

**Ecosystem Description**

Nonalluvial mineral wetlands occur on flat, poorly drained areas of the outer Coastal Plain and occasionally in shallow depressions such as Carolina bays. The soils in these sites are saturated in the wetter seasons, may have shallow standing water, and do not experience overflow flooding. The wetness comes from poor drainage and sheet flow from adjoining peatlands. The soils are less acidic and infertile than the peat soils of pocosins, but they do not have the regular nutrient input of river floodplains. Organic deposits are generally lacking, though occasional examples are found on organic soils where some other factor offsets the tendency of these soils to support pocosins.

There are three community types that differ in wetness and the nature of the soil: non-riverine swamp forests, non-riverine wet hardwood forests, and wet marl forest. Non-riverine swamp forests occur in the wettest sites. They are dominated by trees tolerant of extreme wetness, such as bald cypress, swamp black gum, and red maple. A distinctive variant, transitional to peatland communities, has these species mixed with loblolly pine, pond pine, and Atlantic white cedar.

Non-riverine wet hardwood forests occur in less wet areas. They are dominated by trees typically called "bottomland hardwoods". The undergrowth is usually open beneath the closed canopy, but sometimes dense cane or shrubs occur.

The wet marl forest type occurs where marl or limestone occurs near the surface and affects the soil. This extremely rare community is completely isolated, and is fragmented. Although they are wet, these soils are not acidic and are more fertile than most Coastal Plain soils. The vegetation is dominated by a diverse mixture of tree, shrub, and herb layers. Dwarf palmetto is an abundant and distinctive part of the shrub layer.

The 2005 Wildlife Action Plan described Mid-Atlantic Coastal Plain Nonalluvial Mineral Wetlands as a priority habitat (see Chapter 5A) (NCWRC 2005). 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 (NCWRC 2005).

Table 1 at the end of this report provides a summary of expected climate change impacts to these natural communities.

## **Predicted Effects to Wildlife Species**

Tables 2 through 5 at the end of this report identify the species of conservation concern and priority species that use habitats in this ecosystem.

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 (NCWRC 2005). Wayne's black-throated green warbler is nearly confined to non-riverine swamp forests throughout its narrow range from Virginia to South Carolina. This taxon is declining throughout its range and loss of the population on the Albemarle-Pamlico Peninsula, which is believed to be the largest remaining, due to rising sea-levels would significantly reduce the chances of its survival overall. Storm-related impacts to the Wayne's black-throated green warbler could be particularly severe, since it is a canopy-dwelling species that is often found in the vicinity of tall conifers, which are probable nesting sites, that emerge above a canopy of hardwoods (Fussell *et al.*, 1995). Likewise, the coastal population of the worm-eating warbler also uses this habitat type heavily and is isolated from others that breed in the mountains of North Carolina.

Even more likely to become extirpated is the sole population of wood frogs known to occur in the Coastal Plain of North Carolina. This population exists on the Albemarle-Pamlico Peninsula in the vicinity of hardwoods near Scranton and likely represents a relic from the Pleistocene epoch, as do several other animals and plants recorded in this area (*e.g.*, cranberry, sundew moth, undescribed shrew). The reasons for its restricted range in this area are unknown, but it may not be able to migrate inland to keep pace with sea-level rise.

Other terrestrial vertebrates and invertebrates associated with this ecosystem group occupy other types of habitat, including floodplain forests and peatlands, and are more likely to survive impacts associated with climate change. Two species of canebrake moths, however, are endemic to the North Carolina Coastal Plain plus the portion of the Great Dismal Swamp in Virginia: *Lasopia roblei* and the still-undescribed *Apameine*, New Genus 2, Species 3. Some of their largest known populations are associated with non-riverine habitats, the loss of which would be significant, if not as damaging as for Wayne's black-throated green warbler.

## **Climate Change Compared to Other Threats**

Climate change is a significant threat primarily because of the likelihood of inundation from sea level rise. Rising sea level will be more of a concern in the larger riverine wetlands at lower elevations, such as those around the Alligator River, than wetlands further inland. However, other threats such as logging and the alteration of hydrology, in the form of ditches, pose equal threats to these systems.

Impacts to the non-riverine swamps and hardwood stands in the Albemarle-Pamlico Peninsula, which include the largest blocks of habitats of this ecosystem group in the state, are likely to be

catastrophic. These stands are unlikely to be replaced by the development of new stands located farther inland.

