Croatan Land and Resource Management Plan

Forest Plan Appendices

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APPENDIX A: Ecological Classification System – Description, Use and Application (Management Areas)

Introduction: Ecologically based land management requires classification of land into ecosystem components. The ecological classification described here organizes the landscape into units having similar topography, geology, soil, climate, and natural disturbance regimes. The premise is that these factors provide the environmental conditions that dictate biological responses, site potentials, and site limitations. The linking of biotic and abiotic elements allows for prediction of species suitability and productivity, identifies physical limitations of sites and critical habitats for wildlife, and highlights unique features of the land that might have important recreation and scientific value.

The ecological classification, mapping, and inventory system used on the CNF describes and maps ecosystems at different scales. This type of multiscale system is tied to the National Hierarchical Framework of Ecological Units, "a regionalization, classification, and mapping system for stratifying the Earth into progressively smaller areas of increasingly uniform ecological potential" (ECOMAP, 1993). In short, it provides a framework for implementing ecosystem management across physiographic regions, subregions, and local landscapes. Management is possible because individual ecosystem units can be compared with adjacent units and their patterns and relationships recognized at the landscape and land unit scales.

At the landscape scale, ecological units are termed Landtype Associations and are identified and mapped based on similarities in geomorphic processes, geologic rock types, soil complexes, stream types, lakes, wetlands, and plant association patterns. At the land unit scale, ecological units are termed Landtypes and Landtype Phases and are identified and mapped based on topographic criteria, hydrologic characteristics, soil types, and plant associations and phases. The ecological classification starts by acquiring data from resource maps on climate, geology, soils, water, and vegetation. The maps are combined along with available local knowledge to identify ecological patterns based on the relationships between the different resource components.

Important Ecological Factors on the Croatan: Terrestrial ecosystems on the Croatan are distributed along gradients controlled by landform, soil moisture, fire frequency, and fertility. Lightning ignition, which once created most fires is no longer a significant factor in the landscape. Historic erosion following widespread logging, farming, and other land-clearing during European settlement has been comparable to that in the Piedmont region (Phillips 1995). Extensive land clearing has also reduced the natural distribution of many native species. As a result of these influences, the Croatan landscape, with its complex topography and soils, has lost some of the associated complex vegetation patterns. The losses obscure the relationships among landscape, soil, and vegetation that could be used to identify ecological types.

The relationship between vegetation and its environment is crucial in any ecological classification system. While physical components such as soils and topography define environmental limits on ecosystems, plant communities define the biological potential for plants and animals. Knowing the potential of sites to support various mixtures of species is necessary for making sound decisions about management and sustainability.

The distribution of natural plant communities, or plant associations, has been used to classify land throughout the United States. Plant associations are one ecological component and used on the CNF as a point of reference to define the equilibrium reached between vegetation and its environment. The sorting out of species and communities across the landscape over time, without man's influence, reflects the role that natural processes and physical site limitations play in shaping ecosystems and allows us to better understand and describe these relationships. On the CNF we used an approximation of presettlement vegetation in evaluating these biotic and abiotic interactions.

Classifying and Mapping Presettlement Vegetation: We use the term "presettlement" to describe 'natural' or 'original' vegetation because it is more precise than "pre-Columbian", which just means before 1492. First exposure of the land to European influences came much later in most of the South. In east Florida, for instance, presettlement means before 1565; in southeastern Virginia it means before 1607, and in the southern Appalachians it means before 1800. In the Croatan region, the first settlers arrived along the Neuse River between 1667 and 1700 (Lonsdale 1967).

