sparrow, nightjars and red-cockaded woodpeckers (on nonfederal lands) first and then continue for other birds using dry longleaf pine habitats; of particular importance is documentation of red-cockaded woodpecker clusters around designated recovery populations (see USFWS 2003).
  - Conduct winter surveys for Henslow's sparrow in appropriate grass dominated understory habitat (Carrie et al. 2002).
  - Document the status and distribution of small mammals, bats and eastern fox squirrel.
  - Conduct herpetofaunal surveys for eastern tiger salamander, oak toad, Carolina gopher frog, pine barrens treefrog, northern scarletsnake, southern hog-nosed snake, eastern coachwhip, northern pinesnake and pigmy rattlesnake, canebrake rattlesnake and eastern coral snake and expand eventually to include other reptiles and amphibians.

- Inventory reptile and amphibian species on key public lands where good examples of this habitat type still exist; then expand to areas not well managed or fragmented.
- Conduct extensive surveys to determine the status and distribution of the eastern diamondback rattlesnake in order to facilitate initial habitat protection measures.

- **Monitoring** – Monitoring systems need to be expanded and/or targeted to be able to assess current population status and trend information for all wildlife species associated with dry longleaf pine habitats. Many North Carolina dry longleaf pine bird species require specialized monitoring attention, since neither BBS (nor standard point counts) adequately sample for many species like Bachman's sparrow, nightjars, American kestrel, Henslow's sparrow and red-headed woodpecker. Long-term monitoring for amphibians and reptiles needs to be developed or enhanced (Taylor and Jones 2002) and there is a decided lack of long-term monitoring information on most small mammals and for bat species (Ellis et al. 2002).
  - Establish additional MAPS and migration bird banding stations.
  - Initiate long-term monitoring related to snag ecology and cavity nesting birds during different seasons (e.g., northern flicker, red-headed woodpecker and brown-headed nuthatch) (Wilson and Watts 1999; Kreisel and Stein 1999).
  - Initiate long-term monitoring during breeding, winter and migration periods for all priority landbirds (Wilson and Watts 2000; Brown et al. 2002).
  - Initiate long-term monitoring for priority reptiles and amphibian species associated with dry longleaf pine systems (Taylor and Jones 2002).

- **Research**

  Genetics
  - Determine if the southeastern sub-species of the American kestrel breeds and/or winters in these habitats in North Carolina.

  Habitat use
  - Study nightjar habitat-use and foraging patterns (using telemetry).
  - Conduct habitat-use studies on eastern diamondback rattlesnake (using telemetry).
  - Explore spatial and temporal distribution patterns of amphibians related to temporary and scattered water sources (similar to current work being done on International Paper lands in the southeastern Coastal Plain).

  Population demographics
  - Conduct productivity and nest success research on Bachman's sparrow and brown-headed nuthatch to determine limiting factors for population growth (Wilson and Watts 1999, Stober and Krementz 2000).
  - Conduct Seminole bat life history research, as well as demographic information on other bats (Ellis et al. 2002).

  Predator effects
  - Study predator and cowbird parasitism effects on bird productivity for canopy- and ground-nesting birds.
  - Study the effect of fire ants on ground nesting birds and herpetofauna.

  Management practices
  - Examine the effects of red-cockaded woodpecker management on other birds and reptiles, amphibians, and bats (Krementz and Christie 1999, Conner et al. 2002, Provencher et al. 2002).
  - Develop strategies for pine straw raking that minimizes impacts to understory habitat structure.
  - Examine the effects of intensive fire management on the habitat requirements of the eastern fox squirrel (Weigl et al. 1989).
  - Examine the effects of herbicides used to control hardwoods on non-target herbaceous plants; also, study techniques and preferred chemicals for hardwood control that have the least negative impacts on non-target herbaceous plants.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

Habitat restoration through native understory reestablishment, longleaf pine plantings and growing season prescribed burning is needed to maintain the understory and open pine ecosystem. Controlling midstory development and encouraging understory development through prescribed burning are major objectives in order to restore these communities to presettlement conditions (Lorimer 2001). Although a total eradication of oaks when trying to restore longleaf habitat reduces the food base for many mammals (e.g., eastern fox squirrel), restoration of natural fire frequency, intensity, and seasonality is critical for pine-related reptiles, amphibians, and their prey (Bailey et al. 2004). Acceptance of controlled burning can be enhanced through public education, programs to "fire-safe" properties, and cost-share programs to install fire lines and conduct controlled burns. Mechanical or chemical vegetation controls can supplement or replace burning where appropriate. Snag management should be practiced to increase populations of cavity nesting birds (e.g., red-cockaded woodpecker, USFWS 2003).

We must encourage thinning of pine forests and planting longleaf pine (restoration work) in clearcuts and abandoned fields. We must also work with the NC Forest Service to allow wildfires to burn where safety and property protection considerations allow. Opportunities exist to take advantage of existing initiatives and programs such as Partners for Fish and Wildlife, Safe Harbor, the Forest Landbird Legacy Program and Farm Bill programs to influence and improve habitat conditions for birds and other longleaf pine related wildlife. We must also continue coordination with red-cockaded woodpecker working groups, such as the translocation working group, as well as the Sandhills and Coastal group efforts to better manage for that species.

Management and protection of longleaf communities to promote large, unfragmented tracts is needed for reptiles and some bird species. In order to accomplish this goal, land acquisition and easements, especially for existing unfragmented longleaf pine forest, should be sought through cooperation with land trusts and The Nature Conservancy. This protection could potentially involve poor sites (e.g., recent clearcuts, loblolly pine plantations) whereby conversion to longleaf can be accomplished. Two high priority regions for accomplishing landscape-level connection, protection, and management of longleaf pine and associated communities are the Sandhills region and the Onslow Bight region. In the Sandhills, Fort Bragg, Sandhills Game Lands, and other key priorities need to be connected to facilitate dispersal among the high quality habitats of these managed and protected properties. The Onslow Bight region is located on the Coastal Plain from the Pamlico River to the Cape Fear River. Croatan National Forest, Camp Lejeune, and Holly Shelter Gamelands need to be connected to each other and to other key properties to facilitate dispersal and create a landscape-level mosaic of protected, managed, and high quality habitats. The Natural Heritage Trust Fund and the Recovery Land Acquisition Grants are the primary funding sources at this time for acquisition funds within this habitat.

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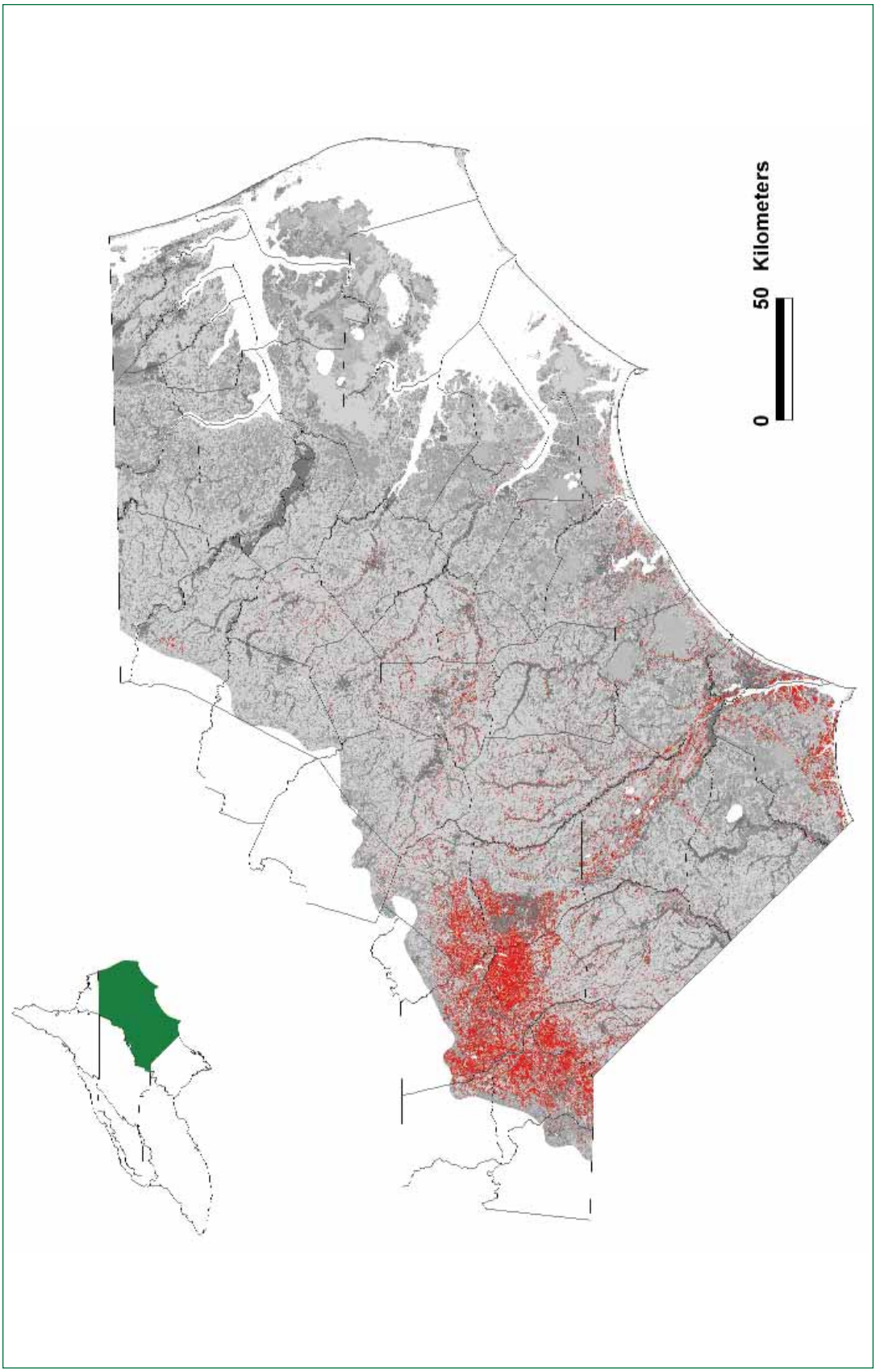

Figure 5A.25. Dry longleaf pine habitats in the Mid-Atlantic Coastal Plain ecoregion of North Carolina (in red) (data source: NC GAP, 1992).

26. **Pocosin** – Peatland communities of the Coastal Plain include low pocosin, high pocosin, pond pine woodlands, peatland Atlantic white cedar forest, bay forest, streamhead pocosin, and streamhead Atlantic white cedar forest. These communities occur on peatlands of poorly drained interstream flats, and peat-filled Carolina bay depressions and swales of the eastern coastal plain (Schafale and Weakley 1990). The streamhead communities occur primarily in the Sandhills along small headwater streams, either on flat bottoms or extending up adjacent seepage slopes.

    Extremely acidic in nature due to organic soils, in general these habitats are nutrient poor and usually continuously saturated with water. Fires were historically associated with droughts, and fire frequency and intensity strongly influence vegetative structure dominance, composition, stature and diversity. All but the streamhead communities occur along a gradient of moisture, nutrients, and peat depth and typically occupy different locations with the domed peatlands of interstream flats and Carolina Bays and swales. The wettest sites (or the center of bays) may contain only low shrubs and stunted pond pine, with beds of sphagnum, pitcher plants, and cranberry. Higher, drier sites are characterized by an extremely dense shrub layer.

    Both High and Low Pocosins are extremely nutrient poor, with little normal nutrient input other than rainfall. Under natural conditions, fire was an important component shaping the structural diversity of these communities. Low Pocosins are centrally located on peatlands on the deepest peat. They are the least productive and most stunted of all the pocosin habitats. True Low Pocosins are much rarer than High Pocosins or Pond Pine Woodlands and differ from the others by having a persistent low stature (<1.5m tall) of shrubby vegetation and sparse, stunted trees. High Pocosins are intermediate between Low Pocosins and Pond Pine Woodlands in terms of location, depth of peat, shrub height and density, and stature of trees. The shrub layer is typically 1.5-3 meters in height and trees still tend to be scattered and small in stature.

    Pond Pine Woodlands occur on parts of domed peatlands on poorly drained interstream flats, peat-filled Carolina bays, and shallow swales and are found throughout the Coastal Plain (Schafale and Weakley 1990). Some stands occupy many thousands of acres, such as in Croatan National Forest, Holly Shelter Game Land, and Green Swamp. These communities are wet and nutrient poor, though less so than Low and High Pocosins, and fire played a role in shaping them historically. In areas where frequent fires have occurred over long periods of time, the understory is dominated by switch cane (Arundinaria) and in general the less frequent the fire regime the greater the dominance by pond pine (Schafale and Weakley 1990). Red-cockaded woodpeckers exist in some of these pond pine-dominated sites.

    Another community that occurs within large peatland landscapes is the peatland Atlantic white cedar forest. Atlantic white cedar-dominated forests are found throughout the Coastal Plain but are most common in the outer Coastal Plain and usually exists as a mosaic with Pond Pine Woodlands, bay forests, nonriverine swamp forests and other communities (Schafale and Weakley 1990). Their occurrence is determined by fire history. They become established after a catastrophic fire removes all competing vegetation and, therefore, usually occur as even-aged stands. Atlantic white cedar dominates in some remaining pocosins where fire is infrequent, but its overall abundance and distribution has been greatly reduced by lack of fire, logging and drainage (Schafale and Weakley 1990).

    Bay forests occur throughout the outer and middle Coastal Plain and also typically exist as a mosaic with pond pine woodlands, Atlantic white cedar forests, and nonriverine swamp forests (Schafale and Weakley 1990). Bay forests occur on shallow organic soils and the canopy is dominated by loblolly bay, sweet bay, and red bay. Bay forests are believed to be a late-successional community that replaces pond pine woodlands and Atlantic white cedar after a long absence of fire. Bay forests may be solely a product of fire suppression, or there may be sites which naturally supported them (Schafale and Weakley 1990).

    Streamhead pocosin communities resemble peatland pocosins but they are found in very different physical settings: ravines in permanently saturated Sandhill seeps. These habitats are subject to influence from fire on adjacent uplands and are characterized by an open canopy of pond pine, with potential for red maple, sourwood, swamp black gum, and tulip poplar. A dense shrub layer is usually present and herbs are sparse. There is a higher shrub and tree diversity in

Priority species associated with coastal plain pocosin habitat:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Colaptes auratus*	Northern Flicker	
	Dendroica discolor	Prairie Warbler	
	Dendroica virens waynei	Wayne's Black-throated Green Warbler	
	Helmitheros vermivorous	Worm-eating Warbler	
	Limnothlypis swainsonii	Swainson's Warbler	
	Melanerpes erythrocephalus	Red-headed Woodpecker	
	Picoides borealis	Red-cockaded Woodpecker	E (E)
	Wilsonia citrina	Hooded Warbler	
Mammals	*Condylura cristata*	Star-nosed Mole	SC
	Mustela frenata	Long-tailed Weasel	
	Peromyscus gossypinus	Cotton Mouse	
	Sylvilagus palustris	Marsh Rabbit	
	Synaptomys cooperi helaletes	Southern Bog Lemming	SR
Amphibians	*Bufo quercicus*	Oak Toad	SR
	Desmognathus auriculatus	Southern Dusky Salamander	
	Hyla andersonii	Pine Barrens Treefrog	
	Stereochilus marginatus	Many-lined Salamander	

these communities due to nutrients released by burning in adjacent uplands and more frequent disturbance from fires that burn into the edges (Schafale and Weakley 1990).

Pocosins are particularly important for wintering birds because of the high amount of soft mast available. Greenbrier (*Smilax* spp.), red bay, sweet bay, and many ericaceous shrubs produce large quantities of berries that are persistent through much of the winter. Pocosin habitats are important for a variety of shrub-scrub birds though we are lacking status and distribution data, as well as detailed information, about the bird communities that utilize them (Karriker 1993). We also lack detailed information about populations of small mammals, bats, reptiles and amphibians in pocosin habitats, in part because of the very dense (often impenetrable) nature of most pocosin habitats (Mitchell 1994).

A. Location and condition of habitat (see Map 5A.26):

Pocosin habitats are found throughout the outer coastal plain; in the inner Coastal Plain they are found mainly in the Sandhills region or in Carolina bays. The condition of pocosin habitats in much of the Coastal Plain is poor due to fire suppression, changes in hydrology, intensive silviculture, and conversion of forest types. Extensive examples of low and especially high pocosins still exist in the Green Swamp, Croatan National Forest, Holly Shelter Game Land, Camp Lejeune, much of the Albermarle-Pamlico peninsula and many other places as well. The Croatan National Forest, Dare Bombing Range, Camp Lejeune, and Holly Shelter Game Land do conduct some pocosin burns, but all other fire introduced into pocosin habitats tends to be on small acreages (<100 acres).

Extensive examples of Pond Pine Woodlands exist in the Green Swamp, at Alligator River Natianal Wildlife Refuge, Pocosin Lakes National Wildlife Refuges and in Dare County at the Dare Bombing Range. Atlantic White cedar dominates in some remaining pocosins where fire is infrequent, but its overall abundance has been greatly reduced by lack of fire, logging, and drainage (Schafale and Weakley 1990). Atlantic white cedar-dominated communities still exist at Alligator River and Pocosin Lakes National Wildlife Refuges, and in the Great Dismal Swamp.

Public lands hold the highest concentrations of pocosin and peatland communities in the Coastal Plain. Pocosins on private land have largely been ditched and converted to loblolly pine plantations by the forest products industry. Pond pine is a very long-lived tree and is very tolerant to fire, so under natural conditions pond pine woodlands and high pocosin habitats would have a very old component. That is to say that many of the trees in these habitats would normally by over 100 years old. Although much of the pond pine dominated sites are still very old, fire suppression is causing a large build-up of fuel. Concerns are that once these stands burn under wildfire conditions, the fire will be so intense that the ground will burn, thus killing the entire stand.

B. Problems affecting species and habitats:

Fire suppression is an important factor threatening many remaining pocosin, peatland, and streamhead communities due to the strong influence fire has on their vegetative structure, composition, and diversity. Fire-suppressed stands may be invaded by species such as red maple; maples are reaching the canopies of some cedar stands in the long absence of fire. Many managers and landowners are wary of introducing fire to long fire-suppressed peatland communities due to the volatile nature of these communities and to smoke management concerns. When fire is introduced, firelines are often placed directly in the transition zone between uplands and pocosins destroying the species-rich ecotone and preventing fire from burning into pocosins.

Conversion of habitat also threatens pocosin habitats; ditching and draining of these sites leads to alteration of hydrology. When done in preparation for conversion to another land use, these activities ultimately lead to destruction of pocosin vegetation. Conversions for development, agricultural and forestry interests are the major contributors. However, conversion to industrial pine plantations has slowed in recent years. Sedimentation due to clearing of adjacent uplands is also a problem for some streamhead communities.

Habitat fragmentation (as a result of habitat conversion and urbanization) threatens the integrity of pocosin and peatland communities since these communities typically occur as mosaics on the landscape and fire plays an important role in determining the structure of that landscape. As the landscape becomes fragmented, prescribed fire becomes more difficult to use as a management tool because of smoke management concerns and safety issues around urban areas.