Table 7 compares climate change with other existing threats.

<b>Threat</b>	<b>Rank Order</b>	<b>Comments</b>
Climate Change	1	Much of the protected acreage is in low elevation areas that are particularly threatened by rising sea level. Areas in Dare and Tyrrell Counties are already being converted to tidal communities and this effect is likely to accelerate.
Flood Regime Alteration	1	Hydrological alteration, in the form of ditches, increases the threat of rising sea level. Ditches bring tidal water into low-lying examples, causing it to penetrate inland into the nonalluvial wetlands.
Logging/Exploitation	1	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.
Invasive Species	2	Non-native plant species ( <i>e.g.</i> , Privet ( <i>Ligustrum</i> ), Japanese stiltgrass ( <i>Microstegium</i> ) are also competing with native vegetation in many areas, especially those frequently disturbed (NCWRC 2005). Several potential threats, including Chinese tallow tree ( <i>Triadica sebifera</i> ) and gypsy moth ( <i>Lymantria dispar</i> ) may become significant even if the climate does not change. Invasive species are currently a significant problem only in the rarer community types. Wet marl forest is highly threatened by invasive plants.
Conversion to agriculture/silviculture	2	The condition of nonalluvial mineral wetlands is generally poor due to alternation of hydrology (primarily from draining for farmland and conversion to loblolly pine plantation) and is rather fragmented (NCWRC 2005).

### **Summary and Recommendations**

Recommendations are to restore or maintain hydrology, protect remaining Coastal Plain nonalluvial mineral wetlands, and control invasive species in these areas in order to intervene against climate change effects. The maintenance of contiguous gradients between wetland and adjacent upland sites is critical for seasonal migration and dispersal of herpetofauna. 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.

## Recommended Actions

- Surveys
- Determine the status and distribution of priority species (NCWRC 2005).
  - Determine the status of yellow-crowned night-heron, other colonial nesting birds, Wayne's black-throated green warbler, as well as other neotropical migrants that are not well sampled by BBS.
- Monitoring
- Establish long-term monitoring for priority species (NCWRC 2005)
  - 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.
  -
- Research
- Explore alternatives (herbicides or mechanical) to using fire for the initial restoration of severely fire suppressed non-alluvial wetlands (NCWRC 2005).
  - 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.
  - Determine why some priority species use this habitat on the coast, when the same species primarily is found in the mountains using completely different habitats (*e.g.*, Wayne's black-throated green warbler, worm-eating warbler, wood frog).
- Management Practices
- Reintroduction of fire to unconverted nonalluvial mineral wetland sites is the single most important factor to restore these sites (NCWRC 2005).
  - Plowed firelines along transition zones between habitats should be rehabilitated (smoothed over) where possible. 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 (NCWRC 2005).
  - Invasive species control for existing problems and to prevent spread of new invasives.
  - Control tide water penetration and salt water intrusion with tide gates where feasible.
  - Restore hydrology to reduce risk of damaging wild fires, especially in organic soils.

- 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.

Land  
Protection

- Site protection and protection of surrounding areas through land acquisition or easements and cooperation with land trusts (NCWRC 2005).

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**Table 1. Predicted Impacts of Climate Change**

<b>Climate Change Factor</b>	<b>Comments</b>
Mild Winters	Warmer temperatures are likely to have only limited impact. Most of the species in these communities range well to the south, and their occurrence here is not limited by temperature. A few more southern species may be able to migrate into them, if the warmer winter temperatures are accompanied by a reduction in the severity of extreme cold events.
Flooding	Increased storm intensity may create local rainwater flooding but is unlikely to have much effect in these flood-tolerant communities
Fire	Droughts may increase the risk of wild fire, but most examples are not very flammable
Drought	Carolina bays and pocosins depend on precipitation and are most vulnerable to drought (Gilbert <i>et al.</i> 2012). Increased drought may allow upland species to invade, but this likely will be offset by wet periods. Drought may increase the risk of wild fire. Most of the vegetation is not very flammable, and fire is not very likely, but uncontrollable wild fire in severe drought could do substantial damage to forests.
Wind Damage	Increased hurricane and severe storm intensity would increase canopy damage. The effect of increased wind damage with climate change will exacerbate the alteration in canopy structure caused by logging.
Sea Level Rise -- Inundation	More inland examples are unlikely to be affected by rising sea level, but some may be indirectly affected by reduced drainage or rising water tables in the surrounding areas. Substantial areas are at low elevations and may be submerged or changed to other communities by rising sea level
Structural Change	Increased wind disturbance will create more canopy gaps and lower
Compositional Change	Composition changes could occur as exotic species and more southerly species are allowed to invade due to mild winters, wind damage, and sea level rise.
Acreage Change	Rising sea level will bring tidal waters into much of this area, turning it into tidal wetlands and causing a large net loss of area of nonalluvial wetlands, particularly in the northern Coastal Plain.