There is some question about what is meant by original vegetation, and, since vegetation is always in a state of change in response to disturbances or changes on some climatic scale, some question whether "original" means anything at all. This often-debated topic is addressed by Cecil Frost in his publication *Presettlement Vegetation and Natural Fire Regimes on the Croatan National Forest (1996):*

> "On a human time scale there is considerable evidence that 'original' vegetation is a valid concept. We are presently in a warm interglacial period, and for as long as genus Homo has been evolving there have been glacial cycles. With each cycle there have been major geographic displacements of species, perhaps to form somewhat different community groupings in their new latitudes (Webb 1988). Some species, like walnuts and hickories with heavy seeds, may take longer to migrate than those with light, windborne seeds, and species may be in somewhat continual adjustment at the fringes of their range, in response to minor climatic fluctuations. One possible conclusion then is that since vegetation is constantly in flux, presettlement vegetation is meaningless, as is any effort to preserve or restore examples. This is a close relative of the reasoning that concern over the extinction of species is misplaced because it is the natural course of species to arise, flourish, and then die off. This is the geological view taken to the extreme. On the time scale of human history, however, somewhat different conclusions are likely to be reached.
>
> Our southeastern plant communities began to sort out at around the same time as the beginning of recorded human history. The Wisconsin glacial epoch ended some 10,000 years age, and a climate with warm winters similar to those we now experience stabilized around 8,000 years ago. Most modern plant assemblages finished responding to these changes and have been in place for the past 6,000 years (Webb 1988). Minor Holocene climatic fluctuations like the "little ice age", a slightly cooler period from AD 1450 to 1850, have produced no substantial shifts in the major plant formations. The natural communities found by the first explorers, then, had been in place for thousands of years. The species of which these communities were composed, themselves probably the products of hundreds of thousands of years of evolution, were the survivors of a number of glacial migrations, whereas literate human civilization has yet to experience its first glaciations. Given that these natural communities existed for all of human recorded history, it seems reasonable that these are the communities that we would want to perpetuate in natural areas. Some interglacial periods have lasted a hundred thousand years, and we are only 10,000 years in the current cycle, so the idea of abandonment of presettlement natural community types is probably premature by up to 90 millennia.
>
> Neither is it appropriate to despair knowing what presettlement vegetation existed on a particular site. The goal of presettlement vegetation methods should be to get to some resolution useful at the site level."

In the Southeastern U.S., it is possible to reconstruct original vegetation and natural fire regimes, even where human land uses have radically transformed upland vegetation. Given modern soil maps as a basis for examination of vegetation, and available historical background, a close approximation of the original forest can be obtained (Frost 1997). The "Pyrographic Method of Mapping Presettlement Vegetation" (Frost 1996), which was used on the CNF, includes steps:
Assemble soil photomaps and historical data relating to disturbance and vegetation distribution.
Sample remnant natural vegetation on each of the 51 soil series found on the Croatan.
Characterize fire effects in each kind of vegetation on each soil series.
Identify fire-frequency indicator species and fire-frequency indicator plant communities.
Develop a fire-frequency map.
Use soil series to put boundaries on vegetation types.
Reevaluate in the field and adjust; the method proceeds in an iterative manner recycling through steps 4-6.

Much of the field data for analysis were collected over a period of 12 years prior to this study. Approximately 90 days were spent in the field in the Croatan, and several times this amount in surrounding counties.

A second approximation map of presettlement vegetation provided the starting point for ecological classification on the Croatan. There were 12 mappable types identified on the Croatan. They included:

1) Hardwood Forests,
2) Hardwood Slopes,
3) Longleaf Pine Forest and Savanna (xeric, dry, and mesic),
4) Longleaf Pine Wet Savanna,
5) Salt Marsh,
6) Brackish Marsh,
7) Oligohaline Marsh,
8) Maritime Forest,
9) Mixed Pine Savanna and Pyrophytic Woodland,
10) Pond Pine/Pocosin,
11) Pond Pine Forest and Savanna, and
12) Swamp Forest and Bottomland Hardwoods.

These tentative ecological types were termed "soil/vegetation" groups.