In general, little detailed information exists for many species of wildlife that use pocosin habitats because of the impenetrable nature of these habitats. Few surveys have been done on a long-term basis, which makes land management decisions difficult. Pocosin habitats are important for a variety of shrub-scrub birds yet we are lacking status and distribution data, as well as detailed information, about the bird communities that utilize them (Karriker 1993). We also lack detailed information about populations of small mammals, bats, reptiles and amphibians in pocosin habitats (Mitchell 1994)

C. Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:

- **Surveys** – Surveys are needed to document the distribution, relative abundance and status of many wildlife species associated with pocosin habitats. Priorities for conducting surveys need to focus on species believed to be declining, at risk or mainly dependent on pocosin communities. Secondary priority for surveys should be for species for which current distribution information is already available or for species that are considered common. Many pocosin-associated bird species have experienced significant declines across North America over the past four decades according to BBS trend data.
  - Determine status and distribution for Wayne's black-throated green warbler, worm-eating warbler, Swainson's warbler, black-billed cuckoo (may warrant further documentation) and other neotropical migrants, including shrub-scrub specialists like prairie warbler, common yellowthroat and yellow-breasted chat.
  - Conduct helicopter surveys for red-cockaded woodpeckers.
  - Initiate surveys for priority small mammals and investigate bat use of pocosin habitats.

- Initiate amphibian surveys, especially for the oak toad, southern dusky salamander, pine barrens treefrog, and many-lined salamander.
- Initiate surveys for reptiles using pocosin habitats.
- Establish frog call survey stations in pocosin habitats.

- **Monitoring** – Monitoring systems need to be expanded and/or targeted to be able to assess current population status and trend information for all wildlife species associated with pocosin habitats. Many North Carolina pocosin bird species require specialized monitoring attention, since BBS (nor standard point counts) does not adequately sample for species like Wayne's black-throated green warbler, worm-eating warbler, Swainson's warbler, black-billed cuckoo and red-headed woodpecker. Long-term monitoring for amphibians and reptiles needs to be developed or enhanced (Taylor II and Jones 2002) and there is a decided lack of long-term monitoring information on most small mammals, and for bat species foraging in pocosins (Ellis et al. 2002).
  - Establish MAPS and migration bird banding stations in pocosin habitats.
  - Initiate long-term monitoring of breeding and wintering birds in pocosin habitats on public lands and industrial forestland (Karriker 1993 and Watts 2002).
  - Initiate long-term monitoring for mammal populations (including bats) in pocosin habitats on public lands and industrial forestland (Mitchell 1994).
  - Initiate long-term monitoring of reptiles and amphibians in pocosin habitats on public lands and industrial forestland.

- **Research** .

  Genetics
  - Determine the genetic relationships of pocosin habitat small mammals (e.g., shrews and rodents).
  - Examine the possibility of a sub-species for the coastal worm-eating warbler.

  Habitat use
  - Examine the relationship between habitat patch size and nesting success of shrubland birds (Burhans and Thompson 1999) and habitat use by small mammals (Litvaitis 2001).
  - Measure soft mast (berry) production in pocosins and wintering bird use of these areas.
  - Determine breeding bird habitat use in Atlantic white cedar stands.

  Population demographics
  - Conduct studies to obtain basic demographics information on priority birds, small mammals, amphibians and reptiles.

  Predator effects
  - Study predator effects on bird nest success and productivity, as well as other productivity or behavioral studies such as nest-searching and spot-mapping, on public lands and industrial forestland (Mamo and Bolen 1999, Karriker 1993).

  Management practices
  - Determine the best ways to burn these sites, or alternative management that will mimic the effects of fire at sites where birds, mammals, reptiles and amphibians are being monitored.
  - Determine how the use of chipping (using a hydro-ax or other heavy chipping machinery) midstory and understory vegetation affects the plant and animal communities. This practice is becoming more common, particularly in areas where red-cockaded woodpeckers are present.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

The increased use of prescribed fire where possible is one conservation action that can be used to increase heterogeneity in some pocosin habitats related to vegetative dominance, stature and diversity. Fire will increase vegetation structural diversity and should help promote establishment of an herbaceous ground cover such as switchgrass in pond pine dominated woodlands

over time. Fire cycles may be important at certain stages in the life cycle of Atlantic white cedar stands; this needs to be explored.

Burning can often be accomplished on uplands without the use of fire-lines in transition zones between upland sites and pocosin habitats (especially in winter). This promotes a healthy transition zone between the two habitats that is critical for many plant species and allows for nutrient flow to some pocosin habitats

Though extensive amounts of pocosin lands are already protected, some specialized types require more protection, such as Carolina bays (Bladen Lakes area) and white cedar stands. Acquisition partnerships via land trusts and The Nature Conservancy will be important. Opportunities exist to take advantage of initiatives and programs that promote pocosin restoration (Forest Landbird Legacy Program, Partners for Wildlife, North American Wetland Conservation Act). Identified funding sources for acquisition include the Clean Water Management Trust Fund, Coastal Wetlands Grants, Natural Heritage Trust Fund, Forest Legacy, and Recovery Land Acquisition Grants.

Finally, land managers and planners need to address management issues related to pocosin habitats in conservation and land-use planning efforts and also work to understand what the public wants and is willing to accept regarding the management of pocosin habitats and the wildlife associated with these habitats (Thompson and DeGraaf 2001).

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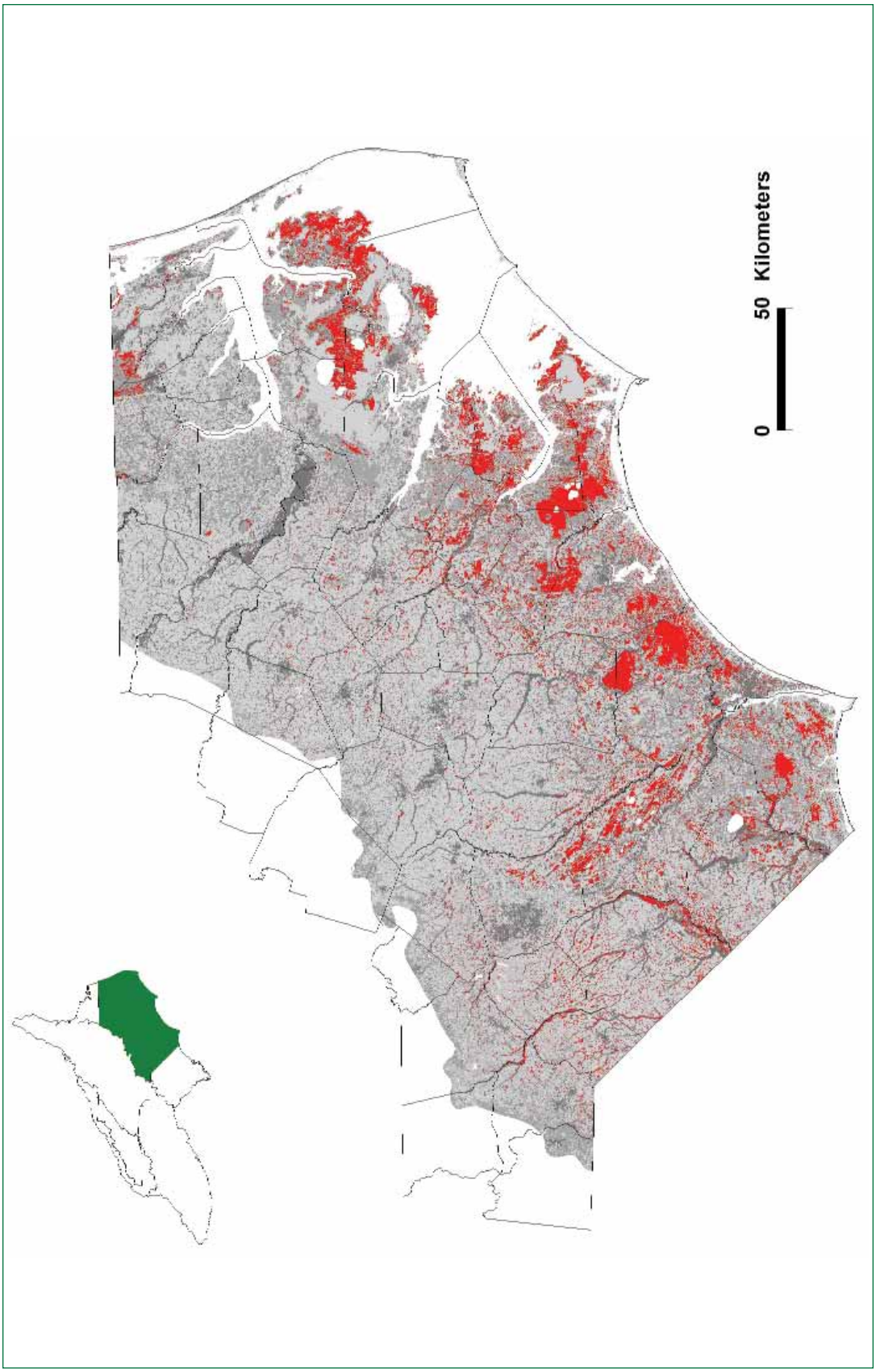

Figure 5A.26. Pocosin habitats in the Mid-Atlantic Coastal Plain ecoregion of North Carolina (in red) (data source: NC GAP, 1992).

27. **Wet pine savanna** – This habitat type includes Pine Savanna, Sandhill Seep, and Wet Pine Flatwoods communities, all of which are mineral wetlands that under natural conditions are subject to frequent burning. With fire, they are characterized by an open canopy dominated by longleaf pine or pond pine, an open midstory, and an understory comprised of some mixture of wiregrass, cane, herbs, and pocosin shrubs depending on soil moisture and fire frequency. Some of the herbaceous plant diversity in these systems, particularly in Pine Savannas, is the highest in temperate North America if burned on a consistent and frequent basis. When fire is suppressed, a dense shrub understory develops and herb diversity declines drastically. These pine communities are similar to dry longleaf pine communities in that they often grade into each other and can occur as a mosaic on the landscape. They may also grade into dry longleaf pine communities, pond pine woodlands, and pocosins.

    Wet Pine Flatwoods are found on seasonally wet to usually wet sites on flat or nearly flat Coastal Plain sediments, and are widespread in the outer and middle Coastal Plain and found occasionally in the Sandhills. These communities have a closed to open canopy of longleaf pine that is sometimes mixed with loblolly or pond pine, and have a low shrub and herb layer of varying density. These sites naturally experienced frequent, low to moderate intensity surface fires (Schafale and Weakley 1990).

    Pine Savannas are found in the lower Coastal Plain on wet, flat areas, and occasionally low "islands" in peatlands or swamps, and are saturated at least part of the year (Schafale and Weakley 1990). These communities naturally experienced frequent fairly low intensity surface fires and with such conditions have a dense herb layer, a very high herb species diversity and an open to sparse pine canopy. In the absence of fire the canopy becomes denser, shrubs invade and herb diversity drops (Schafale and Weakley 1990). There are many rare plants associated with this community type.

    Sandhill Seep communities are found on wet sands underlain by clays on slopes in sand ridges or sandhill areas, primarily in the Sandhills region, but are also present in scarps and sand ridges in the Coastal Plain (Schafale and Weakley 1990). Community structure is strongly controlled by fire regime, and with fire these areas are open and herb dominated and somewhat resemble Pine Savannas but can quickly shift to shrub-dominated understory in the absence of fire (Schafale and Weakley 1990). Like other small natural communities in sandhill areas, nutrients mobilized by fire may be available to Sandhill Seeps even if they do not themselves burn (Schafale and Weakley 1990). Many of these Sandhill Seep areas are becoming overgrown with shrubs due to declining fire frequency.

A. Location and condition of habitat (see Map 5A.27):

The condition of wet pine savanna communities in the Coastal Plain has been greatly reduced due to fire suppression. In the absence of fire, herb diversity and density greatly decline as shrubs present in the understory or surrounding habitat quickly invade and attain dominance. In many areas where fire has been used on adjacent stands, plow-lines at the edge of the wetland have caused a marked loss in transition habitat into these savannas where plant diversity would naturally be very high. Also, a lack of fire has allowed loblolly pines (which are less resistant to fire, especially when young) to invade some areas. This has resulted in a heavier canopy which reduces light to the forest floor, once again inhibiting plant diversity. The additional overstory also somewhat dries the site through transpiration. Ditching, draining and conversion to loblolly plantations has also reduced historic savanna habitat.

A few good examples of these community types still do exist on lands managed by The Nature Conservancy (Green Swamp), the Commission (Holly Shelter Game Lands, Sandhills Game Land), and the US Forest Service (Croatan National Forest). Originally probably the nicest example of wet pine savanna was a 1500 acre site called the Big Savanna in Pender County. Although this site was converted to farmland in the late 1950's, a small (117 acre) but significant extension to the site called Pelham Savanna has been purchased by the North Carolina Coastal Land Trust. The Coastal Land Trust is now in the process of restoring some of the remaining habitat on Pelham Savanna with fire and midstory chipping. Fortunately, experience has shown that even after decades of fire suppression, chipping or burning the midstory in these fire-suppressed stands produces diverse herbaceous understory vegetation.

Priority species associated with coastal plain wet pine savanna:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Aimophila aestivalis*	Bachman's Sparrow	SC
	Ammodramus henslowii	Henslow's Sparrow	SR
	Colaptes auratus	Northern Flicker	
	Colinus virginianus	Northern Bobwhite	
	Dendroica discolor	Prairie Warbler	
	Falco sparverius	American Kestrel	
	Melanerpes erythrocephalus	Red-headed Woodpecker	
	Picoides borealis	Red-cockaded Woodpecker	E (E)
	Sitta pusilla	Brown-headed Nuthatch	
Mammals	*Mustela frenata*	Long-tailed Weasel	
Amphibians	*Ambystoma mabeei*	Mabee's Salamander	SR
	Ambystoma tigrinum	Eastern Tiger Salamander	T
	Bufo quercicus	Oak Toad	SR
	Eurycea quadridigitata	Dwarf Salamander	SC
	Hyla andersonii	Pine Barrens Treefrog	
	Hyla gratiosa	Barking Treefrog	
	Plethodon glutinosus sensustricto	Northern Slimy Salamander	
	Pseudacris brimleyi	Brimley's Chorus Frog	
	Pseudacris nigrita nigrita	Striped Southern Chorus Frog	
	Pseudacris ornata	Ornate Chorus Frog	SR
	Rana capito	Carolina Gopher Frog	T
	Scaphiopus holbrookii	Eastern Spadefoot	
Reptiles	*Elaphe guttata*	Corn Snake	
	Eumeces laticeps	Broad-headed Skink	
	Heterodon platirhinos	Eastern Hog-nosed Snake	
	Lampropeltis calligaster rhombomaculata	Mole Kingsnake	
	Lampropeltis triangulum elapsoides	Scarlet Kingsnake	
	Ophisaurus attenuatus longicaudus	Eastern Slender Glass Lizard	
	Ophisaurus mimicus	Mimic Glass Lizard	SC
	Rhadinaea flavilata	Pine Woods Littersnake	
	Sistrurus miliarius	Pigmy Rattlesnake	SC

These habitats are particularly important for reptiles and amphibians where ponds are embedded in savannas or flatwoods; however, little is known about herpetofauna in these areas. Red-cockaded woodpeckers also use these habitats since they typically have a sparse overstory and open midstory that is preferred by the woodpeckers.

B. *Problems affecting species and habitats:*

Many of the problems affecting dry longleaf pine communities also affect wet pine savannas. Intensively managed pine plantations, urban development, a lack of fire, and subsequent habitat fragmentation continue to threaten these communities, and have caused a great deal of losses to wet pine savanna sites. Draining and clearing have altered hydrology and vegetative assemblages. Poor logging practices, especially on non-industrial forestlands, have severely rutted or high-graded many areas.

Fire suppression and a lack of growing-season prescribed burning has caused a thick shrubby understory to develop which shades out grasses and herbaceous ground vegetation and greatly reduces overall plant and animal diversity. The loss of a transition zone between uplands and savannas and between savannas and pocosins due to fireline construction is also a major

concern. Microhabitats and ecotones have been lost due to this practice, and a lack of woody debris particularly impacts reptiles, amphibians and small mammals. Many of the bird species of highest conservation concern inhabit these communities and depend on frequent fire to create suitable habitat conditions (e.g., red-cockaded woodpecker, Bachmans's sparrow, Henslow's sparrow, brown-headed nuthatch, American kestrel, prairie warbler) according to Partners in Flight (Hunter et al. 2001 and Johns 2004).

C. Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:

- **Surveys** – Surveys are needed to document the distribution, relative abundance and status of many wildlife species associated with these habitats. Priorities for conducting surveys need to focus on species believed to be declining, at risk or mainly dependent on these communities. Secondary priority for surveys should be for species for which current distribution information is already available or for species that are considered common. Many bird species associated with these community types have experienced significant declines across North America over the past four decades according to BBS trend data.
  - Conduct priority bird surveys for Bachman's sparrow, Henslow's sparrow, brown-headed nuthatch, American kestrel, nightjars, prairie warbler and red-cockaded woodpeckers (on nonfederal lands), then for other species.
  - Determine the status and distribution of the long-tailed weasel, as well as small mammals and bats.
  - Conduct amphibian surveys with focus on the Mabee's salamander, eastern tiger salamander, dwarf salamander, ornate chorus frog, Brimley's chorus frog, Carolina gopher frog and Pine Barrens treefrog (Taylor and Jones 2002).
  - Determining the status and distribution of hard to find reptile species or species for which we have little information (e.g., pigmy rattlesnake, scarlet kingsnake, pine woods littersnake and glass lizards) (Taylor and Jones 2002).
- **Monitoring** – Long term monitoring should be initiated once baseline surveys have been conducted. Focus should begin with herpetofauna and bird species in decline, or for which little is known about the population fluctuations and demographics.
  - Establish MAPS and bird migration banding stations.
  - Establish long-term monitoring for all birds of high conservation concern.
  - Establish long-term monitoring for all reptiles and amphibians in this habitat type (Taylor and Jones 2002).
- **Research**

  Genetics
  - Determine the sub-species status of the American kestrel.

  Habitat use
  - Initiate studies of cavity nesters' use of snags in these systems.
  - Conduct habitat use research on pigmy rattlesnakes.

  Predator effects
  - Study predator effects (including fire ants) on ground nesting bird nest productivity, and productivity as related to cowbird parasitism (Dawson and Bollinger 2000).
  - Study impacts of fire ants on herpetofaunal communities.

  Management practices
  - Document the response of birds, small mammals, amphibians and reptiles to burned vs. unburned wet savanna habitats.
  - Determine habitat response to different seasons/timing of burns (e.g., winter burns vs. spring burns).
  - Explore alternatives (herbicides or mechanical) to using fire for the initial restoration of severely fire-suppressed wet pine savannas.
  - Explore hydrologic restoration of extensively drained sites.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

Habitat restoration should primarily occur through growing season prescribed burning, to develop and maintain the herbaceous layer and open pine stands. Where growing season burns can not be administered, winter burns can be constructive. Burning should be accomplished without placing firelines in transition zones from uplands to wetlands and with the fire allowed to burn through transition zones.