**Table 2. Bird Species Utilizing Coastal Plain Nonalluvial Mineral Wetlands**

Species	Common Name	Element Rank	Endemic	Major Disjunct	Extinction/Extirpation Prone	US/NC/WAP*	Comments
<b>BIRDS</b>							
<i>Anhinga anhinga</i>	Anhinga	G5/ S3B				/W2/P	
<i>Dendroica cerulea</i>	Cerulean warbler	G4/S2B				FSC/SR/P	
<i>Dendroica virens waynei</i>	Wayne's black-throated green warbler	G5TU/S2S3B	YES		YES	FSC/SR/P	Appears to be restricted to non-riverine swamp forests. Populations in the Albemarle-Pamlico Peninsula are under high threat of extirpation due to sea level rise. Populations in the southern Coastal Plain are probably more secure.
<i>Helmitheros vermivorous</i>	Worm-eating Warbler					/ /P	
<i>Limnothlypis swainsonii</i>	Swainson's warbler	G4/ S3B				/W2, W5/P	
<i>Nyctanassa violacea</i>	Yellow-crowned Night-heron					/ /P	
<i>Oporornis formosus</i>	Kentucky Warbler					/ /P	
<i>Wilsonia citrina</i>	Hooded Warbler					/ /P	

**Table 3. Mammal Species Utilizing Coastal Plain Nonalluvial Mineral Wetlands**

Species	Common Name	Element Rank:	Endemic	Major Disjunct	Extinction/Extirpation Prone	US/NC/WAP*	Comments
<b>MAMMALS</b>							
<i>Corynorhinus rafinesquii macrotis</i>	Rafinesque's big-eared bat	G3G4TNR / S3				FSC/T/	Coastal Plain subspecies
<i>Lasiurus intermedius</i>	Northern Yellow Bat					/SR/P	
<i>Lasiurus seminolus</i>	Seminole Bat					/ /P	
<i>Myotis austroriparius</i>	Southeastern Bat	G3G4/ S3				FSC/SC/P	
<i>Neotoma floridana</i>	Eastern Woodrat					/T/P	

**Table 4. Reptile Species Utilizing Coastal Plain Nonalluvial Mineral Wetlands**

Species	Common Name	Element Rank	Endemic	Major Disjunct	Extinction/Extirpation Prone	US/NC/WAP*	Comments
<b>REPTILES</b>							
<i>Cemophora coccinea copei</i>	Northern Scarletsnake					/ /P	
<i>Crotalus horridus</i>	Timber (Canebrake) Rattlesnake					/SC/P	
<i>Elaphe guttata</i>	Corn Snake					/ /P	
<i>Eumeces laticeps</i>	Broad-headed Skink					/ /P	
<i>Farancia abacura abacura</i>	Eastern Mudsnap					/ /P	
<i>Heterodon platirhinos</i>	Eastern Hog-nosed Snake					/ /P	
<i>Lampropeltis calligaster rhombomaculata</i>	Mole Kingsnake					/ /P	
<i>Lampropeltis getula getula</i>	Eastern Kingsnake					/ /P	
<i>Lampropeltis triangulum elapsoides</i>	Scarlet Kingsnake					/ /P	
<i>Masticophis flagellum</i>	Eastern Coachwhip					/SR/P	
<i>Ophisaurus mimicus</i>	Mimic Glass Lizard					/SC/P	
<i>Rhadinaea flavilata</i>	Pine Woods Littersnake					/ /P	
<i>Sistrurus miliarius</i>	Pigmy Rattlesnake					/SC/P	
<i>Tantilla coronata</i>	Southeastern Crowned Snake					/ /P	
<i>Virginia valeriae valeriae</i>	Eastern Smooth Earthsnake					/ /P	