Defining Ecological Mapping Units from Soil Surveys: Each soil series was labeled with its corresponding vegetation type in a geographic information system (GIS). Since topography influences the spread and intensity of fires and therefore the potential vegetation type, there is not always a one-to-one relationship between soil series and vegetation. For example, vegetation on the well-drained Autryville loamy sand ranges broadly depending upon landscape position and degree of slope. On rolling sands in the northwestern part of the Croatan, pure longleaf pine and mixed pine stands would occur. Along the White Oak River, on more steeply sloping sites, partially protected from fire by slope and bodies of water, hardwood slope forests would occur with mixed oak, hickories, and distinctly non-pyrophytic species like red buckeye and umbrella magnolia. The GIS was used to calculate acres within each soil series/vegetation map unit. These data were combined in a database along with soil series name, drainage, surface texture, subsurface texture, soil classification, vegetation type, rare species

occurrence, and tree productivity. Data analysis and map displays revealed additional soil and vegetation correlations and patterns. Some types were aggregated into Landtypes (all Marshes), and most were further separated into Landtype Phases. Soil drainage and texture were the primary criteria used for separating types. Some examples include: Mixed Pine - separated into 5 Landtype Phases, Longleaf Pine Forest and Savanna - 3 Landtype Phases, and Pond Pine/Pocosin - 3 Landtype Phases. A total of 10 Landtype Associations, 13 Landtypes, and 26 Landtype Phases were classified and mapped in the Croatan area.

Landtype Associations (LTAs) were mapped by aggregating Landtypes. Most LTAs were identified using a variety of factors. These factors included topography (3 LTAs), stream density (2 LTAs), vegetation diversity (2 LTAs), Landtype pattern (2 LTAs), aquatic systems (2 LTAs), geology (1 LTA), and landform (1 LTA). Landtype Associations are summarized in Table 1 and described in Section 2.1.
Landtypes were based on the refinement of soil/vegetation groups using soil drainage and texture as primary design criteria. Landtypes are described in Section 2.2.
Landtype Phases were subdivisions of Landtypes based on soil organic matter, soil drainage and texture, and timber productivity. Landtype Phases are described in Section 2.2.

ECOLOGICAL CLASSIFICATION HIERARCHY

National Hierarchy of Ecological Units:

DOMAIN 200 - HUMID TEMPERATE
DIVISION 230 - SUBTROPICAL
PROVINCE 232 - OUTER COASTAL PLAIN MIXED FOREST
SECTION 232C - ATLANTIC COASTAL FLATWOODS
SUBSECTION 232Cb - LOWER TERRACES

LANDTYPE ASSOCIATION 232Cb01 - New Bern-Havelock Dissected Lowlands
LANDTYPE ASSOCIATION 232Cb02 - Central Pocosin and Lakes
LANDTYPE ASSOCIATION 232Cb03 - Stella-White Oak Dissected Lowlands
LANDTYPE ASSOCIATION 232Cb04 - Bogue-Newport Paleo Shoreline
LANDTYPE ASSOCIATION 232Cb05 - Newport River Tidal Transition
LANDTYPE ASSOCIATION 232Cb06 - Neuse River System
LANDTYPE ASSOCIATION 232Cb07 - Wet Forest-Pocosin Transition
LANDTYPE ASSOCIATION 232Cb09 - Onslow-Outer Banks
LANDTYPE ASSOCIATION 232Cb10 - Simmons Corner Wet Forest Transition
SUBSECTION 232Ch - TIDAL AREA
LANDTYPE ASSOCIATION 232Ch08 - Pamlico Terrace

Landtype Associations:

232Cb01 - New Bern-Havelock Dissected Lowlands Landtype Association

General location/description: This LTA is approximately 102,000 acres in size and occurs in Craven and Jones Counties. It occupies 15,700 acres or 10% of the Croatan National Forest.

Distinguishing features: Highly dissected landscape, clayey soils of wet places (aquults) and clayey soils not saturated > 90 days (udults) are common, high stream density, and a diverse flora with a large proportion of mixed hardwood-pine.