Snags should be retained during logging operations to increase the numbers available for cavity-using wildlife species. Efforts need to be made to maintain sufficient levels of woody debris in stands for reptiles, amphibians and small mammals. In disturbed sites, consideration should be given to create barrow sites or ponds for breeding use by amphibians. Otherwise, amphibians are scarce in most flatwoods and savannas devoid of pools or open water.

Management, restoration, and protection of all wet pine savanna communities is needed to promote large, unfragmented tracts, which is especially important for reptiles and amphibians. We must begin to explore opportunities for hydrologic restoration of extensively drained sites. Education and financial or technical guidance incentives should be offered to persuade landowners not to log when soil moisture conditions are conducive to rutting.

Because of the great number of rare plants and animals in these habitats, protection of remaining sites is of utmost importance and urgency. Land acquisition and easements should be promoted through cooperation with land trusts and The Nature Conservancy. Opportunities exist to take advantage of existing initiatives and programs with the US Fish & Wildlife Service and the Natural Resources Conservation Service, such as the Forest Landbird Legacy Program, Partners for Fish and Wildlife, and Farm Bill programs, to improve forest habitat for birds and other wildlife on privately-owned lands. Regional landscape-level conservation initiatives such as those in the Sandhills and Onslow Bight regions for dry longleaf pine also apply to wet pine savanna communities. Identified funding sources for acquisition include the Clean Water Management Trust Fund, Coastal Wetlands Grants, Natural Heritage Trust Fund, Forest Legacy, and Recovery Land Acquisition Grants.

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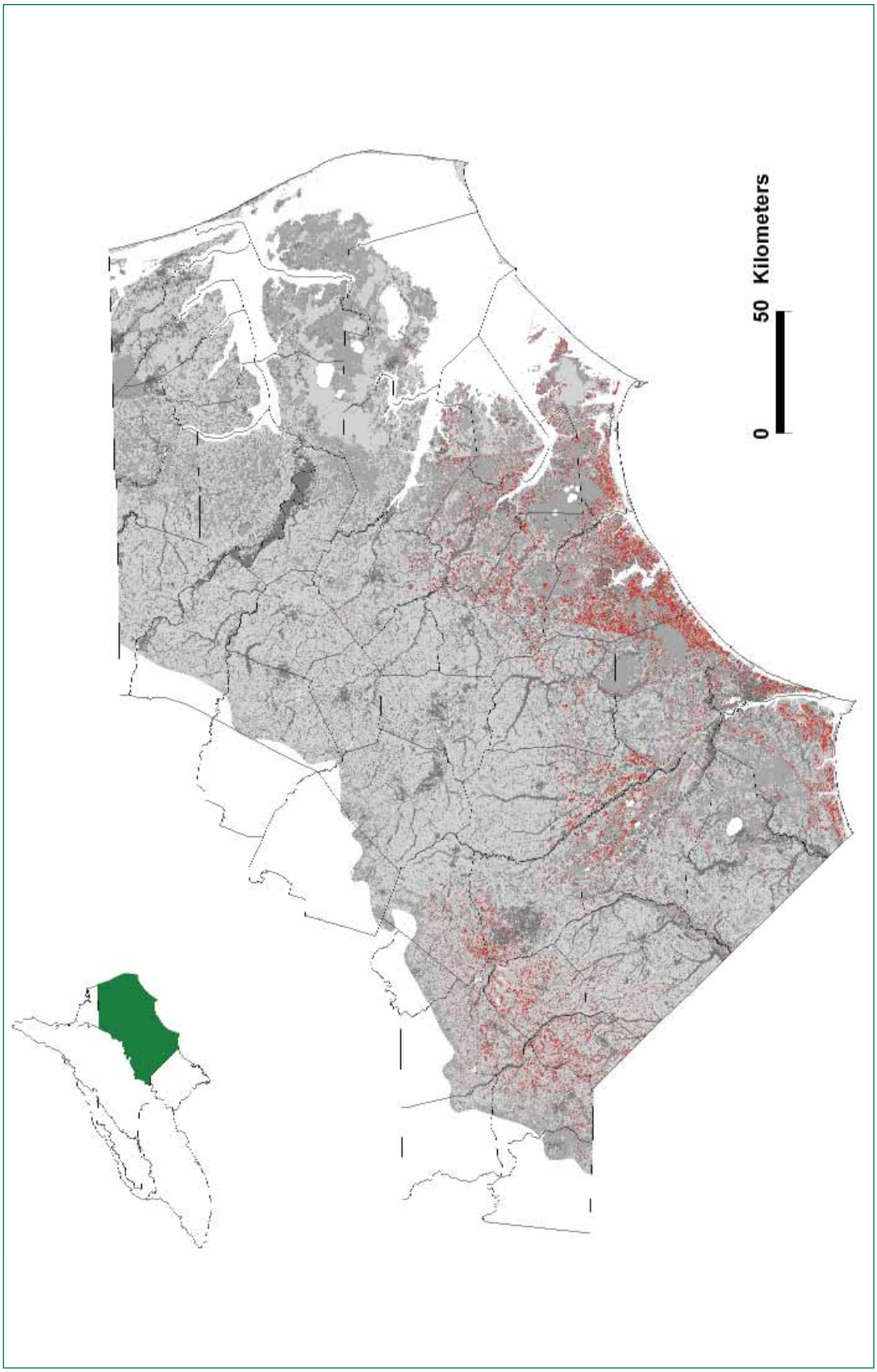

Figure 5A.27. Wet pine savanna habitats in the Mid-Atlantic Coastal Plain ecoregion of North Carolina (in red) (data source: NC GAP, 1992).

28. **Floodplain forest** – The Coastal Plain floodplain forest habitat includes levee forest, cypress-gum swamps, bottomland hardwoods, and alluvial floodplains with small poorly defined fluvial features (such as Small Stream Swamps), as well as semipermanent impoundments (beaver ponds and mill ponds), sand and mud bars, and oxbow lakes. Floodplain forest may be associated with blackwater rivers (originating in the Coastal Plain) or brownwater rivers (originating the Piedmont or Mountains but flowing into the Coastal Plain). The floodplain forest systems of the Coastal Plain in the southeast are now only small fragments and sections of the original millions of acres present before European settlement and have been lost or altered by development, drainage, agriculture and logging (Weller and Stegman 1977). Several of the species of wildlife that once called large floodplain systems home are gone or greatly reduced in numbers.

    Sand and Mud Bar communities are found throughout the Coastal Plain and are usually in and adjacent to streams and rivers and these areas are mostly too wet, young or severely flooded to support a forest canopy (Schafale and Weakley 1990). The dynamic nature of these sand and mud bars also prevents establishment of vegetation. These communities are small and vary widely within and among sites with the size and gradient of river, frequency of duration of flooding, degree of consolidation of substrate, amount of regular fluvial deposition and location within the Coastal Plain (Schafale and Weakley 1990). They are common sites for migrating shorebirds or wading birds to briefly stopover and rest or forage. Coastal Plain Semipermanent impoundments are distinguished from the surrounding floodplain communities by having permanent or semipermanent standing water (beaver ponds, and similar manmade impoundments) and are found throughout the Coastal Plain (Schafale and Weakley 1990). Oxbow Lakes are abandoned river channel meanders with permanent nonflowing water found throughout the Coastal Plain along major rivers (Schafale and Weakley 1990).

    Levee Forest communities in blackwater systems occur on natural levee deposits along channels of large rivers. Dominant trees include wetland hardwoods such as laurel oak, overcup oak, willow oak, river birch, sweetgum, red maple and American elm. Loblolly pine may be common, especially in disturbed sites. These areas are seasonally to intermittently flooded, and typical of blackwater river systems, there is a highly variable flow regime with floods of short duration and periods of very low flow (Schafale and Weakley 1990). The shrub layer ranges form sparse to dense and the herb layer is usually well developed. These areas are greatly affected by the forces of the river and are the rarest of the blackwater floodplain natural communities (Schafale and Weakley 1990).

    Bottomland Hardwoods in blackwater systems occur on high parts of the floodplain away from the channel and are dominated by laurel oak, water oak, willow oak, overcup oak, red maple, sweetgum, loblolly pine, and occasionally Atlantic white cedar (Schafale and Weakley 1990). Shrub layers can be very dense and switch cane can be common. Vines can be dense, but usually not as dense as on levees, and the herb layer is usually sparse. Flooding occurs in these sites occasionally but they are seldom disturbed by flowing water like levees. Blackwater rivers carry little inorganic sediment so flooding does not provide a substantial nutrient input as it does in brownwater systems (Schafale and Weakley 1990). These areas may carry fires (due to dense lower layers of vegetation) when dry and the occurrence of fire would affect the plant community composition and structure.

    Brownwater Levee Forests, in contrast to blackwater levee habitats, tend to have periods of sustained high flow and the water is high in pH, nutrients and mineral sediment (Schafale and Weakley 1990). Forests are dominated by bottomland hardwood species such as sycamore, sugarberry, green ash, river birch, boxelder, water hickory and sweetgum, with moderately dense shrub layers, abundant vines and a dense herb layer (Schafale and Weakley 1990).

    Bottomland hardwoods in brownwater systems are found throughout the Coastal Plain and typical trees include swamp chestnut oak, cherrybark oak, laurel oak, water oak, willow oak, Shumard's oak, sweetgum, green ash, shagbark hickory, bitternut hickory, water hickory and American elm (Schafale and Weakley 1990). These systems are seasonally to intermittently flooded and the water table may be high for long periods even when the site is not flooded (Schafale and Weakley 1990).

Priority species associated with coastal plain floodplain forest:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Anhinga anhinga*	Anhinga	SR
	Chaetura pelagica	Chimney Swift	
	Coccyzus americanus	Yellow-billed Cuckoo	
	Contopus virens	Eastern Wood-pewee	
	Dendroica cerulea	Cerulean Warbler	SR
	Dendroica virens waynei	Wayne's Black-throated Green Warbler	
	Elanoides forficatus	Swallow-tailed Kite	
	Haliaeetus leucocephalus	Bald Eagle	T (T)
	Helmitheros vermivorous	Worm-eating Warbler	
	Hylocichla mustelina	Wood Thrush	
	Ictinia mississippiensis	Mississippi Kite	SR
	Limnothlypis swainsonii	Swainson's Warbler	
	Melanerpes erythrocephalus	Red-headed Woodpecker	
	Nyctanassa violacea	Yellow-crowned Night-heron	
	Oporornis formosus	Kentucky Warbler	
	Picoides villosus	Hairy Woodpecker	
	Scolopax minor	American Woodcock	
	Wilsonia citrina	Hooded Warbler	
Mammals	*Condylura cristata*	Star-nosed Mole	SC
	Corynorhinus rafinesquii	Rafinesque's Big-eared Bat	T
	Lasiurus intermedius	Northern Yellow Bat	SR
	Lasiurus seminolus	Seminole Bat	
	Myotis austroriparius	Southeastern Bat	SC
	Neotoma floridana	Eastern Woodrat	T
	Peromyscus gossypinus	Cotton Mouse	
	Sorex hoyi winnemana	Southern Pygmy Shrew	
	Sylvilagus palustris	Marsh Rabbit	
Amphibians	*Ambystoma mabeei*	Mabee's Salamander	SR
	Ambystoma maculatum	Spotted Salamander	
	Ambystoma opacum	Marbled Salamander	
	Desmognathus auriculatus	Southern Dusky Salamander	
	Eurycea guttolineata	Three-lined Salamander	
	Eurycea quadridigitata	Dwarf Salamander	SC
	Eurycea sp 1	Sandhills Salamander	
	Hemidactylium scutatum	Four-toed Salamander	SC
	Plethodon glutinosus sensustricto	Northern Slimy Salamander	
	Scaphiopus holbrookii	Eastern Spadefoot	
Reptiles	*Clemmys guttata*	Spotted Turtle	
	Crotalus horridus	Timber (Canebrake) Rattlesnake	SC
	Elaphe guttata	Corn Snake	
	Eumeces laticeps	Broad-headed Skink	
	Lampropeltis getula getula	Eastern Kingsnake	
	Terrapene carolina	Eastern Box Turtle	
	Thamnophis sauritus sauritus	Common Ribbonsnake	

Blackwater Cypress-Gum Swamps contain just a few tree species, tolerant of nearly permanent flooding: bald cypress, pond cypress, and swamp black gum. These communities get little input of nutrients due to the poor inorganic sediment load carried by blackwater rivers and the infertile acidic soils and wetness produce slow growth in the trees (Schafale and Weakley 1990). The difference between cypress and gum dominance is probably related to logging history, but environmental factors such as flooding frequency and depth, water chemistry, soil type and latitude also contribute (Schafale and Weakley 1990). Since cypress-gum swamps flood for long periods of time their vegetational diversity is usually low but they may serve as important habitat for some aquatic animals and plants. Hollow cypress and swamp black gum are particularly important for bats, chimney swifts and other cavity dwelling species. In addition, several colonial waterbird species rely on swamp forests for nesting habitat.

Pond cypress and swamp black gum are unusual in brownwater Cypress-Gum Swamp systems, replaced by a mix of water tupelo and bald cypress as dominant tree species. Carolina water ash and red maple are typical in the understory of blackwater Coastal Plain cypress-gum swamps with Carolina water ash the predominant understory species in brownwater subtypes (Schafale and Weakley 1990). Floodplain forests are usually a mix of trees of different types growing close together that may be associated with different microenvironments that are close enough to interact with trees in different microenvironments. If a floodplain contains levees and ridges large enough to support distinctive communities, larger than the zone of edge effect between them, then the low areas between them may be considered Cypress-Gum Swamps (Schafale and Weakley 1990).

A. *Location and condition of habitat (see Map 5A.28):*

Floodplain forest communities in various conditions and sizes can be found throughout the Coastal Plain region. The condition of coastal plain floodplain forests of all types have been greatly reduced in recent years throughout North Carolina and the entire southeast (Weller and Stegman 1977, Schafale and Weakley 1990) by a variety of anthropogenic factors.

Factors that impact these systems include flooding regime patterns that have been changed by dams and other development, habitat fragmentation, changes in water chemistry and organic matter loads, increased nitrogen from agricultural and development-related runoff, exotic species and high-grading of stands and logging that reduces wide buffers. All of these factors individually or interactively produce abrupt or gradual changes in floodplain plant and wildlife communities. In particular, the sediment load in many brownwater rivers is now a major problem in the Coastal Plain, and even many blackwater systems now have high sediment loads (Schafale and Weakley 1990).

Floodplain forest along the Roanoke River may be the finest example remaining in the state, yet even there flow regime has been greatly impacted by dams. Other large floodplain forests are associated with the Cape Fear River, Neuse River, Tar/Pamlico River, and Chowan River. Non-point source and point source pollution from a variety of human introduced activities has greatly increased in many drainages due to growing human population. Untreated stormwater runoff from large cities and towns is a major problem that impacts both aquatic life and terrestrial wildlife associated with floodplain forests.

B. *Problems affecting species and habitats:*

Alteration of hydrology due to dam creation and the draining of wetlands are one of the primary problems affecting this habitat type. Long-duration flooding has had impacts on all ground nesting bird species. Loss of old growth characteristics (canopy gaps, vine tangles, hollow trees, dead and downed woody material) and fragmentation of stands is a major concern. A lack of standing dead or older trees has impacted the availability of quality bat and chimney swift roosting and breeding sites and nesting productivity for species such as wood duck and hooded merganser. Lack of downed woody debris has impacted a variety of amphibians and reptiles.

Fragmentation of stands has contributed to the loss of intact large riparian corridors and the width of many riparian corridors has been greatly reduced. Breeding area-sensitive bottomland-hardwood birds have likely been impacted by the loss of intact woodland systems. Large patches of floodplain habitat are lacking in much of the Coastal Plain. Swallow-tailed kites are one such

species that is area sensitive and although are not presently known to breed within the state, do breed just across the South Carolina border. High-grading of stands has changed plant species diversity and stand vegetative structure. Forestry activities (e.g., logging) have reduced colonial waterbird and eagle nesting areas. Increases in amounts of non-native plants (e.g., Privet, Japanese grass, Japanese honeysuckle) and the overall loss of large canebreaks are partly due to the lack of infrequent fire and also certain logging practices. Understory vegetative diversity has declined in many areas due to modified flooding regimes and increases in invasive non-native plant species. Sewerlines have been constructed along many floodplain corridors, especially in the upper Coastal Plain.

Drainage of wetlands has exacerbated the problems in and adjacent to floodplain forest habitats. This habitat loss impacts all floodplain species, including furbearers, breeding amphibians, overwintering birds, and migrant species that use these areas as stopover sites. Water quality is also an issue in certain major river drainages that negatively affects many invertebrates, fish, amphibians and reptiles.

C. Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:

- **Surveys** – Surveys are needed to document the distribution, relative abundance and status of many wildlife species associated with floodplain forest habitats. Priorities for conducting surveys need to focus on species believed to be declining, at risk or mainly dependent on floodplain forest communities. Secondary priority for surveys should be for species for which current distribution information is already available or for species that are considered common.
  - Design specific surveys to determine status and distribution of birds not adequately picked up by the Breeding Bird Survey in floodplain forests (e.g., cerulean warbler, Swainson's warbler, Kentucky warbler, worm-eating warbler, hooded warbler, prothonotary warbler).
  - Determine the status and distribution of Wayne's black-throated green warbler.
  - Determine the status and distribution of swallow-tailed kite, Mississippi kite, yellow-crowned night-heron and anhinga (as well as other colonial nesting waterbirds).
  - Determine the breeding and roosting status and distribution of chimney swift in natural conditions along major floodplains with appropriate habitat conditions (e.g., older, hollow trees).
  - Determine the status and distribution of priority bat species (e.g., Rafinesque's big-eared bat, northern yellow bat, Seminole bat and southeastern bat).
  - Conduct small mammal surveys, especially for the eastern woodrat with a focus on circumneutral soils (other small mammal survey needs include the cotton mouse and southern pygmy shrew).
  - Determine the status and distribution of the numerous salamanders associated with floodplain forests (Taylor and Jones 2002).
  - Determine the status and distribution of canebrake rattlesnakes, as well as other snakes using floodplain forest habitats (Taylor and Jones 2002).
  - Document bald eagle nesting sites..

- **Monitoring** – Monitoring systems need to be expanded and/or targeted to be able to assess current population status and trend information for all wildlife species associated with floodplain forest habitats. Many North Carolina floodplain forest bird species require specialized monitoring attention, since neither BBS (nor standard point counts) adequately sample irregularly distributed or clumped species like cerulean and Swainson's warbler. Long-term monitoring for amphibians and reptiles needs to be developed or enhanced (Taylor and Jones 2002) and there is a decided lack of long-term monitoring information on most bat species (Ellis et al. 2002).
  - Continue long-term monitoring of active bald eagle territories, successful breeding pairs, and fledged eagles.
  - Conduct long-term monitoring for floodplain forest birds (breeding, migration, and winter periods) in forest patches of varying size (Robbins et al. 1989 and Doherty, Jr. and Grubb, Jr. 2000).