**Table 5. Amphibian Species Utilizing Coastal Plain Nonalluvial Mineral Wetlands**

Species	Common Name	Element Rank:	Endemic	Major Disjunct	Extinction/Extirpation Prone	US/NC/WAP*	Comments
<b>AMPHIBIANS</b>							
<i>Ambystoma opacum</i>	Marbled salamander	G5/ S5				/ /P	
<i>Desmognathus auriculatus</i>	Southern Dusky Salamander					/ /P	
<i>Pseudacris brimleyi</i>	Brimley's chorus frog	G5/ S3S4				/W1/P	
<i>Pseudacris nigrita nigrita</i>	Striped Southern Chorus Frog					/ /P	
<i>Rana sylvatica</i>	Wood frog	G5/S5		Yes	Yes	/ /	A relict population of this primarily montane and northern species occurs on the Albemarle-Pamlico Peninsula, where it appears to be associated with non-riverine hardwood forests.

**Table 6. Invertebrate Species Utilizing Coastal Plain Nonalluvial Mineral Wetlands**

Species	Common Name	Element Rank	Endemic	Major Disjunct	Extinction/Extirpation Prone	US/NC/WAP*	Comments
<b>INVERTEBRATES</b>							
<i>Acrapex relictus</i>	A canebrake moth	G4/S3				/W3/	
<i>Anacamptodes cypressaria</i>	An inchworm moth	G2G4/SU				/SR/	Appears to be primarily associated with non-riverine stands of cypress
<i>Apameine, New Genus 2, Species 3</i>	A canebrake moth	GNR/S2S3				/SR/	Only known from the NC Coastal Plain and the Dismal Swamp in VA.
<i>Apameine, New Genus 4, Species 1</i>	A canebrake moth	GNR/S2S3				/SR/	Recently described as <i>Lascopia roblei</i> . Only known from the North Carolina Coastal Plain and an adjoining area of the Great Dismal Swamp in Virginia.
<i>Argillophora furcilla</i>	A cane moth	G3G4/S2S3				/W3/	
<i>Callosamia securifera</i>	Sweetbay silkmoth	G4/ S2S3				/SR/	
<i>Catocala blandula</i>	Southern pine looper	G5T3/S1S3				/W3/	Southeastern form
<i>Catocala lincolniana</i>	Lincoln underwing	G3/S2S3		YES		/SR/	
<i>Catocala orba</i>	Orba underwing	G4/ S2S3		YES		/SR/	
<i>Cerma cora</i>	A bird-dropping moth	G3G4/S2S3				/SR/	
<i>Cisthene kentuckiensis</i>	Kentucky lichen moth	G4/SU				/W3/	
<i>Cleora projecta</i>	Projecta gray (moth)	G4/S3?				/W3/	

**Table 6. Invertebrate Species Utilizing Coastal Plain Nonalluvial Mineral Wetlands**

Species	Common Name	Element Rank	Endemic	Major Disjunct	Extinction/Extirpation Prone	US/NC/WAP*	Comments
<b>INVERTEBRATES</b>							
<i>Dasychira atrivenosa</i>	A tussock moth	G4/S3?				/W3/	
<i>Dysgonia similis</i>	An owlet moth	G3G4/S2S3				/SR/	
<i>Franclemontia interrogans</i>	A noctuid moth	G3G4/S3?				/SR/	
<i>Hypomecis longipectinaria</i>	A wave (moth)	G2G4/S3S4				/W3/	
<i>Orgyia detrita</i>	A tussock moth	G3G4/S2S3				/SR/	
<i>Papaipema sp. 3</i>	Southeastern cane borer moth	G4/ S3S4				/W3/	
<i>Spilosoma dubia</i>	Dubious tiger moth	G4/ S3S4				/W3/	
<i>Tolype minta</i>	Southern tolype (moth)	G4/ S2S3				/W3/	
<i>Xestia youngii</i>	Young's xestia (moth)	G5/ S3S4				/W3/	

**\* US/ NC/ WAP Abbreviations (species are subject to reclassification by USFWS, NHP, or WRC).**

E	Endangered	SC	Special Concern	P	WAP Priority Species
T	Threatened	SR	Significantly Rare		
FSC	Federal Species of Concern	W	Watch Category		
T(S/A)	Threatened due to Similarity of Appearance				

NatureServe Element Rank: <http://www.natureserve.org/explorer/ranking.htm>

USFWS Endangered Species Listing Status: [http://www.fws.gov/raleigh/es\\_tes.html](http://www.fws.gov/raleigh/es_tes.html)

NC Natural Heritage Program Status:  
<http://www.ncnhp.org/Images/2010%20Rare%20Animal%20List.pdf>

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