Primary design criteria: Topography - dissected and undissected interstream flats with low relief. Stream Density -high density with low gradient but relatively steep drainage side slopes.
Associated criteria: Soil series associations - Rains-Goldsboro-Lynchburg—nearly level, poorly drained to moderately well-drained soils with loamy or clayey subsoil, Lenoir-Craven-Leaf—nearly level and gently sloping, moderately well-drained to poorly drained soils with a clayey and loamy subsoil.
Vegetation: Potential communities - Mixed hardwood-pine, mixed wet pine (pond, loblolly, longleaf), mesic longleaf pine savannas and flatwoods, mixed mesic hardwoods (beech-oak), swamps forests, and pond pine forests.

232Cb02 - Central Pocosin Landtype Association

General location/description: This LTA is approximately 73,000 acres in size and occurs in Craven, Jones, and Carteret Counties. It occupies 63,160 acres or 38% of the Croatan National Forest.

Distinguishing features: Landscape is dominated by a very large, raised peatland having parent material consisting almost completely of decomposed plant remains and saturated with water for 6 months or more of the year (saprists). These soils are very infertile and dominated by pond pine and evergreen shrub communities.

Primary design criteria: Topography/soils - large raised peatland.

Associated criteria: Soil series associations - Croatan-Dare—nearly level, very poorly drained mucky soils on uplands having 16”-51” and > 51” of organic surface material.

Vegetation: Potential communities - High and low pocosin with occasional Atlantic white cedar forest. Evergreen shrub communities are dominated by pond pine, loblolly bay, fetterbush, zenobia, and ti-ti.

232Cb03 - Stella-White Oak Dissected Lowlands Landtype Association

General location/description: This LTA is approximately 36,000 acres in size and occurs in Jones and Carteret Counties. It occupies 15,980 acres or 10% of the Croatan National Forest.

Distinguishing features: Dissected landscape with major streams, aquults and udults, and a diverse flora with a large proportion of mesic longleaf pine, mixed wet pine (loblolly, pond, longleaf), and swamp forests.

Primary design criteria: Topography - dissected and undissected interstream flats with low relief. Stream Density - high. Diversity and complexity - diverse vegetation and complex, varied soils.

Associated criteria: Soil series associations - Rains-Goldsboro-Lynchburg—nearly level, poorly drained to moderately well-drained soils that have a loamy or clayey subsoil; Torhunta-Pantego-Rains—nearly level, very poorly drained and poorly drained loamy soils; Baymeade-Onslow-Lynchburg—nearly level to gently sloping, well drained to somewhat poorly drained, sandy and loamy soils.

Vegetation: Potential communities - dry to wet longleaf pine savannas and flatwoods, mixed wet pine/evergreen shrubs, pond pine-loblolly bay, cypress-gum swamps, and tidal marshes.

232Cb04 - Bogue-Newport Paleo Shoreline

General location/description: This LTA is approximately 33,000 acres in size and occurs in Carteret County. It occupies 16,000 acres or 10% of the Croatan National Forest.

Distinguishing features: Highly patterned landscape dominated by ridges and swales that reflect the old ocean shoreline since inundated by water. A large proportion of deep sandy, very poorly drained soils without an organic surface horizon but with a spodic horizon (aquods) and soils on well sorted sands (psamments). These sandy soils are dominated by pond pine/evergreen shrubs and longleaf pine savannas.

Primary design criteria: Landscape pattern - matrix of pocosin on mineral soil with numerous small and medium patches of pine savannas and flatwoods; extensive ridge and swale network.

Associated criteria: Soil series associations - Leon-Murville-Mandarin—nearly level to gently sloping, poorly drained, very poorly drained, and somewhat poorly drained, sandy soils that have a subsoil in which organic matter has accumulated; Wando-Seabrook-Kureb—nearly level to gently sloping, well drained, moderately well drained, and excessively drained sandy soils.