- Establish MAPS and migration banding stations, as well as specialized long-term monitoring for hard to sample species such as cerulean and Swainson's warbler (Graves 2001).
- Establish long-term monitoring for all bat species.
- Establish long-term monitoring for herpetofauna using floodplain forest habitat (especially breeding salamanders and canebrake rattlesnakes).

- **Research** – Research studies targeting birds need to be long-term and large-scale, replicated studies that have controlled experimental approaches and focus on population demographics and the response of species to habitat manipulations where appropriate as outlined by the National Partners in Flight Research working group (Donovan et al. 2002). Similar research priorities are needed for other floodplain forest taxa including bats, small mammals, amphibians and reptiles.

  Genetics
  - Research the genetic makeup of the coastal population of the black-throated green warbler.
  - Research the genetic relationships among floodplain salamanders.

  Management practices
  - Examine the response of bird, amphibian, small mammal and plant communities to canopy gap management (Kilgo et al. 1999, Grialou et al. 2000, Twedt et al. 2001 and Moorman et al. 2002).
  - Examine the impacts of long-term flooding regimes on ground-nesting birds (e.g., Swainson's warbler) (Swift et al. 1984); similar studies are also needed for salamanders.
  - Determine the conservation and restoration efforts needed for canebrakes in floodplain forests (Brantley and Platt 2001).

  Predator effects
  - Conduct bird productivity research (especially neotropical migrants) with a focus on nest searching studies to determine the predator community and bird nesting success in patches of different size and with various landscape context (Rodewald and Yahner 2001).

  Population demographics
  - Obtain information on the demographics and habitat-use of floodplain neotropical migrant landbirds during breeding and migration periods (Donovan et al. 2002).
  - Examine demographics and habitat-use of bats in floodplain forests; there is also a need to identify, monitor, and maintain (or recruit) key bat habitats and microhabitats in floodplain forests (Ellis et al. 2002).
  - Examine the demographics and habitat-use of small mammals in floodplain forests (Yates et al. 1997).

  Habitat use
  - Conduct studies (similar to the long-term studies ongoing in South Carolina) to document habitat-use and nesting success of Swainson's warbler in managed and unmanaged systems (Graves 2002 and Somershoe et al. 2003).
  - Study the effects of riverine buffer width characteristics on bird species diversity, richness, survival, nest success and productivity (Perkins et al. 2003) (similar studies also needed for small mammals, bats, amphibians and reptiles to determine long-term productivity in buffers of various widths).
  - Examine resource abundance (e.g., insects and fruits) in canopy gaps and use by breeding and migrant birds (Blake and Hoppes 1986).
  - Study the territory and nest-site selection of cerulean warblers along the Roanoke River (Jones and Robertson 2001).
  - Examine the demographics, habitat-use patterns, and impacts of feral hogs on ground nesting birds, salamanders and small mammals (Warren and Ford 1997).
  - Examine the effects of habitat patch size on small mammal populations (Yates et al 1997).

- Determine the habitat-use patterns of salamanders and reptiles in floodplain forests.
- Document habitat-use patterns of canebrake rattlesnakes in floodplain forests (using telemetry).
- Study the impacts of beaver and beaver ponds on species composition (both flora and fauna) to determine negative or positive impacts of beaver or beaver control measures.
- Study nutria impacts on both floral and faunal communities and individual species.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

Land acquisition and easements should be pursued through cooperation with land trusts with an effort to increase the width of riparian buffers and create larger patches of connected habitat. Priority should be given to brownwater bottomlands, as these are the most species-rich and are more susceptible to clearcutting and other timber harvest than are cypress-gum swamps (i.e., wetter sites). Wherever possible, maintenance or restoration of floodplain forest connectivity should be pursued; floodplain forest are important distribution and dispersal corridors for many species (Bailey et al. 2004). The South Atlantic Coastal Plain Partners In Flight Bird Conservation Plan calls for eight patches of forested wetlands of at least 10,000 acres in size throughout the South Atlantic Coastal Plain (Hunter et al. 2000). Identified funding sources for fee simple or easement purchases are the Clean Water Management Trust Fund, the Natural Heritage Trust Fund, the Coastal Wetlands Grant program and the North American Wetland Conservation Act program. An attempt should be made to protect waterbird nesting colonies.

Efforts need to be made to retain old growth floodplain forest (e.g., for chimney swifts, bats, and herpetofauna). Partnerships to begin cane restoration projects and research should be initiated with the Natural Resources Conservation Service. Floodplain buffers of 300–600 feet should be realized in as many areas as possible. This would benefit floodplain forest species such as northern parula, yellow-throated warbler, prothonotary warbler, wood thrush, Swainson's warbler, worm-eating warbler, and acadian flycatcher, as well as amphibians, canebrake rattlesnakes and forest bats. The Forest Landbird Legacy Program (a cooperative effort between the Commission, the US Fish & Wildlife Service, and the Natural Resources Conservation Service) should be further expanded to influence habitat for birds and other wildlife in mature floodplain forest through canopy gap management and other options. The cooperative efforts with colonial waterbird (wading bird) working groups should continue and future management recommendations from the North American Waterbird Management Plan should be followed (Kushlan et al. 2002).

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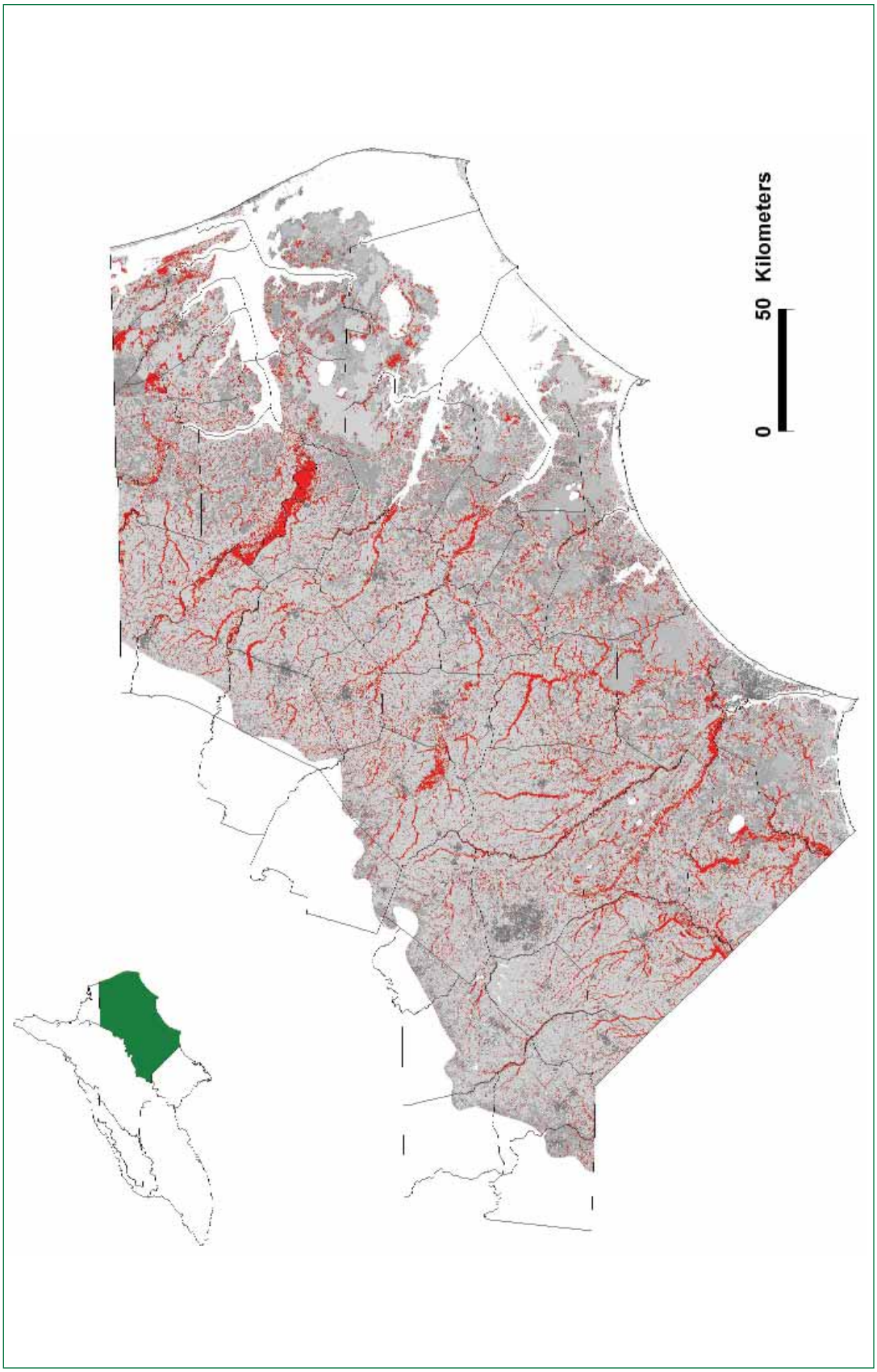

Figure 5A.28. Floodplain forest habitats in the Mid-Atlantic Coastal Plain ecoregion of North Carolina (in red) (data source: NC GAP, 1992).

29. **Nonalluvial mineral wetlands** – These wetlands occur on poorly drained areas of the eastern Coastal Plain. Saturation is due to poor drainage and sheet flow from adjoining peatlands. Nonalluvial mineral wetlands are more nutrient-rich than pocosins, but not as rich as floodplain wetlands. In the wettest areas, bald cypress, swamp black gum, and red maple dominate. Where these areas transition to peatland, loblolly pine, pond pine, and Atlantic white cedar may also be present. In less saturated nonalluvial wetlands, trees characteristic of bottomland hardwood systems dominate: cherrybark oak, laurel oak, swamp chestnut oak, tulip poplar, sweetgum, American elm, and red maple.

    Where limestone deposits are near the surface of the ground, the fertility of the soil is improved and a wide variety of trees can occur, including nutmeg hickory, Shumard's oak, Carolina basswood, swamp chestnut oak, water hickory, bitternut hickory, and sweetgum. Pawpaw and redbud may be present in the understory and dwarf palmetto is abundant in the shrub layer (NCNHP 2001).

    Both Nonriverine Wet Hardwood Forest and Nonriverine Swamp Forest communities exist in the outer Coastal Plain and both are seasonally saturated or flooded by high water tables (Schafale and Weakley 1990). Fire was unlikely an important part of these systems naturally, although some Nonriverine Wet Hardwood Forests did support canebrakes historically (Schafale and Weakley 1990). Nonriverine Wet Hardwood Forests are typically drier than Nonriverine Swamp Forests and have more bottomland hardwood species present in their canopy (Schafale and Weakley 1990).

    These sites are important for variety of neotropical migrants during the breeding season and migration periods (Hunter et al. 2000 and Johns 2004), and also several reptiles of conservation concern. The shrubby nature of some of these sites is thought to be related to logging and since they are easy to drain and make excellent farmland, most of these areas have been lost (Schafale and Weakley 1990).

    Examples of this habitat type can be found in Alligator River National Wildlife Refuge, Swanquarter National Wildlife Refuge, Great Dismal Swamp National Wildlife Refuge, Hoffman Forest, Rocky Point and several swamps in Washington County.

A. Location and condition of habitat (see Map 5A.29):

The condition of nonalluvial mineral wetlands in the Coastal Plain is generally poor due to alternation of hydrology (primarily from draining for farmland and conversion to loblolly pine plantation) and is rather fragmented. Some of the best remaining examples are on public lands such as on Alligator River National Wildlife Refuge, Swanquarter National Wildlife Refuge and the Great Dismal Swamp National Wildlife Refuge. Nonalluvial mineral wetlands tend to be converted for forestry and agriculture more readily since the mineral soils can support heavy equipment better than organic soils, and they are more fertile. Much of this type existed in Beaufort and Pamlico counties until recent years; relatively little remains. A higher percentage of this habitat type has probably been destroyed than any other type in the Coastal Plain, with the exception of dry longleaf pine.

B. Problems affecting species and habitats:

Fire suppression has certainly led to a decline in some of the diversity of these habitats but the alteration of hydrology from ditches associated with farming and forestry practices is the biggest factor impacting this habitat type. Non-native plant species (e.g., Privet, Japanese grass) are also competing with native vegetation in many areas, especially those frequently disturbed. Although little of this quality habitat remains, it can be burned more safely than those sites with organic soils. Therefore the potential still exists to re-establish some high quality nonalluvial mineral wetlands on the Coastal Plain of North Carolina, where it has not already been converted to farmland or ditched for pine plantations.

Priority species associated with coastal plain nonalluvial mineral wetlands:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Dendroica virens waynei*	Wayne's Black-throated Green Warbler	
	Helmitheros vermivorous	Worm-eating Warbler	
	Limnothlypis swainsonii	Swainson's Warbler	
	Nyctanassa violacea	Yellow-crowned Night-heron	
	Oporornis formosus	Kentucky Warbler	
	Wilsonia citrina	Hooded Warbler	
Mammals	*Corynorhinus rafinesquii*	Rafinesque's Big-eared Bat	T
	Lasiurus intermedius	Northern Yellow Bat	SR
	Lasiurus seminolus	Seminole Bat	
	Myotis austroriparius	Southeastern Bat	SC
	Neotoma floridana	Eastern Woodrat	T
Amphibians	*Desmognathus auriculatus*	Southern Dusky Salamander	
	Pseudacris nigrita nigrita	Striped Southern Chorus Frog	
Reptiles	*Cemophora coccinea copei*	Northern Scarletsnake	
	Crotalus horridus	Timber (Canebrake) Rattlesnake	SC
	Elaphe guttata	Corn Snake	
	Eumeces laticeps	Broad-headed Skink	
	Farancia abacura abacura	Eastern Mudsnake	
	Heterodon platirhinos	Eastern Hog-nosed Snake	
	Lampropeltis calligaster rhombomaculata	Mole Kingsnake	
	Lampropeltis getula getula	Eastern Kingsnake	
	Lampropeltis triangulum elapsoides	Scarlet Kingsnake	
	Masticophis flagellum	Eastern Coachwhip	SR
	Ophisaurus mimicus	Mimic Glass Lizard	SC
	Rhadinaea flavilata	Pine Woods Littersnake	
	Sistrurus miliarius	Pigmy Rattlesnake	SC
	Tantilla coronata	Southeastern Crowned Snake	
	Virginia valeriae valeriae	Eastern Smooth Earthsnake	

C. Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:

- **Surveys**
  - Determine the status of yellow-crowned night-heron and Wayne's black-throated green warbler, as well as other neotropical migrants and colonial nesting birds that are not well sampled by BBS.
  - Document the status and distribution of priority bat species (e.g., Rafinesque's big-eared bat, northern yellow bat, Seminole bat and southeastern bat) in this habitat.
  - Conduct eastern woodrat surveys and subsequently establish standardized long-term monitoring of the species in this habitat.
  - Determine the status and distribution of canebrake and pigmy rattlesnakes.
  - Survey for other high priority snakes and lizards.
- **Monitoring**
  - Establish long-term monitoring for Wayne's black-throated green warbler and other neotropical migrants that are not well tracked by BBS in this habitat type.
  - Establish MAPS and migration bird banding stations.

- Following the establishment of surveys to document priority bat use of the habitat, continue with long-term monitoring.
- Following the establishment of surveys to document priority reptile use of the habitat, continue with long-term monitoring.

- **Research**
  - Conduct home-range and movement research on timber (canebrake) and pigmy rattlesnakes (possibly on other snakes of conservation concern as well).
  - Conduct genetics research to determine if the coastal worm-eating warbler is a separate sub-species.
  - Explore alternatives (herbicides or mechanical) to using fire for the initial restoration of severely fire suppressed non-alluvial wetlands.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

Site protection and protection of surrounding areas through land acquisition or easements and cooperation with land trusts are urgently needed, as large acreages (>500 acres) are frequently clearcut all at once for agriculture, pine conversion, or development. Regional land trusts and The Nature Conservancy can be valuable partners in these efforts. Identified funding sources for acquisition include the Clean Water Management Trust Fund, Coastal Wetlands Grants, Natural Heritage Trust Fund, Forest Legacy Grants, and Recovery Land Acquisition Grants. Restoration efforts may be possible in some cases through partnerships with land trusts, the Nature Conservancy, and state and federal agencies.

The use of fire at the remaining unconverted nonalluvial mineral wetland sites is the single most important factor to restore these sites. Plowed firelines along transition zones between habitats should be rehabilitated (smoothed over) where possible. If feasible, fires should be allowed to sweep through the habitat or at least into the edges of the wetland from the adjacent upland sites. New firelines should be constructed when necessary. These areas should be maintained as a permanent narrow opening by discing with a tractor or by wetting with water or foam prior to a burn. The maintenance of contiguous gradients between wetland and adjacent upland sites is critical for seasonal migration and dispersal of herpetofauna. Roads, agriculture, or forestry operations between complimentary sites may still render them ineffective at supporting amphibian and reptile populations. Where fire cannot be introduced back into the site for smoke management or other reasons, the use of a hydro-ax or other chipping machinery should be considered to control midstory (where funds allow).