Vegetation: Potential communities - pond pine pocosin and canebrake, wet longleaf pine savannas and flatwoods, dry to xeric longleaf pine savannas, mesic longleaf pine savannas and flatwoods, and maritime live oak and yaupon.

232Cb05 - Newport River Tidal Transition Landtype Association

General location/description: This LTA is approximately 22,000 acres in size and occurs in Carteret County. It occupies 4,460 acres or 7% of the Croatan National Forest.

Distinguishing features: Landscape with a wide but short coastal river that is tidally influenced and having estuaries, swamps, and associated uplands. A large portion of aquults, udults, and black or peaty wet soils with weathered horizons in acid, sediments (humaquents).

Primary design criteria: Aquatic system - coastal, tidal river and estuaries. Disturbance - highly urbanized landscape.

Associated criteria: Soil series associations - Baymeade-Onslow-Lynchburg—nearly level to gently sloping, well drained to somewhat poorly drained, sandy and loamy soils; Masontown-Dorovan—nearly level, very poorly drained, mucky soils that are frequently flooded; Torhunta-Pantego-Rains—nearly level, very poorly drained and poorly drained, loamy soils.

Vegetation: Potential communities - mesic longleaf pine savannas and flatwoods, cypress-gum swamps, wet longleaf pine savannas and flatwoods, tidal marshes, mixed wet pines (pone, loblolly, longleaf), and pond pine forests.

232Cb06 - Neuse River System Landtype Association

General location/description: This LTA is 23,000+ acres in size and occurs in Craven and Pamlico Counties. It forms a large part of the Croatan National Forests eastern boundary but is entirely outside of the proclamation boundary.

Distinguishing features: Tidally influenced zone of a very large coastal river.
Primary design criteria: Aquatic system - coastal, tidal river with poorly developed estuary system.

Associated criteria: There are no uplands in this LTA.

Vegetation: Potential communities - oligohaline and fresh water marshes along shoreline.

232Cb07 - Wet Forest-Pocosin Transition Landtype Association

General location/description: This LTA is approximately 82,000 acres in size and occurs in Craven, Jones, and Carteret Counties. It occupies 45,160 acres or 28% of the Croatan National Forest.

Distinguishing features: A band of undissected, wet flatlands that form a perimeter around a large interior raised peatland and a transition to highly dissected lower lying uplands. A large proportion of aquults, aquepts, and saprists.

Primary design criteria: Hydrology - extensive poorly drained to very poorly drained wetlands and wetland transitions. Vegetation - dominance by pond pine forests.

Associated criteria: Soil series associations - Pantego-Torhunta—nearly level, very poorly drained soils that have a loamy subsoil; Rains-Pantego-Torhunta—nearly level, poorly drained and very poorly drained soils that have a loamy subsoil; Leaf-Bayboro—nearly level, poorly drained and very poorly drained soils that have clayey and loamy subsoil.

Vegetation: Potential communities - Pond pine-loblolly bay forests, pond pine pocosin, wet longleaf pine savannas and flatwoods, and cypress-gum swamps.

232Cb08 - Pamlico Surface Landtype Association

General location/description: This LTA is approximately 38,300+ acres in size and occurs in Craven and Carteret Counties. It occupies 710 acres or less than 1% of the Croatan National Forest.

Distinguishing features: Younger marine terrace with a large portion of aquults and gray and mottled, water saturated (aqualfs). This LTA is more properly placed in Subsection 232Ch-Tidal Area but is included here because of its very limited extent on the Croatan.

Primary design criteria: Geology - late Pleistocene to Holocene (other Croatan LTAs are late Pleistocene).

Associated criteria: Soil series associations - Altavista-Augusta-Tomotley—nearly level, moderately well drained to poorly drained soils that have a loamy subsoil, on stream terraces; Deloss-Tomotley-

Arapahoe—nearly level, very poorly drained and poorly drained, loamy soils on low marine and stream terraces.

Vegetation: Potential communities - Pond pine-loblolly bay forests, mixed mesic hardwoods (beech-oaks), pond pine pocosin.

232Cb09 - Onslow-Outer Banks Landtype Association

General location/description: This LTA is approximately 27,000 acres in size and occurs in Carteret County. It is entirely outside of the Croatan National Forest.

Distinguishing features: Active beach, barrier islands and sound. Dominance by psamments.
Primary design criteria: Landform - barrier island.

Associated criteria: Soil series associations - Newhan-Corolla-Beaches—nearly level to moderately steep excessively drained and moderately well drained to somewhat poorly drained, sandy soils and beaches, on the Outer Banks; Lafitte-Hobucken-Carteret—nearly level, very poorly drained, mucky and sandy soils, in marshes flooded frequently by salt water.

Vegetation: Potential communities - Maritime Evergreen Forest, Coastal Fringe Evergreen Forest (Schafale and Weakley 1990), live oak and yaupon, salt and oligohaline marshes.

232Cb10 - Simmons Corner Wet Forest Transition Landtype Association

General location/description: This LTA is approximately 16,440+ acres in size and occurs in Craven County. It is entirely outside of the Croatan National Forest.

Distinguishing features: Landscape with relatively small raised peatlands intermixed with very poorly drained soils supporting pond pine forests. A high proportion of aquults, aquods, and saprists.

Primary design criteria: Landscape pattern - matrix of poorly to very poorly drained sandy, loamy, and clayey soils with patches of raised peatlands.

Associated criteria: Soil series associations - Murville-Ponzer-Leon—nearly level and gently sloping, very poorly drained and poorly drained, sandy soils and nearly level, very poorly drained, organic soils, on stream terraces; Leaf-Bayboro—nearly level, poorly drained and very poorly drained soils that have a clayey and loamy subsoil; Dare—nearly level, very poorly drained soils with a > 51” organic surface.

Vegetation: Potential communities - Pond pine-loblolly bay forests, pond pine pocosin and canebrake, wet longleaf pine savannas and flatwoods, and cypress-gum swamps.

LANDTYPES and Landtype Phases - LIST

01 - TIDAL STREAMS AND ESTUARIES (landtype)

0101 - Salt and brackish marshes (landtype phase)
0102 - Brackish to oligohaline marshes
0103 - Oligohaline marshes

02 - LAKE AND STREAM SWAMPS
0204 - Deep organic stream and lake cypress-gum swamps
0205 - Mucky small stream cypress-gum swamps
03 - STREAM AND RIVER TERRACES
0306 - Partially protected, dry-mesic hardwoods on well-drained loamy sands
0307 - Very protected, mesic hardwoods on somewhat poorly drained loams
04 - DRAINAGE SLOPES
0408 - Well-drained dry-mesic hardwood slopes
0409 - Well-drained to mod. well-drained dry-mesic hardwood lower slopes
05 - DRAINAGE HEADLANDS AND INTERSTREAM FLATS
0510 - Well-drained dry-mesic mixed hardwood-pine on sands
0511 - Mod. well-drained mesic mixed hardwood-pine on loams and sands
0512 - Somewhat poorly drained mixed hardwood-pine on loams
06 - BROAD INTERSTREAM FLATS
0613 - Somewhat poorly drained mesic mixed pine on loams
0614 - Poorly to very poorly drained wet mixed pine on loams and sands
07 - PEAT-MANTLED FORESTED WETLANDS
0715 - Poorly drained pond pine forest on fine sandy and silt loams
0716 - Very poorly drained pond pine forest on fine sandy loams
08 - RAISED PEATLANDS
0817 - Low pocosin on broad, very deep peatlands
0818 - High pocosin and canebrake on broad, moderately deep peatlands
0819 - Low to high pocosin & canebrake on mucky mineral soils
09 - WET SAVANNAS AND FLATWOODS
0920 - Poorly drained longleaf pine ridges and flats on loams
0921 - Poorly drained longleaf pine ridges and flats on sands
10 - MESIC SAVANNAS AND FLATWOODS
1022 - Moderately well-drained longleaf pine flats on sands and loams
1023 - Somewhat poorly drained longleaf pine flats on sands and loams
11 - DRY-MESIC SAVANNAS
1124 - Well-drained longleaf pine ridges and flats on fine and loamy sands