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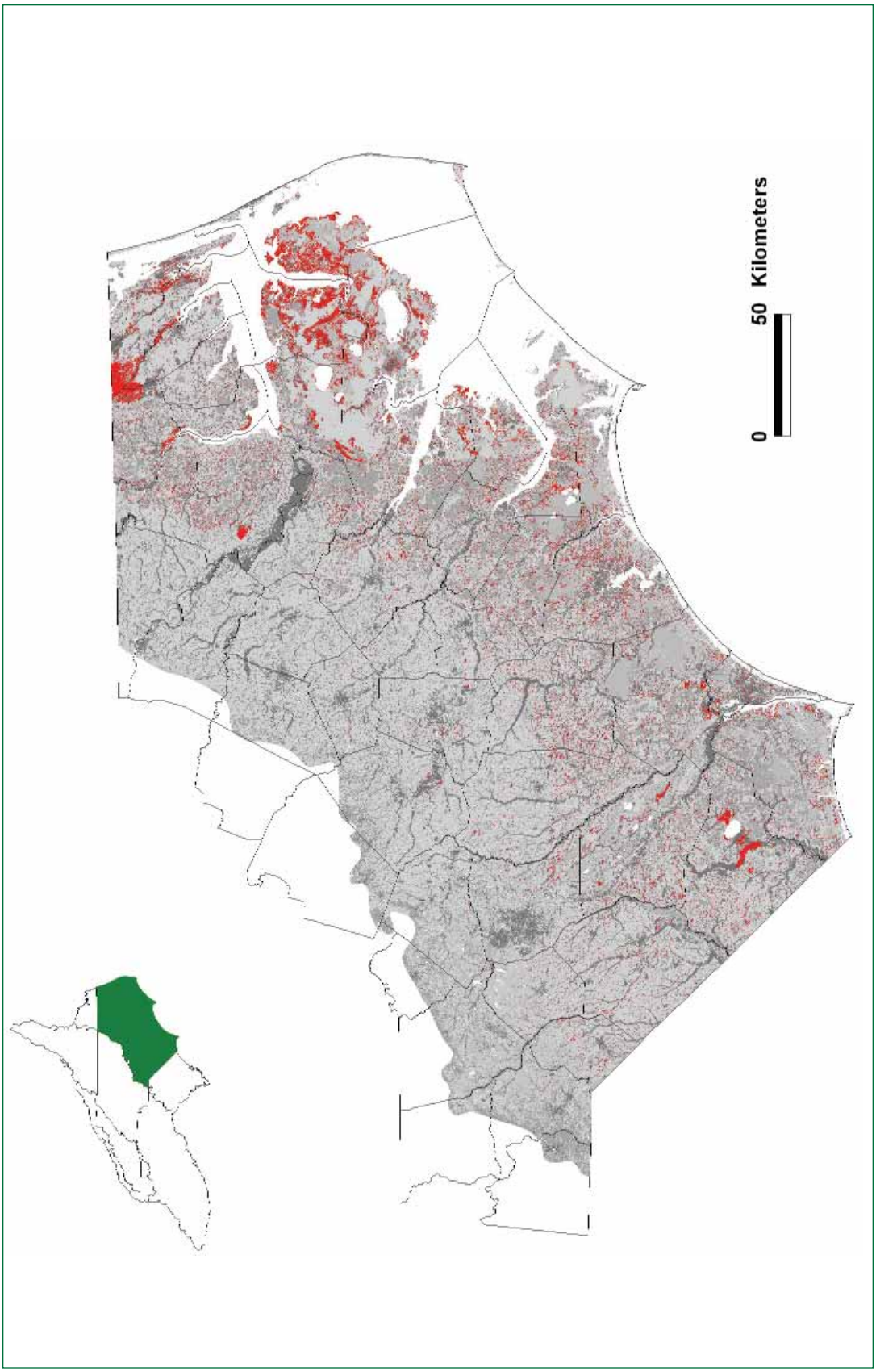

Figure 5A.29. Nonalluvial mineral wetlands in the Mid-Atlantic Coastal Plain ecoregion of North Carolina (in red) (data source: NC GAP, 1992).

30. **Lakes and reservoirs** – There are 22 natural lakes in the Coastal Plain. Basins range from Carolina bays to peatland depressions. Most natural lakes in North Carolina are acidic and therefore have relatively low productivity. Lake Waccamaw is an exception, with neutral pH and a high calcium content. This lake is home to many endemic species and is therefore of extreme importance.

    Reservoirs tend to be quite small on the Coastal Plain since topography is so flat. Millponds, farm ponds, Carolina bays and impoundments are quite common and provide key habitat for lentic aquatic or semi-aquatic wildlife species. These areas (and the immediate shoreline vegetation) are also important areas for many bird species (nesting, roosting, and feeding sites) and provide habitat for fish, reptiles, amphibians, and aquatic or semi-aquatic mammals. *Beaver ponds are discussed in the Small Wetland Communities section.*

    In particular, these sites and immediately adjacent cover (especially the smaller ponds) are habitat for wading birds and shorebirds for foraging, and also important sites for breeding for species such as green heron. Common yellowthroat and red-winged blackbird are typical nesters in vegetation along shorelines, and swallows and swifts often forage over lakes and ponds. Bald eagle and osprey nest and/or forage at these sites, and waterfowl roost, loaf and feed during migration and winter. Double-crested cormorants are becoming common year-round residents at most coastal lakes. Anhinga are sometimes seen during summer, nesting at millponds and/or natural lakes. In addition, these water bodies are popular destinations for human recreational activities such as canoeing, fishing, crabbing and swimming.

    Other fully aquatic taxa (fish, mussels, crayfish, and snails) are referenced in the river basins portion of the report. See the river basin sections (Chapter 5B) for more detailed information on aquatic species and habitats, by basin.

Priority species associated with coastal plain lakes and reservoirs:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Anhinga anhinga*	Anhinga	SR
	Egretta caerulea	Little Blue Heron	SC
	Egretta thula	Snowy Egret	SC
	Gallinula chloropus	Common Moorhen	
	Haliaeetus leucocephalus	Bald Eagle	T (T)
	Ixobrychus exilis	Least Bittern	
	Melanerpes erythrocephalus	Red-headed Woodpecker	
	Mycteria americana	Wood Stork	E (E)
	Nyctanassa violacea	Yellow-crowned Night-heron	
Reptiles	*Alligator mississippiensis*	American Alligator	T (T)
	Apalone spinifera aspera	Gulf Coast Spiny Softshell	
	Deirochelys reticularia	Eastern Chicken Turtle	SR
	Farancia abacura abacura	Eastern Mudsnake	
	Farancia erytrogramma erytrogramma	Common Rainbow Snake	
	Kinosternon baurii	Striped Mud Turtle	
	Regina rigida	Glossy Crayfish Snake	SR
	Thamnophis sauritus sauritus	Common Ribbonsnake	

A. Location and condition of habitat (see Map 5A.30):

Many of the natural lake communities (e.g., Lake Mattamuskeet) in the Coastal Plain are in public ownership. However, the degree to which the shoreline and water quality are protected varies (NCNHP 2001). Many of these sites are important waterfowl, wading bird and even shorebird wintering and migration stopover areas, especially at National Wildlife Refuges (NWR) like Lake Mattamuskeet NWR and Pocosin Lakes NWR.

Millponds and man-made impoundments provide key habitat for many species of waterfowl, wading birds and other waterbirds throughout the year and are found throughout the Coastal Plain. Impoundments vary with age, water depth and disturbance history; the isolation of these ponds may be an important factor in determining the flora and fauna present (Schafale and Weakley 1990).

B. Problems affecting species and habitats:

Development and loss of associated riparian habitats are primary concerns. Although bald eagles have found additional shorelines to use as perch/foraging sites through the many constructed reservoirs, most of these shorelines are becoming heavily impacted by development.

Changes in hydrology and water chemistry are leading to water quality concerns. Exotic species (e.g., *Hydrilla* and other plants, *Corbicula*, carp) negatively affect native frogs and turtles due to decreased native plant and animal diversity. Avian Vacuolar Myelinopathy (AVM) is a disease that affects birds that use these habitats. It has been known to kill at least 99 bald eagles in the southeast and is associated with a Noval Cyanobacterial species in aquatic plants such as hydrilla. Shorelines are often trampled and shoreline erosion and mowing is a concern in many areas. Point and non-point source pollution sources from residental areas and other sources (e.g., 2-stroke engines) are prevalent, and non-point source pollution from agriculture and logging is possible at several sites, potentially leading to algal blooms and low dissolved oxygen events. Disturbance (boat and personal watercraft wakes and associated noise pollution) by boats and potential Outlying Landing Field aircraft are also a concern relating to some species of wildlife, especially waterfowl. Until regulation changes in 2004, trapping of turtles for the food market was a severe impact on Coastal Plain lakes and ponds.

C. Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:

- **Surveys**
  - Conduct status and distribution survey work for bald eagle, anhinga, common moorhen, swallows, wood stork, yellow-crowned night-heron (and other ibis, herons and egrets).
  - Document the status and distribution of rails at all times of the year, and least bittern use of marsh areas.
  - Document breeding landbird use of water-filled Carolina bay edges (Mamo and Bolen 1999).
  - Establish survey stations for foraging bats.
  - Document the status and distribution of uncommon or hard to find reptiles (e.g., eastern chicken turtle, eastern mudsnake, glossy crayfish snake); initiate surveys for other reptiles and amphibians using lentic habitats.
  - Establish frog call survey stations at several sites in the Coastal Plain on public lands (and if possible on private lands).
- **Monitoring**
  - Continue long-term monitoring for bald eagles and expand long-term monitoring for nesting ospreys, rails and other marshbirds.
  - Continue surveys and monitoring of heronries.
  - Establish long-term monitoring for all pond turtles (often subject to collection).
  - Conduct monitoring to track impacts of exotics on native wildlife.
- **Research**
  - Track and identify problems associated with avian vacuolar myelinopathy that cause mortality in American coots, other waterfowl, and bald eagles (to continue to follow up on recent research) (Augspurger et al. 2003).
  - Conduct movement research for eastern chicken turtle and some snakes (e.g., eastern mudsnake, common rainbow snake and glossy crayfish snake), using telemetry.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

Elimination and control of exotics, especially aquatic plants, is imperative. Native vegetative composition and structure are important to the seasonal migrations of many wetland-related reptiles and amphibians (Bailey et al. 2004). Better buffers surrounding these areas are also needed and lakeshore development needs to be limited to reduce pollution and recreational access impacts on lake communities. Natural structures, in the form of logs, rocks, and snags, should be retained. Development near bald eagle nest trees needs to be controlled.

Conservation of millponds that are being drained due to dike maintenance costs will also be a pressing issue in the coming years. We need to promote techniques for managing beaver damage that minimize loss of quantity and quality of beaver ponds. Beaver ponds are important habitat for many birds, mammals, amphibians and reptiles. Coordination with waterbird working groups should continue and future recommendations from the North American Waterbird Conservation Plan should be followed (Kushlan et al. 2002).

Acquisition and other protection of natural lakes and ponds is a high priority. There are still a few such lakes in the “Bladen Lakes” region that are in private, unprotected ownership. Protection of some millponds is also warranted, though this is a lower priority than protection of natural water bodies.

See the river basin sections for more detailed conservation recommendations regarding aquatic species and habitats.

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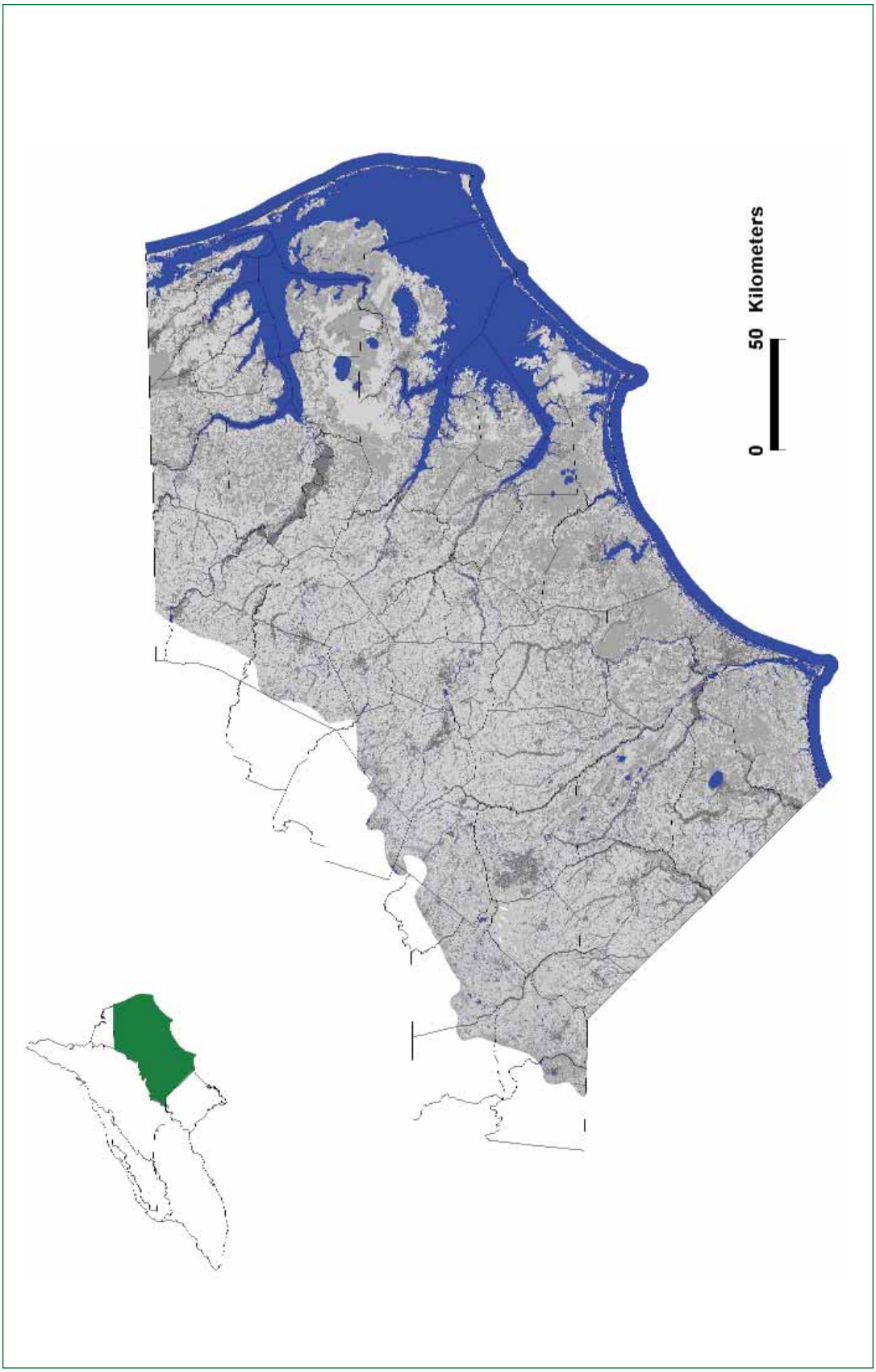

Figure 5A.30. Lakes in the Mid-Atlantic Coastal Plain ecoregion of North Carolina (in blue; open water and sounds also shown) (data source: NC GAP, 1992).

31. **Riverine aquatic communities** – Coastal Plain riverine habitats (including streams) are important for a number of wildlife species, especially to herpetofauna that utilize aquatic habitats during part or all of their life cycle, and to aquatic mammals such as the manatee. Examples of birds that utilize river and streams include the Louisiana waterthrush, prothonotary warbler, many waterfowl species, wading birds and some shorebirds. These habitats are also important for a variety of common mammals that are semi-aquatic and/or that have an aquatic food base (e.g., beavers, river otters, certain bats). Many of the issues identified in the floodplain forest section will also have relevance for these taxa (Weller and Stegman 1977).

    Coastal Plain rivers and streams provide a number of important habitat, life cycle, or prey components to a vast assemblage of terrestrial, semi-aquatic, and aquatic wildlife. In addition, the importance of maintaining water quality of riverine habitats cannot be overstated, both in terms of the species that rely upon rivers and streams for habitat, as well as those species which rely indirectly upon the habitat by virtue of provision of habitat for their prey.

    Other fully aquatic taxa (fish, mussels, crayfish, and snails) are referenced in the river basins portion of the report. See the river basin sections (Chapter 5B) for more detailed information on aquatic species and habitats, by basin.

Priority species associated with coastal plain riverine aquatic communities:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Anhinga anhinga*	Anhinga	SR
Mammals	*Trichechus manatus*	Manatee	E (E)
Amphibians	*Eurycea guttolineata*	Three-lined Salamander	
	Eurycea sp 1	Sandhills Salamander	
	Necturus lewisi	Neuse River Waterdog	SC
	Rana heckscheri	River Frog	SC
	Siren lacertina	Greater Siren	
	Stereochilus marginatus	Many-lined Salamander	
Reptiles	*Alligator mississippiensis*	American Alligator	T (T)
	Apalone spinifera aspera	Gulf Coast Spiny Softshell	
	Deirochelys reticularia	Eastern Chicken Turtle	SR
	Farancia abacura abacura	Eastern Mudsnake	
	Farancia erytrogramma erytrogramma	Common Rainbow Snake	
	Kinosternon baurii	Striped Mud Turtle	
	Regina rigida	Glossy Crayfish Snake	SR
	Seminatrix pygaea	Black Swamp Snake	SR
	Thamnophis sauritus sauritus	Common Ribbonsnake	

A. Location and condition of habitat[1]:

Riverine aquatic communities are found alongside and within all Coastal Plain rivers. Human-influenced alterations have affected much of the coastal plain's riverine and floodplain habitats. Water quality and quantity have been impacted by run-off from municipalities, road construction and poorly managed agricultural operations (originating in the Coastal Plain, and/or from upstream sources in the Piedmont). Dam construction has altered flows and river hydrology and morphology. Removing woody debris from streams after storms has influenced in-stream habitat structure and food webs. The condition of some Coastal Plain rivers is greatly reduced due to these impacts. However, some sections of Coastal Plain rivers are designated High Quality Water and Outstanding Resource Water Management Zones and provide excellent opportunities for maintaining relatively pristine waterways. (*Also see Chowan, Pasquotank, Roanoke, Tar-Pamlico, Neuse, White Oak, Cape Fear, and Lumber River basin sections*).

[1]A map of this habitat is not provided, due to scale and sensitivity issues.

B. *Problems affecting species and habitats:*

Water quality is a primary concern, especially for fully aquatic species. Dams have altered hydrology and stream flows, and have created barriers for movement for species that depend on the rivers and streams for their primary mode of travel. Irregular flooding during the growing and nesting seasons can affect the reproductive success and survival of species that depend on this habitat type. Dams buffer against peak flows that disperse seeds of plants to maintain habitats. Many streams and rivers are heavily laden with sediment, which has disturbed the food webs on which these species depend. Exotic species like *Corbicula* impact nutrient flow and outcompete many native aquatic invertebrates.

Water quality deterioration and loss of habitat are two of the most serious problems affecting wildlife that utilize riverine habitat. Water quality concerns, originating from both point and non-point sources have had, and continue to pose a threat directly to species that occur in riverine habitat, and indirectly through alteration of the food base or habitat. Direct and indirect impacts of decreased water quality upon wildlife associated with riverine habitat are difficult to quantify, and have not been as fully explored as have impacts upon fully aquatic species. However, there is little doubt that clean water is critical to a host of species that live in rivers and streams for a portion of their lives, and that sedimentation, channel scour, and other alterations of the physical habitat can lead to both deterioration of the habitat quality and negative impacts upon aquatic flora and fauna, which form the base of the food web for numerous wildlife species.

A condition with historic roots that still affects riverine habitat and its wildlife is the impoundment of rivers and streams for a variety of purposes including hydroelectric power generation, flood control, water supply, and recreation/aesthetics. Again, the effects have been both direct and indirect, in that lotic habitat has been lost and the food web has shifted, at least in portions of former riverine habitat, to species that do not depend upon flowing water. Other than directly measuring the direct impact of this habitat conversion, we do not know the overall impact upon the wildlife species present from the indirect effects of river or stream impoundment.

Another impact upon riverine habitat that can be construed as habitat loss, at least for some species, is the development of floodplains or riparian areas. River or stream-front development may or may not have a direct negative impact upon water or habitat quality in the stream or river, however in most instances it usually does. The impacts of development adjacent to rivers and streams includes potential problems associated with direct input of contaminants and sediment, alteration of hydrologic patterns and processes, temperature regimes, and loss of critical habitat adjacent to aquatic habitat that may be of equal importance to species that only spend a portion of their lives in the water, like some amphibians.

Most of the listed priority amphibian and reptile species associated with riverine habitat have limited distributions, unknown distributions or widely dispersed but small populations. Isolation or fragmentation of particular habitat stretches occupied by those species could have significant long-term effects upon the sustainability of those populations in the Coastal Plain of North Carolina.

C. *Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:*

- **Surveys** – Surveys are needed to document the distribution, relative abundance and status of many wildlife species associated with riverine habitats. Priorities for conducting surveys need to focus on species believed to be declining, at risk or mainly dependent on riverine communities. Secondary priority for surveys should be for species for which current distribution information is already available or for species that are considered common.
  - Determine the status and distribution of manatees in coastal rivers.
  - Determine the components of foraging bat communities along rivers.
  - Determine the status and distribution for priority herpetofauna associated with Coastal Plain riverine aquatic communities (e.g., river frog, many-lined salamander, sandhills salamander, greater siren, Neuse River waterdog, Gulf Coast spiny softshell, eastern

chicken turtle, striped mud turtle, common rainbow snake, eastern mudsnake, glossy crayfish snake, black swamp snake) and secondarily for other reptiles and amphibians using riverine habitat.
  - Better determine the status and distribution of the American alligator.

- **Monitoring** – Monitoring systems need to be expanded and/or targeted to be able to assess current population status and trend information for the wildlife species associated with riverine habitats. Long-term monitoring for amphibians and reptiles needs to be developed or enhanced (Taylor and Jones 2002) and there is a decided lack of long-term monitoring information on most bat species associated with riverine habitat (Ellis et al. 2002).
  - Establish long-term efforts to monitor the northward range expansion of the manatee.
  - Establish long-term monitoring of bats using riverine habitat for foraging.
  - Establish long-term monitoring for priority amphibian and reptiles.

- **Research**

  Genetics
  - Verify the genetic makeup of the sandhills salamander, which has yet to be formally described.

  Population demographics
  - Collect basic demographics information on riverine-associated reptiles, amphibians and bats.

  Management practices
  - Determine the effect of buffer widths on amphibian and reptile species diversity and productivity.
  - Determine the impacts of "snagging" (removing woody debris after storms) on wildlife populations.
  - Examine the extent and impact of exotic species introductions; conduct research on effective control measures for the most problematic exotics.
  - Investigate the effect of beaver ponds on downstream movement of pollutants (toxins and sediment).

  Habitat use
  - Examine foraging and habitat use patterns of bats, using telemetry.
  - Examine habitat-use patterns of the eastern mudsnake, common rainbow snake, glossy crayfish snake, black swamp snake and eastern chicken turtle, using telemetry.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

The biggest need in Coastal Plain riverine aquatic communities is to increase buffer widths to mitigate impacts from pollution into river systems, and to maintain habitat at the edge of these aquatic communities that will provide cover and foraging areas for many wildlife species using riverine habitat. Immediate and continuing efforts need to be undertaken to limit water quality deterioration from point sources of pollution as well as non-point sources. Toxic chemicals and sediment are entering waterways and having a direct negative impact upon the species in the rivers and streams, but also having significant negative impacts upon the quality of the habitat itself.

Measures to address these issues, some of which are in practice currently, such as regulation of point and non-point sources of pollution, need to be enacted and enforced. Mandatory and incentive-based practices to improve water quality need to be actively pursued with cooperation from agencies and organizations at local, state and federal levels. River and stream ecosystem enhancement and restoration efforts and programs need to be enhanced and supported as well. And finally, within the frameworks afforded by state, local, federal, and private initiatives, riverine habitats need to be permanently protected from the negative impacts of development

through conservation ownership (fee title or easement) of as much habitat as possible. Fee title (linear length protection) and easements acquisition through partnerships with land trusts is essential. Where possible forest patches should be connected along river systems to provide connectivity. The Clean Water Management Trust Fund is an important funding organization for riverine aquatic sites.

Also see the appropriate river basin sections for more detailed conservation recommendations regarding fully aquatic species.

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32. **Small wetland communities** – These communities include vernal pools, cypress savanna, small depression ponds, beaver ponds, small depression pocosin, interdune ponds, clay-based Carolina bays and limesink depressions. They are often mimicked by barrow sites along small dirt roads. These depressions may hold water for a significant portion of the year and most are important habitat for many rare or poorly understood reptiles and amphibians. A single small North Carolina vernal pool can contain several species of frogs. Across the landscape, these habitats are widely scattered but provide key breeding sites for amphibians. Small wetlands can also be important breeding habitat for crayfishes (*for more about crayfishes and other aquatic taxa, see the individual river basin sections*).

    Vernal Pools are small sites that flood seasonally and occur throughout the Coastal Plain and Sandhills (Schafale and Weakley 1990). They are dominated by a dense to sparse herb layer and when dry are subject to fires spreading from adjacent uplands. These Vernal Pools are almost always key amphibian breeding sites because they contain no fish.

    Small Depression Ponds are on sites with permanently flooded (at least in the center) sinkholes, Carolina bays and other upland depressions that have complex and irregular zones of vegetation (Schafale and Weakley 1990). Most occur in the lower Coastal Plain, over limestone formations. Scattered trees (pond cypress and swamp blackgum) may be present in both deep and shallow water zones and most ponds are surrounded by a dense shrub layer. These shrubby zones provide breeding habitat for shrub-scrub-nesting birds (Hunter et al. 2000 and Johns 2004) and these sites are used by wading birds for foraging/nesting. The main value of these sites, however, is that they provide critical habitat for reptiles and breeding amphibians.

    Cypress Savannas are rare sites and are found in the southern part of the inner Coastal Plain on wetland soils with a clay hardpan, and include clay-based Carolina bays and other wet clay-like depressions (Schafale and Weakley 1990). They typically dry up during summer, and usually have an open canopy of cypress. Small Depression Pocosin sites are small depressions found throughout the Coastal Plain and seldom distinguished on soil maps. Historically, portions of these depressions likely burned from fires spreading from adjacent uplands (Schafale and Weakley 1990). These are also important amphibian breeding sites since they rarely contain fish.

A. Location and condition of habitat[1]:

Clay-based Carolina bays are particularly abundant in Robeson, Hoke, and Scotland counties; most feature cypress savannas. Small Depression Pocosin examples are found on Croatan National Forest and on Sandhills Game Land, and good examples of Vernal Pools are found on Sandhills Game Land and at Carolina Beach State Park. Small Depression Ponds are primarily found in Brunswick, New Hanover, Onslow, and Carteret counties. All depression habitats have been greatly reduced by development and drainage.

Beaver ponds are a natural community, but result from modification of other community types, and thus there is the potential for human action to mimic them effectively. Beaver ponds vary with age, water depth and disturbance history; the isolation of these ponds may make "accidents of dispersal" important factors in the flora and fauna present (Schafale and Weakley 1990). With stable beaver populations, beaver ponds can be maintained for decades, but dam destruction can shorten their lifespan. A reduction of beaver ponds will place more importance on man-made ponds as the primary habitat for many lentic aquatic species. Dead trees in beaver ponds are important foraging and nesting habitat for woodpeckers (such as the red-headed woodpecker) and for wood duck nesting.

[1]A map of this habitat is not provided, due to scale and sensitivity issues.

Priority species associated with coastal plain small wetland communities:

Group	Scientific Name	Common Name	State Status (Federal Status)
Mammals	*Condylura cristata*	Star-nosed Mole	SC
	Synaptomys cooperi helaletes	Southern Bog Lemming	SR
Amphibians	*Ambystoma mabeei*	Mabee's Salamander	SR
	Ambystoma maculatum	Spotted Salamander	
	Ambystoma opacum	Marbled Salamander	
	Ambystoma tigrinum	Eastern Tiger Salamander	T
	Bufo quercicus	Oak Toad	SR
	Eurycea quadridigitata	Dwarf Salamander	SC
	Hemidactylium scutatum	Four-toed Salamander	SC
	Hyla andersonii	Pine Barrens Treefrog	
	Hyla gratiosa	Barking Treefrog	
	Pseudacris brimleyi	Brimley's Chorus Frog	
	Pseudacris nigrita nigrita	Striped Southern Chorus Frog	
	Pseudacris ornata	Ornate Chorus Frog	SR
	Rana capito	Carolina Gopher Frog	T
	Scaphiopus holbrookii	Eastern Spadefoot	
	Siren intermedia intermedia	Eastern Lesser Siren	
Reptiles	*Clemmys guttata*	Spotted Turtle	
	Deirochelys reticularia	Eastern Chicken Turtle	SR
	Farancia abacura abacura	Eastern Mudsnake	
	Regina rigida	Glossy Crayfish Snake	SR
	Seminatrix pygaea	Black Swamp Snake	SR
	Thamnophis sauritus sauritus	Common Ribbonsnake	

B. *Problems affecting species and habitats:*

Development and fragmentation has reduced the availability of small wetland communities, impacting breeding amphibians. Increased road densities are correlated with declines in amphibian diversity and abundance (Vos and Chardon 1998, Findlay et al. 2001, Fahrig et al. 1995). Roads can cause heavy mortality for reptiles and amphibians and can effectively isolate breeding populations, or separate wetland habitats from upland habitats that are used during non-breeding portions of amphibian and reptile life cycles.

Many of these habitats are inherently small and are easily impacted by nearby development or drainage. Cutting ditches through wetlands can alter their hydrology and habitat quality. Drainage of many Coastal Plain depressions has occurred, primarily for agricultural or development purposes. Most amphibians are highly sensitive to changes in water quality. Pollution associated with these land uses has altered water quality at some sites. An increase in impervious surfaces due to Coastal Plain development has caused excess stormwater runoff into adjacent seasonal wetlands. Long-term drought and possibly excessive pumping of ground water has caused lowered water tables and lowered pond levels in some areas.

Ephemeral and isolated wetlands are very valuable to amphibians because they typically do not naturally support fish and other predators of amphibian eggs. The introduction of fish, bullfrogs, and other predatory species can devastate the breeding effort of amphibians in small wetlands.

Lastly, the use of all terrain vehicles (ATVs) and other recreational vehicles can cause significant damage around wetland communities. ATVs cause soil disturbance, increase erosion and sedimentation, elevate vehicle related mortality rates, and cause noise-related disruptions of faunal activities.

C. Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:

- **Surveys**
  - Conduct surveys on all amphibian species associated with small wetland communities, especially Mabee's salamander, spotted salamander, eastern tiger salamander, oak toad, dwarf salamander, four-toed salamander, ornate chorus frog, Pine Barrens treefrog, and Carolina gopher frog.
  - Determine the status and distribution of the eastern chicken turtle, eastern mudsnake, black swamp snake, and glossy crayfish snake.
  - Initiate frog call surveys (potentially coordinated through NC Partners in Amphibian and Reptile Conservation).
  - Expand cooperative survey efforts for amphibians and reptiles with industrial forest landowners such as Weyerhaeuser and International Paper (small wetlands may be a matrix habitat within larger stands of upland forest).
- **Monitoring**
  - Establish long-term breeding amphibian monitoring in these habitat types.
  - Monitor the long-term quality and quantity of beaver pond habitats in the region.
- **Research**
  - Investigate movements of amphibians and reptiles between small wetlands within a complex and use of adjoining uplands.
  - Investigate the potential to create vernal ponds for the benefit of wildlife, particularly amphibians.
  - Examine small wetlands to determine the importance of foraging and nesting areas for wading birds.
  - Determine the importance of beaver ponds to birds, reptiles and amphibians and document populations of basking turtles in areas with beaver ponds as compared to areas with few or no ponds.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

Protection of sites and surrounding areas through land acquisition or easements and cooperation with land trusts is the most critical conservation need in Coastal Plain small wetland sites. Quite a large number of lime sink (small depression) ponds still remain in private, unprotected status. Regional land trusts and The Nature Conservancy can be valuable partners in these efforts. The maintenance of contiguous gradients between wetland and adjacent upland sites is critical for seasonal migration and dispersal of amphibians; roads, agriculture, or other land use operations between complimentary sites may still render them ineffective at supporting amphibian and reptile populations. However, research has shown that with proper management, herpetofaunal communities can succeed on managed forestland (Leiden et al. 1999; Russell et al. 2002a, Russell et al. 2002b, Ryan et al. 2001). In instances where natural wetlands have been lost or degraded, the construction of artificial wetlands may assist in facilitating dispersal and recolonization of sites (Bailey et al. 2004). Recommendations on how to construct borrow pits during private road construction to benefit amphibians should also be developed.

Wetland restoration efforts should focus on restoring natural hydrology, water quality, and plant communities. The Natural Resources Conservation Service's Wetlands Reserve Program provides a good tool for promoting wetland conservation on private lands. Strategies for the effective removal of introduced aquatic predators need to be developed, and a mechanism for identifying and prioritizing sites for removal should be worked out.

There is a need to promote the adoption of agricultural and forestry best management practices that reduce run-off, erosion, and pollution of small wetland communities. The federal Farm Bill and other cost share programs provide incentives for land stewards to adopt these practices. Technical guidance manpower is needed to proactively promote and facilitate participation in these programs. Allowing prescribed fire in uplands to burn into and/or through depression wetlands during dry seasons or dry years is recommended.

Another critical aspect of small wetland conservation involves the development of outreach materials for the general public, developers, and land-use planners that describe the importance of vernal pools and depression sites for amphibians and reptiles. Better understanding of these seemingly isolated and insignificant sites as critical amphibian breeding areas may lead to more significant consideration of their protection during site design and planning.

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33. **Tidal swamp forest and wetlands** – These habitats occur along rivers or sounds in areas where flooding is influenced by lunar or wind tides. Fresh water input may heavily influence the salt content. Vegetation may range from Cypress-Gum swamps, characterized by swamp black gum, water tupelo, and bald cypress, to freshwater marshes containing giant cordgrass, sawgrass, cattails, American threesquare, black needle rush, spike-sedges, southern wildrice, arrowhead, and marsh fern. Regularly flooded herbaceous sites are reported to have high productivity, equivalent to salt marshes (Schafale and Weakley 1990).

    Areas dominated by dense herbaceous vegetation are important for several high priority bird species (Hunter et al. 2000, Johns 2004 and Rich et al. 2004) including rails and bitterns. Invasive *Phragmites* forms dense patches to reduce plant and animal diversity in some places. Fire was likely a natural component of some of these communities (Tidal Freshwater Marsh) and likely reduced dominance of large plant species and increased overall plant diversity (Schafale and Weakley 1990).

    Areas that are forested (Tidal Cypress-Gum Swamp) have a canopy dominated by bald cypress, swamp black gum, water tupelo, a dense to open shrub layer and are influenced by lunar or wind tides with little or no salinity in the water (Schafale and Weakley 1990). Salt-water intrusion during major storm events can cause major disturbance to this community.

Priority species associated with tidal swamp forests and wetlands:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Ammodramus caudacutus*	Saltmarsh Sharp-tailed Sparrow	
	Ammodramus nelsoni	Nelson's Sharp-tailed Sparrow	
	Anhinga anhinga	Anhinga	SR
	Asio flammeus	Short-eared Owl	
	Botaurus lentiginosus	American Bittern	SR
	Circus cyaneus	Northern Harrier	SR
	Cistothorus platensis	Sedge Wren	
	Coturnicops noveboracensis	Yellow Rail	SR
	Egretta caerulea	Little Blue Heron	SC
	Egretta thula	Snowy Egret	SC
	Elanoides forficatus	Swallow-tailed Kite	
	Gallinula chloropus	Common Moorhen	
	Haliaeetus leucocephalus	Bald Eagle	T (T)
	Himantopus mexicanus	Black-necked Stilt	SR
	Ixobrychus exilis	Least Bittern	
	Laterallus jamaicensis	Black Rail	SR
	Mycteria americana	Wood Stork	E (E)
	Nyctanassa violacea	Yellow-crowned Night-heron	
	Plegadis falcinellus	Glossy Ibis	SC
	Porzana carolina	Sora	
	Rallus elegans	King Rail	
	Rallus limicola	Virginia Rail	
Mammals	*Condylura cristata*	Star-nosed Mole	SC
	Cryptotis parva	Least Shrew	
	Sylvilagus palustris	Marsh Rabbit	
Reptiles	*Alligator mississippiensis*	American Alligator	T (T)
	Farancia abacura abacura	Eastern Mudsnake	
	Farancia erytrogramma erytrogramma	Common Rainbow Snake	
	Kinosternon baurii	Striped Mud Turtle	
	Thamnophis sauritus sauritus	Common Ribbonsnake	

A. Location and condition of habitat (see Map 5A.29):

This habitat can be found primarily in the northern Coastal Plain surrounding Currituck and Albemarle sounds, but is found sporadically southward at sites along rivers that empty into the sounds and at the upper end of estuaries. The forested habitat is in relatively good condition since it is not suitable for development, though still, little old growth tidal forested wetlands remain. Drainage and reduced burning frequency in both tidal and freshwater marshes has led to reductions in those habitat types. Good remaining examples of the herbaceous variant occur in Currituck, Camden, Chowan and Dare counties.

B. Problems affecting species and habitats:

Reduced fire regimes have led to successional changes in marsh habitats. Drainage and conversion of wetlands for development have also been moderate problems. Drainage for mosquito control has been the largest factor changing the characteristics of this habitat. An increase in the amounts of *Phragmites* in these marshlands decreases overall vegetative and animal diversity. Lack of fire in marshes has led to increased shrub and tree growth, especially red maple. The relative lack of old growth forested habitat here has depleted the amount of nest sites for bald eagles, but these sites are still important for a variety of birds that use herb dominated marsh sites.

C. Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:

- **Surveys** – Surveys are needed to document the distribution, relative abundance and status of many wildlife species associated with these habitats. Priorities for conducting surveys need to focus on species believed to be declining, at risk or mainly dependent on these communities (like rails). Secondary priority for surveys should be for species for which current distribution information is already available or for species that are considered common. Many bird species associated with these community types are not sampled well or at all by BBS.
  - Conduct marshbird surveys (especially tape playbacks for rails and bitterns) to determine the status and distribution of all marshbirds (Legare et al. 1999, Gibbs and Melvin 1997, Conway et al. 2004).
  - Establish species-specific surveys to improve our knowledge of the status and distribution of least bittern, American bittern, yellow rail, and black rail at all times of the year (Conway et al. 2004).
  - Conduct status and distribution surveys for black-necked stilt, common moorhen, wood stork, northern harrier, short-eared owl, sedge wren and both saltmarsh and Nelson's sharp-tailed sparrows.
  - Establish small mammal surveys to obtain distribution information on the star-nosed mole and least shrew in this habitat, as well as other small mammals.
  - Determine the status and distribution of the marsh rabbit.
  - Determine the status and distribution of the American alligator, eastern mudsnake, common rainbow snake and striped mud turtle.
- **Monitoring**
  - Long-term monitoring, following survey data, is needed for all marshbirds, mammals and reptiles in this habitat type.
  - Continue nest monitoring for colonial waterbirds.
  - Establish mist net stations for passerine birds in this habitat type at all times of the year.
- **Research**
  - Examine habitat use and conduct nesting habitat research on the black rail using telemetry, and then on other marshbirds (Bogner and Baldassarre 2002).
  - Research the relationship between habitat area and the distribution of tidal marshbirds (Benoit and Askins 2002).
  - Conduct research on fire management in marsh habitats to determine optimal frequency, timing, and firing techniques (e.g., flanking fire, back fire) to benefit priority birds.