12 - XERIC SAVANNAS
1225 - Excessively drained longleaf pine sand ridges

13 - MARITIME RIDGE AND DUNE FOREST
1326- Well-drained to moderately well-drained maritime oak-pine sand ridges

14 - BEACHES & DUNES (not on Forest)
15 - WATER,
16 - URBAN AREAS and other HIGHLY DISTURBED AREAS

Landtypes and Landtype Phases -Descriptions

Tidal Streams And Estuaries-01
General Description - Salt, brackish, and brackish-fresh water marshes associated with the coastal estuarine systems that are dominated by sedges, grasses, and herbs. Salt marshes occur at the lowest elevations within the LT where tidal influence is greatest. At the highest elevations within the LT, salt

influence is minimal and species diversity is higher. The LT occupies approximately 1,200 acres within the CNF boundary.

Landscape/Landform Pattern - Tidal streams are long and narrow in shape while estuaries are irregular and broad.

Disturbance - Flooding is the major disturbance. Tidal waters affect salinity and influence the distribution of communities and species along a salt tolerance gradient. These marshes originally experienced frequent fires, which started in the fire-exposed and flammable upland communities. Some marshes that are dominated by only 1 or 2 species, such as black needlerush, show large increases in species richness when burned. The marsh-upland transition also shows signs of fire suppression, being dominated in places by cedar, loblolly pine, and wax myrtle.

Rare Elements - This LT has suitable habitat for beaked spikerush, a rare plant.

Wildlife - Marshlands are an important part of the coastal ecosystems and important breeding and feeding habitat for the birds, fish, invertebrates and mammals that depend on estuarine habitat. They connect to the marsh islands south of the Forest that support wading bird rookeries and gull, tern, and skimmer colonies. Marshes on the Croatan support terns, gulls, egrets, herons, osprey, water snakes, raccoon, river otter, and marsh rabbit.

Management Considerations - Management concerns relate to protection of the important functions that these coastal estuarine systems provide, especially nutrient cycling, energy production, and habitat. Areas with regular daily lunar tides have a regular input of nutrients, which makes them highly productive. The marsh plants contribute nutrients to the estuaries benefiting fish and shellfish and provide habitat for wetland wildlife.

Variations - This LT includes 3 landtype phases (LTP) separated on differences in salinity, drainage, and vegetation.

0101 - Salt And Brackish Marshes

This LTP is strongly influenced by tidal flooding. Water salinity ranges from 5 to 35 parts per thousand. It supports dense black needle rush stands, sometimes with patches of salt grass. Sites occur in the lower White Oak River and Mill Creek at elevations less than 2 feet above sea level. Soils are predominately Hobucken muck. A small amount of Carteret sand occur in the lowest elevations.

0102 - Brackish To Oligohaline Marshes

This LTP is mostly confined to small areas near the mouths of streams and small swamp drainages. Water salinity ranges from 5 to 30+ parts per thousand. Sites are dominated by black needle rush or saltmeadow cordgrass or occasionally by big cordgrass or sawgrass. A majority of the LTP occurs along the Neuse River estuary in Cahooque Creek, Little John Creek, Gum Branch, and the White Oak River at elevations less than 2 feet above sea level. Soils are Lafitte muck.

0103 - Oligohaline Marshes

This is the largest LTP and is concentrated at the uppermost reaches of marsh along the White Oak River at elevations less than 5 feet above sea level. Water salinity varies from .5 to 5 parts per thousand. Within the marsh system in the region, over 300 species occur and most of these occur on the Croatan. Soils are Hobonny muck. A portion of this type is succeeding to trees and shrubs.