- Conduct a systematics study to differentiate between the two subspecies of least shrew.
- Explore techniques for restoration of tidal swamp forest and wetlands.
- Investigate the past, current and potential future impact of nutria on tidal wetlands (especially freshwater marshes).

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

Partnerships with the North Carolina Coastal Land Trust and The Nature Conservancy should be nurtured to acquire more of these types of habitats, particularly marshes in the Currituck Sound region. Identified funding sources for acquisition include the Clean Water Management Trust Fund, Coastal Wetlands Grants, Natural Heritage Trust Fund, Forest Legacy Grants, and Recovery Land Acquisition Grants. Priorities for protection include colonial waterbird nesting sites, eagle nesting sites, wood stork foraging areas, and important black rail habitat once it is better identified. Adjacent nesting habitat for snakes and turtles should also be protected.

Increased burning on sites dominated by herbaceous vegetation needs to be encouraged to retard invasion of maples and other trees and shrubs. This might be pursued through cooperative efforts with the Atlantic Coast Joint Venture, Migratory Bird Committee of the US Fish & Wildlife Service and the South Atlantic Migratory Bird Initiative. Non-native vegetation control (e.g., *Phragmites*) is needed in many areas. Snags, logs, rocks, and other structures that are important for basking reptiles should be retained or restored wherever possible.

Education efforts are needed to emphasize the importance of tidal wetlands. Existing wetland regulations need to be enforced and strengthened. The use of bulkheads should be discouraged when other possibilities are available.

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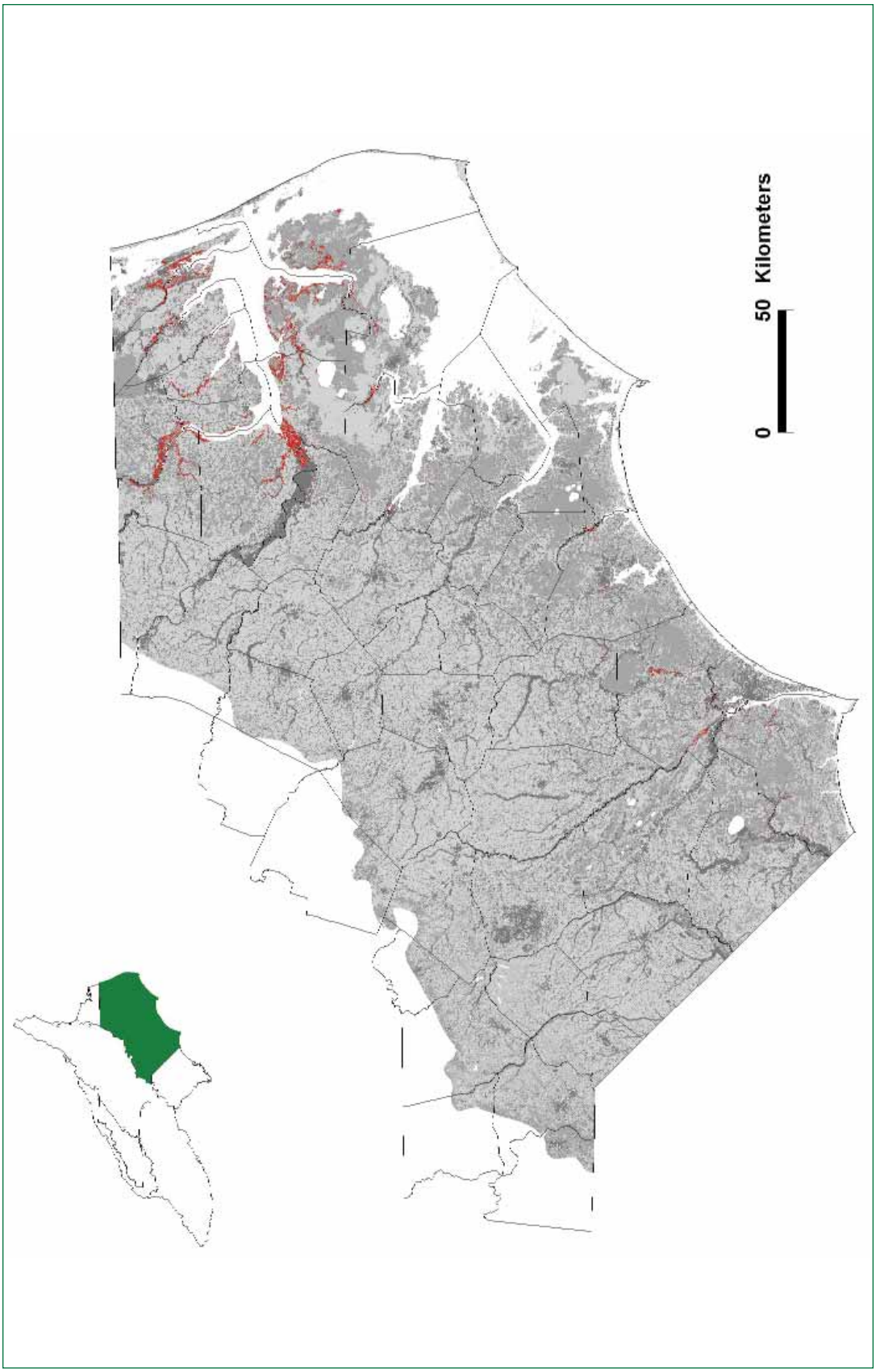

Figure 5A.33. Tidal swamp forest and wetlands in the Mid-Atlantic Coastal Plain ecoregion of North Carolina (in red) (data source: NC GAP, 1992).

34. **Maritime forest/shrub** – Maritime communities are found along barrier islands and the mainland North Carolina coast on stabilized upper dunes and flats protected from salt water flooding and the most extreme salt spray. Hydrology is variable and some of the Maritime Shrub communities are subject to heavy salt spray (Schafale and Weakley 1990). All of the barrier island maritime forest/shrub communities occur in very dynamic environments that are often disturbed or even permanently converted to other community types.

    Maritime Shrub communities are found throughout the barrier islands and are dominated by dense shrubs, especially wax myrtle, yaupon holly, groundsel tree, red cedar and stunted live oak (Schafale and Weakley 1990). There are also often gaps containing grassy areas. Successional shrub communities have become more common on former grass dominated sites due to artificial building of dunes (Schafale and Weakley 1990). The natural community type is not uncommon on the barrier islands, but extensive natural examples are rare.

    Canopies of Maritime Evergreen Forests are dominated by live oak, sand laurel oak, and loblolly pine. Understories are typified by shrubby woody growth, vines are important and common and the herb layer is sparse. These communities occur in sheltered parts of the barrier islands but are still subject to extremes of the maritime environment (Schafale and Weakley 1990). Sites that have been recently logged often are dominated by loblolly pine, and storm disturbance produces canopy gaps. These communities apparently burned historically at irregular intervals and understories have become denser, although natural fire was probably less frequent than in mainland forests (Schafale and Weakley 1990). These communities depend on the canopy for protection from salt spray.

    The rare Maritime Deciduous Forest (Nags Head Woods is the best remaining example) is dominated by beech, American holly, loblolly pine and hickory. Shrubs and vines can be dense and there can be a moderate herb layer present. Maritime vegetation exposed to frequent salt spray during storms is stunted. These are the most sheltered communities of any barrier island sites, and are one of the rarest and most endangered natural communities in North Carolina (Schafale and Weakley 1990).

    Coastal Fringe Evergreen Forests and Coastal Fringe Sandhill communities typically occur on the mainland adjacent to estuaries and barrier islands, although both community types are very rare due to developmental pressures, widespread fire suppression and limited range (Schafale and Weakley 1990).

    These habitats are important breeding and migration stopover points for many migratory birds, and key breeding areas for declining populations of the eastern painted bunting (Hunter et al. 2000, Johns 2004). These communities are also important for some snake species for which we have little status, distribution or demographic information.

Priority species associated with maritime forest/shrub habitats:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Passerina ciris*	Eastern Painted Bunting	
Mammals	*Peromyscus leucopus easti*	White-footed Mouse	SC
Amphibians	*Bufo quercicus*	Oak Toad	SR
	Desmognathus auriculatus	Southern Dusky Salamander	
	Scaphiopus holbrookii	Eastern Spadefoot	
Reptiles	*Cemophora coccinea copei*	Northern Scarletsnake	
	Heterodon simus	Southern Hog-nosed Snake	SC
	Lampropeltis getula getula	Eastern Kingsnake	
	Lampropeltis getula sticticeps	Outer Banks Kingsnake	SC
	Masticophis flagellum	Eastern Coachwhip	SR
	Micrurus fulvius	Eastern Coral Snake	E

A. *Location and condition of habitat[1]:*

The condition of these habitats in the state is extremely poor. Maritime forest is one of the most endangered habitat types in North Carolina, primarily due to coastal development, which has literally destroyed much of the maritime habitats. In many places where some assemblage of the habitat remains, houses and other structures are spread throughout.

Only one good example of Maritime Deciduous Forest remains at Nags Head Woods in Dare County; an additional example occurs in nearby Kitty Hawk Woods. Maritime Evergreen Forest is found throughout the barrier islands and good examples can be found at Buxton Woods, Theodore Roosevelt State Natural Area on Bogue Banks, and Bald Head Island. Maritime Shrub is found throughout the barrier islands, but good examples are rare. Some examples exist at Cape Hatteras National Seashore, Shackleford and Core Banks, Bear Island in Onslow County, Fort Macon State Park, Bogue Banks, and Fort Fisher.

B. *Problems affecting species and habitats:*

Residential and commercial coastal development leading to fragmentation and overall reduction of habitat is the single most important factor leading to the loss of this habitat. Almost all this habitat is high ground and suitable for development, and is found in areas close to the beach where human population growth is booming. The creation of numerous small clearings for houses will likely have far-reaching effects on the dynamics of these habitats (Schafale and Weakley 1990).

A lack of fire to maintain some variants of these habitats is also leading to successional changes in many of these sites. Burning is almost impossible to conduct in areas surrounded by homes. There are also feral animal impacts (horses, goats, cows, cats) on some of the barrier islands (e.g., Shackleford Banks). In addition, egg predators such as raccoons and foxes that typically did not inhabit most of the Outer Banks are now widespread because of the increased amount of food available now that people inhabit the area.

C. *Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:*

- **Surveys**
  - Conduct migration surveys to determine bird use, especially during the fall.
  - Conduct small mammal surveys on barrier island systems to verify species status, distribution and community composition.
  - Determine the status and distribution of amphibians and reptiles in maritime communities.
- **Monitoring**
  - Continue long-term monitoring and banding work (currently being done by the US Geological Survey) on eastern painted buntings and support the goals and objectives of the Painted Bunting Working Group that involves Florida, Georgia, South and North Carolina.
  - Establish MAPS and migration banding stations in this habitat type.
  - Establish long-term monitoring of amphibians and reptiles, once survey data has been established.
- **Research**

  Genetics
  - Conduct cooperative research with western states to determine the genetic relationships between eastern and western painted buntings.
  - Conduct genetics research on all “kingsnake” species.

  Demographics and habitat use
  - Initiate productivity and habitat use research eastern painted bunting (Norris and Elder 1982, Lanyon and Thompson 1986 and Kopachena and Crist 2000).

[1]A map of this habitat is not provided, due to scale and sensitivity issues.

- Document the habitat selection and competition factors related to indigo bunting and painted bunting in these habitats (Kopachena and Crist 2000).
- Maritime forests in the far southeastern portion of the state historically supported eastern woodrats; consider those habitats as potential reintroduction sites.
- Examine demographics/population dynamics/specific habitat requirements of the white-footed mouse subspecies (listing is almost certain for the subspecies).
- Conduct habitat-use research on southern dusky salamander, eastern spadefoot, southern hog-nosed snake, eastern coachwhip, northern scarletsnake, kingsnakes and eastern coral snake to better determine habitat use patterns.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

In general, there is a need to better track the extent of maritime habitats: *How much is there? What is the condition of each site? How much development pressure is being exerted on each site?* This information should be integrated into our understanding of maritime forest wildlife species current status and distribution and how those distributions may have differed without such extensive coastal development.

Remaining coastal maritime habitats must be a priority for land acquisition efforts. Though coastal uplands are essentially the most costly areas to acquire in the state, it is essential to acquire remaining undeveloped maritime forests, both on barrier islands and on the mainland. In fact, maritime (coastal fringe) forests on the mainland are grossly under-protected. The Atlantic Coast Joint Ventures or South Atlantic Migratory Bird Initiative may be able to help coordinate such projects along with the North Carolina Coastal Land Trusts and The Nature Conservancy. Identified funding sources for acquisition include Coastal Wetlands Grants, Natural Heritage Trust Fund, Forest Legacy Grants, and Recovery Land Acquisition Grants.

Re-establishment of maritime forest habitats should also be pursued, including initiation of prescribed burning of appropriate maritime habitats, where possible. The presence of dense canopies are a key habitat element in maritime forests; many maritime forest-associated herpetofauna, and their prey, are adapted to survive under particular sun and shade regimes (Bailey et al. 2004). An attempt should be made to work with local governments to develop laws or ordinances that require certain amounts of native vegetation be retained, and buffers of vegetation be left along the sounds.

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35. **Estuarine communities** – These include salt marsh, brackish marsh, salt flat, sand flat, mud flats, algal mats, salt scrub, estuarine island communities, and sounds along coastal North Carolina. Marsh habitats usually develop on the mainland side of the barrier islands after sand is deposited during storm events. They also develop on the mainland side of the sounds and in the lower reaches of our rivers as sea-level rise, salt intrusion or storms kill forested or shrub-scrub habitats.

    Salt marsh communities are often strongly dominated by saltmarsh cordgrass and these areas occur throughout the coastal part of the state, while brackish marsh is dominated by black needlerush and are found throughout the estuarine parts of North Carolina (Schafale and Weakley 1990). Vegetation may include salt meadow cordgrass, glasswort, saw grass, marsh elder, and wax myrtle, as determined by the salinity level of the water.

    Sand flats and mud flats are often created and maintained near one of our 20 inlets as flood tide or ebb tide deltas. These are very dynamic systems and can appear and disappear with each storm event, although most persist for 10–20 years at a time barring major dredging activities. Salt flats and algal mats are either found as shoals within the sounds or on very low stretches of the barrier beaches. These sites are particularly important for foraging shorebirds.

    Salt marsh and brackish marsh habitats are important habitat year-round for a variety of rails, bitterns, wading birds and marsh sparrows, several of which are species of conservation concern according to Partners in Flight (Hunter et al. 2000, Pashley et al. 2000, Rich et al. 2004 and Johns 2004). Waterfowl impoundments created within brackish marshes provide valuable habitat for waterfowl, wading and shorebirds, and furbearers. Estuarine communities also provide important habitat for high priority birds during some stage of their life cycle such as piping plover, Wilson's plover, American oystercatcher, black skimmer, gull-billed tern, bald eagle, peregrine falcon and wood stork. Endangered or threatened sea turtles use these areas and diamond-backed terrapins key in on these habitats. In all these are some of the most important habitats for large numbers and types of immediate coastal wildlife that are federally or state listed, or are experiencing precipitous population declines.

    Estuarine islands can be either natural or created by dredged material. These sites are particularly important for nesting terns, skimmers, pelicans, wading birds, and American oystercatchers. Dredged material islands are not only usually devoid of mammalian predators, but usually have the added advantage of being high enough in elevation that ground nesting birds do not lose their nests during high tides.

    Other fully aquatic taxa (fish, mussels, crayfish, and snails) are referenced in the river basins portion of the report. See the river basin sections (Chapter 5B) for more detailed information on aquatic species and habitats, by basin.

    A focused discussion of coastal and estuarine habitats as they relate to marine species can be found in Chapter 5C (Marine Systems).

A. Location and condition of habitat (see Map 5A.35):

The condition of all these habitats is poor or threatened due to development, fragmentation, wetland ditching and filling, dredging, or a lack of fire, as well as increased human recreational activity. Losses, drastic alteration or disturbance of these habitat types (especially marsh habitats) could have serious consequences for nutrient cycling and for reproduction of marine and estuarine organisms (Schafale and Weakley 1990).

B. Problems affecting species and habitats:

Water quality impacts (pesticide use related to mosquito control, developmental secondary impacts) and water flow impacts (through ditching, canals, etc.) have greatly affected this habitat. Dredging and dredge material placement can also affect these sites through draining of marshes or filling of wetland types. Dredged material placement has been used very effectively in some areas to create marsh or upland bird nesting areas within the estuaries. However, it has become increasingly difficult to direct dredged material to bird nesting islands that need it because of a lack of US Army Corps of Engineer funding for dredging projects and because

Priority species associated with estuarine communities:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Ammodramus caudacutus*	Saltmarsh Sharp-tailed Sparrow	
	Ammodramus nelsoni	Nelson's Sharp-tailed Sparrow	
	Asio flammeus	Short-eared Owl	
	Botaurus lentiginosus	American Bittern	SR
	Calidris alba	Sanderling	
	Calidris canutus	Red Knot	
	Charadrius melodus	Piping Plover	T (T)
	Charadrius wilsonia	Wilson's Plover	SR
	Circus cyaneus	Northern Harrier	SR
	Cistothorus platensis	Sedge Wren	
	Coturnicops noveboracensis	Yellow Rail	SR
	Egretta caerulea	Little Blue Heron	SC
	Egretta thula	Snowy Egret	SC
	Egretta tricolor	Tricolored Heron	SC
	Falco peregrinus	Peregrine Falcon	E
	Haematopus palliatus	American Oystercatcher	SR
	Haliaeetus leucocephalus	Bald Eagle	T (T)
	Himantopus mexicanus	Black-necked Stilt	SR
	Ixobrychus exilis	Least Bittern	
	Laterallus jamaicensis	Black Rail	SR
	Mycteria americana	Wood Stork	E (E)
	Nyctanassa violacea	Yellow-crowned Night-heron	
	Pelecanus occidentalis	Brown Pelican	SR
	Plegadis falcinellus	Glossy Ibis	SC
	Porzana carolina	Sora	
	Rallus elegans	King Rail	
	Rallus limicola	Virginia Rail	
	Rynchops niger	Black Skimmer	SC
	Sterna antillarum	Least Tern	SC
	Sterna caspia	Caspian Tern	SR
	Sterna hirundo	Common Tern	SC
	Sterna nilotica	Gull-billed Tern	T
Mammals	*Cryptotis parva*	Least Shrew	
	Sylvilagus palustris	Marsh Rabbit	
	Trichechus manatus	Manatee	E (E)
Reptiles	*Caretta caretta*	Loggerhead Sea Turtle	T (T)
	Chelonia mydas	Green Sea Turtle	T (T)
	Eretmochelys imbricata imbricata	Atlantic Hawksbill Sea Turtle	E (E)
	Lampropeltis getula getula	Eastern Kingsnake	
	Lampropeltis getula sticticeps	Outer Banks Kingsnake	SC
	Lepidochelys kempii	Kemp's Ridley Sea Turtle	E (E)
	Malaclemys terrapin	Diamond-backed Terrapin	SC
	Nerodia sipedon williamengelsi	Carolina Watersnake	SC
	Thamnophis sauritus sauritus	Common Ribbonsnake	

coastal towns are now competing for the sand for beach nourishment projects. Other beach stabilization projects (e.g., inlet channel relocation and efforts to restrict channel movement) reduce availability of microhabitats such as mud and algal flats around inlets. Development has also taken much of this habitat type and disturbance by humans and their pets is becoming a growing problem, as well as predation by non-native predators on nesting birds. A lack of fire is particularly troublesome in the marsh sites.

Another suite of threats can be found in and on the water. Negative fisheries interactions include diamond-backed terrapins drowning in crab pots and gill nets; trawls and hook and line fisheries impacting endangered sea turtles; red-throated loons and other diving birds getting caught and drowning in gill nets. Recreational boaters may accidentally strike turtles, manatees and birds. There are also now potential impacts related to offshore wind power turbines on both birds and bats (major activity zones for both).

C. *Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:*

- **Surveys** – Surveys are needed to document the distribution, relative abundance and status of many wildlife species associated with these habitats. Priorities for conducting surveys need to focus on species believed to be declining, at risk or mainly dependent on these communities. Secondary priority for surveys should be for species for which current distribution information is already available or for species that are considered common. Many bird species associated with these community types have experienced significant declines according to inventory and survey data.
  - Determine the breeding and wintering status and distribution of the saltmarsh sharp-tailed sparrow, Nelson's sharp-tailed sparrow (DiQuinzio et al. 2001, Hodgman et al. 2002) and the seaside sparrow in North Carolina.
  - Determine the status and distribution of sedge wren, northern harrier and short-eared owl.
  - Conduct secretive marshbird surveys for the black rail, American bittern, least bittern, yellow rail and other marsh birds (birds not adequately surveyed by BBS) (Legare et al. 1999).
  - Continue surveys for Wilson's plover and American oystercatcher to assess state-wide trends in abundance and distribution.
  - Determine the status and distribution of priority mammals (e.g., manatee, marsh rabbit).
  - Determine the status and distribution of the diamond-backed terrapin and Carolina watersnake.
- **Monitoring**
  - Continue ongoing all-season piping plover monitoring, as well as other ongoing shorebird and colonial waterbird monitoring.
  - Establish long-term monitoring for all marsh birds (Gibbs and Melvin 1997, Benoit and Askins 2002, Bogner and Baldassarre 2002, Conway et al. 2004).
  - Establish long-term monitoring for passerine birds using marsh habitat; establish bird banding stations at all times of the year in marsh habitats.
  - Continue long-term sea turtle nesting and stranding monitoring; strandings need to be monitored to a greater extent in estuary sites.
  - Establish long-term monitoring for diamond-backed terrapins (post survey work).
- **Research**

  Genetics
  - Conduct systematics studies to differentiate between the two subspecies of least shrew.
  - Explore the genetic relationships among "kingsnake" species.

  Diet, Nutrition
  - Research the nutrition needs of plovers and oystercatchers and the diet niches of terns, skimmers, herons and egrets.

Habitat use/demographics

- Study marsh bird habitat needs and life histories, especially the black rail (Benoit and Askins 2002 and Conway et al. 2004).
- Conduct shorebird foraging studies, wading bird foraging studies, and expanded colonial waterbird research (possible partnerships with Atlantic Coastal Joint Ventures, South Atlantic Migratory Bird Initiative).
- Conduct marsh food productivity/food web research related to shorebirds, rails and wading birds.
- Explore population dynamics related to controlled burns in marshes.
- Examine the reproductive success of beach nesting birds on dredge material islands as compared to success on beaches.
- Explore the use of field readable bands on royal terns and American oystercatchers to attain survivorship information.
- Conduct studies to examine two-egg clutches in royal terns.
- Determine the cause of sharp nesting population declines in snowy egrets.

Predator effects

- Study estuarine predator communities and effects on nesting birds.

Management practices

- Identify causal factors in sea turtle strandings and fishery related mortality issues (using telemetry).
- Conduct diamond-backed terrapin research to better identify causal factors and minimize fisheries related mortality.
- Study the effectiveness of burning marshes, especially brackish marshes, to retard growth of shrubs and stimulate growth of grasses, sedges, and rushes.
- Study the effectiveness of vegetation control measures on dredge material islands for birds that require early successional nesting habitat.
- Determine limiting factors for oystercatchers, plovers, black skimmers, gull-billed, royal, least and common terns and implement management to halt population declines.
- Explore techniques for restoration of estuarine communities.
- Investigate the past, current and potential future impacts of nutria on estuarine wetlands (especially brackish-fresh water marshes).

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

Many of our brackish marshes, especially on the mainland side of Pamlico Sound, are in private ownership, as are a number of heronries (e.g., Rawls Island, Gull Island). Land acquisition and protection are the primary actions needed. Atlantic Coast Joint Ventures and the North Carolina Coastal Land Trust are partners for these efforts. Coordination with regulatory agencies should be continued and expanded to encourage and enforce wetlands regulations and to enforce the Migratory Bird Treaty Act and the Endangered Species Act. Acquisition targets should include brackish marsh impoundments, which will then require continued management for maintenance. In addition, efforts need to be made to thwart loss of estuarine islands to theft or erosion.

Education and outreach efforts directed at the public, land-use planners, and regulatory agencies such as the NC Department of Transportation and US Army Corps of Engineers are needed to emphasize the ephemeral nature of sand and mud flats so that these habitats will not be destroyed as they are recreated by storms. Other educational needs include increased public awareness concerning potential impacts of boats and recreational fisheries, including ghost fishing line, hooks and bycatch, on wildlife (e.g., sea turtles, diamondback terrapin). Building setback distances should be considered and buffer zones and living sills/marsh should be encouraged. Estuarine bulkheads can destroy adjacent inter-tidal sand or mud flats and marsh

and should be discouraged. The Coastal Habitat Protection Plan (CHPP) (Street et al. 2004) has good details about the negative aspects of bulkheads and we should work to help promote the suggestions/guidelines within the CHPP.

Continued coordination is needed with waterbird working groups such as the North Carolina Waterbird Committee, the Piping Plover Recovery Team, The American Oystercatcher Working Group and the Royal Tern Working Group. Future recommendations from the North American Waterbird Conservation Plan should be implemented (Kushlan et al. 2002). Promotion of and support for oyster restoration programs (e.g., NC Coastal Federation), which would in-turn enhance food sources and ecosystem functioning in estuarine systems, should also be encouraged.

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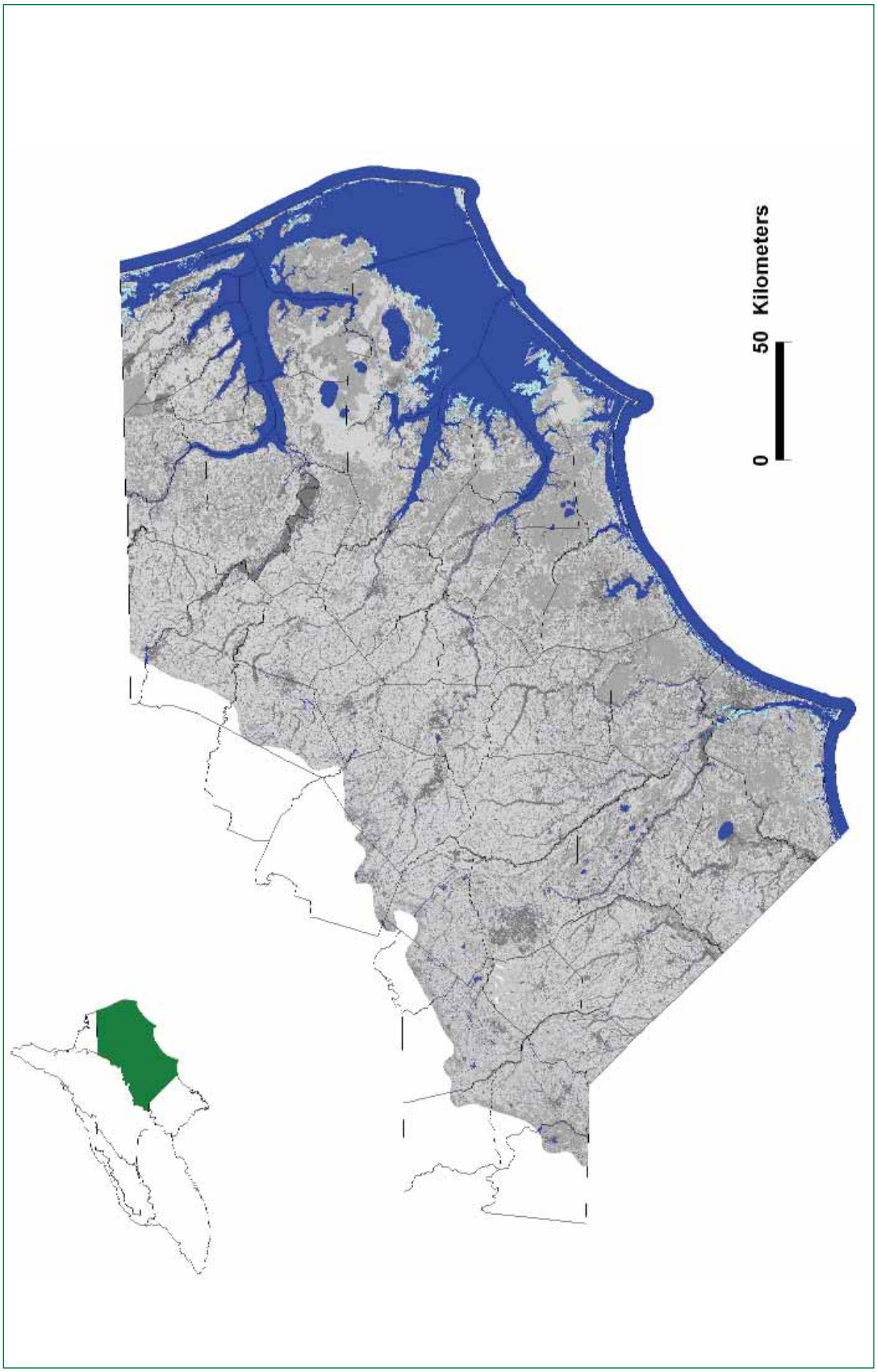

Figure 5A.35. Estuarine habitats (mapped as tidal marsh in light blue) in the Mid-Atlantic Coastal Plain ecoregion of North Carolina (data source: NC GAP, 1992). *As defined in the Plan, this habitat would also include the shallow bays, estuaries and sounds along the coast.*

36. **Beach/dune** – Upper beach vegetation includes sea rocket, Dixie sandmat, seaside sandmat, Russian thistle, and seabeach amaranth. Dune vegetation is characterized by sea oats grass and American beach grass. These habitats are also well imitated by dredged material islands within our sounds that are often devoid of the predators that have invaded the barrier beaches. Overwash, salt spray, and erosion contributes to ever-changing beach/dune dynamics. The beach/dune habitat is particularly important to sea turtles, beach nesting birds and shorebirds. Many of the bird species rely on the dynamic nature of the beach, and need storms to recreate wide beaches with bare sand and shell overwash areas. The swash zone (the area between high and low tide) is particularly important to beach invertebrates which are used as a food source by fish and waterbirds.

A focused discussion of coastal and estuarine habitats as they relate to pelagic and marine species can be found in Chapter 5C (Marine Systems).

Priority species associated with beach and dune habitats:

Group	Scientific Name	Common Name	State Status (Federal Status)
Birds	*Calidris alba*	Sanderling	
	Calidris canutus	Red Knot	
	Charadrius melodus	Piping Plover	T (T)
	Charadrius wilsonia	Wilson's Plover	SR
	Chordeiles minor	Common Nighthawk	
	Falco peregrinus	Peregrine Falcon	E
	Haematopus palliatus	American Oystercatcher	SR
	Pelecanus occidentalis	Brown Pelican	SR
	Rynchops niger	Black Skimmer	SC
	Sterna antillarum	Least Tern	SC
	Sterna caspia	Caspian Tern	SR
	Sterna hirundo	Common Tern	SC
	Sterna nilotica	Gull-billed Tern	T
Mammals	*Peromyscus leucopus easti*	White-footed Mouse	SC
Reptiles	*Caretta caretta*	Loggerhead Sea Turtle	T (T)
	Chelonia mydas	Green Sea Turtle	T (T)
	Dermochelys coriacea	Leatherback Sea Turtle	E (E)
	Lepidochelys kempii	Kemp's Ridley Sea Turtle	E (E)
	Malaclemys terrapin	Diamond-backed Terrapin	SC
	Masticophis flagellum	Eastern Coachwhip	SR

A. Location and condition of habitat[1]:

These habitats occur all along coastal North Carolina, but are restricted to the immediate coastline. The condition of these habitats is probably among the worst of all habitats within the state. Development has exploded on the coast. Beach houses, motels, and other structures, and the infrastructure to support them, have caused a significant stabilization effect on the beaches that will be very difficult to reverse.

B. Problems affecting species and habitats:

Development of our beaches is the primary cause for the depletion in the beach/dune habitat. Several of the bird species we are most concerned about require early successional habitat for nesting and these habitats have been destroyed or severely altered. Predators (native and non-native) have increased many-fold. Many of these species (cats, herring and great black-backed

[1]A map of this habitat is not provided, due to scale and sensitivity issues.

gulls, raccoons, foxes) were not present before the beach became populated with people and their associated trash. These predators have caused significant problems for beach-nesting birds and sea turtles. Vehicle use has also created disturbance issues as well as direct impacts to nesting turtles and birds. Chronic human disturbance is becoming a problem at many sites. People are now able to access even the most remote beaches via shallow draft boats and personal watercrafts. Direct and indirect disturbance, not only by humans but also by their pets, causes problems for nesting and non-nesting birds. Artificial dune stabilization, associated with the protection of homes and infrastructure (roads, powerlines, waterlines), prevents the natural re-creation of wide beaches and overwash areas. Beach renourishment and beach bulldozing can cover or destroy macro-invertebrates in the swash zone and on the beach that foraging shorebirds and surf fishes depend upon. These activities can also destroy sea turtle nests when conducted between May and November. Even under the best survey conditions, all sea turtle nests can not be found and marked or relocated to prevent take from these activities. Beach renourishment can also lead to more development and possibly decrease washover and increase vegetation, thus decreasing the amount of suitable nesting habitat for beach nesting birds. Landscaping choices (e.g., introduced species such as *Vitex*) can also strongly affect the dune system.

C. *Priority research, survey, and monitoring efforts needed to identify factors to assist in restoration/conservation of species:*

- **Surveys** – Surveys are needed to document the distribution, relative abundance and status of many wildlife species associated with these beach/dune habitats. Priorities for conducting surveys need to focus on species believed to be declining, at risk, or mainly dependent on these communities. Secondary priority for surveys should be for species for which current distribution information is already available or for species that are considered common.
  - Conduct shorebird surveys throughout the year to better understand population fluctuations for breeding, wintering and migratory birds (especially piping plover, American oystercatcher, Wilson's plover).
  - Determine distribution and status of wintering shorebirds (Sprandel et al. 2000).
- **Monitoring**
  - Monitor status and reproductive success of gull-billed tern, common tern, least tern, black skimmer, piping plover, and Caspian tern.
  - Continue support for regular colonial waterbird surveys (currently conducted coast wide roughly every three years).
  - Determine seasonal numbers and distribution of shorebirds (Dinsmore et al. 1998).
  - Continue sea turtle nest and stranding monitoring.
  - Monitor introduced non-native species effects (especially plants and invertebrates) on native coastal wildlife, including sea turtles.
- **Research**

  Predator impacts
  - Identify causal factors responsible for low beach nesting bird reproductive success; initiate predator impact studies (e.g., ghost crabs, fire ants, gulls, foxes, raccoons, feral cats) (Wolcott and Wolcott 1999).

  Life history/demography
  - Conduct American oystercatcher and Wilson's plover reproductive success research (more important for Wilson's plover reproductive success since studies are already underway looking at oystercatcher success).
  - Conduct foraging strategies and energy budget allocations of migrating shorebirds (Davis and Smith 2001).
  - Conduct life history studies of colonial waterbirds (Wambach and Emslie 2003).
  - Study the demographics/population dynamics/specific habitat requirements of the white-footed mouse subspecies (listing is almost certain for the subspecies).

Management practices

- Evaluate impacts of beach renourishment on sea turtle reproduction.
- Examine the effectiveness of vegetation control for beach nesting birds that require early successional habitat.
- Examine the effectiveness of trapping or other predator control measures (potentially for native and non-native species alike).
- Work with owners and managers of buildings containing nesting least terns to increase reproductive success while allowing owners/managers to maintain good public relations.

Telemetry

- Conduct habitat use and time allotment studies on sea turtles.

D. Conservation actions necessary to conserve the species and habitat and priorities for implementation:

Building setback distances need to be reevaluated and lengthened. This should prevent much of the need for beach renourishment and stabilization projects. Although coastal development can not be fully controlled, there are a few areas of great importance that can still be purchased fee title or as an easement (South Topsail near New Topsail Inlet, North Topsail near New River Inlet, Lee and Hutaff islands, parts of Masonboro Island, north end of Carolina Beach). These purchases should remain at the top of the list of priorities.

Coordination needs to continue to influence where dredged material is placed to be most beneficial/least detrimental to beach nesting birds, foraging shorebirds, and sea turtles. Reducing disturbance from off road vehicles, people and their pets on coastal beach and dune systems is needed. Continued support for and enhanced coordination among coastal management agencies regarding existing restrictions and programs aimed at regulating beach activities is also critical.

Continued coordination is needed with waterbird working groups such as the North Carolina Waterbird Committee, the Piping Plover Recovery Team, The American Oystercatcher Working Group and the Royal Tern Working Group. Future recommendations from the North American Waterbird Conservation Plan should be implemented (Kushlan et al. 2002).

Predators (not limited to exotic species) must be controlled through education efforts, trapping or other means to increase sea turtle and beach nesting bird reproductive success.

To better manage sea turtle populations, mortality factors must be reduced. In addition, continued efforts need to address beach lighting, sand fencing, sand pushing and beach stabilization issues, so that sea turtles have a better chance for nesting success. Another educational need includes increasing public awareness of potential impacts of tourists and visitors on beach/dune associated species. Recently, there have been severe public conflicts regarding keeping beach access areas open despite conservation agencies recommendations for closure to protect beach-nesting birds and turtles (e.g., Fort Fisher, 2004).

See the Coastal Habitat Protection Plan (Street et al. 2004) for an in-depth discussion of issues pertaining to coastal fisheries habitat protection. Also see Chapter 5C (Marine Systems).

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