Lake And Stream Swamps-02

General Description - Cypress and hardwood swamps associated with small to moderately large streams, and nonriverine wetlands on lake margins, and upland depressions. This LT is located throughout the Croatan occurring on approximately 7,900 acres within the CNF boundary. These wetlands are seasonally to semipermanently flooded. The water table is mostly at or near the soil surface. Flow regimes are mostly variable, with floods of short to long duration and periods of very low flow. Water is colored by tannins but relatively clear, mostly very acidic, low in mineral sediment, and low in nutrients. This LT may also occur in fire-tension zones around the periphery of large peatlands, in depression ponds dominated by cypress and in small bottomland sites. The bottomland forest types were too small and complex to map.

Landscape/Landform Pattern - Swamps appear as meandering linear arms with many small tributary branches radiating out from the central raised peatland or as oval patches along lake shores.

Disturbance - Low intensity, small-scale disturbances are most common although occasional large-scale hurricanes are probable. These normally result in major losses to hardwoods. Except during years of extreme drought, these sites are protected from fire due to their wetness or position adjacent other wetlands.

Presettlement Vegetation - This LT supported a variety of swamp forest types, with mixtures of baldcypress, swamp black gum, and ash. Some of the best presettlement examples occur around the peripheries of all the Croatan lakes, where the lakes acts as a natural firebreak. Stream swamps included sweetbay, swamp redbay, ti-ti, fetterbush, coastal sweet-pepperbush, American holly, ironwood, dwarf palmetto, Virginia chainfern, netted chainfern, and sphagnum moss. Near tidal areas, eastern red cedar, wax myrtle, and cane dominated patches in the understory.

Existing Vegetation - In most areas, cypress has been removed through logging before the end of the 19th century. This led to rapid closure of the canopy by hardwoods, most notably swamp tupelo and water tupelo.

Rare Elements - Rare plants include Long's bittercress, cypress knee sedge, and mannagrass. Rare animals in or near swamps include anhinga, double-breasted cormorant, Neuse river waterdog, and American alligator.

Wildlife - This LT can provide important nesting, foraging and hiding areas for many species including black bear, numerous reptiles, red-bellied woodpecker, pileated woodpecker, barred owl, Acadian flycatcher, red-eyed vireo, northern parula warbler, black-throated green warbler, prothonotary warbler, worm-eating warbler, hooded warbler, and Swainson's warbler.

Management Considerations - Flooding occurs frequently for long periods and reduces the probability of cypress regeneration but also curtails invasion of more shade tolerant species. Stocking levels may be low, and tree growth is generally only moderate for sweetgum, oaks, and loblolly pine.

Variations - This LT includes 2 landtype phases separated on differences in soil and flooding regimes.

0204 - Deep Organic Stream And Lake Cypress-Gum Swamps

This LTP occurs on approximately 2,100 acres. Soils are Dorovan muck having organic matter 80 inches thick. Tree growth is poor in this LTP and the risk of subsidence and ground fire is significantly increased if the sites are drained.

0205 - Mucky Small Stream Cypress-Gum Swamps

This LTP occurs on approximately 5,700 acres. Soils are Masontown mucky fine sandy loam, Muckalee loam, and Bayboro mucky loam. The mucky loam surfaces are thick and overlay sands or loams. These swamps are moderately productive sites for Cypress, Sweetgum, Carolina ash, wet-site oaks, and loblolly.

Stream And River Terraces-03

General Description - This LT includes partially fire-protected terraces associated with stream swamps and rivers and dominated by mesophytic hardwoods. This LT is located in the eastern and western edges of the Croatan occurring on approximately 2,700 acres within the Forest boundary.

Landscape/Landform Pattern - The terraces are mostly low and inconspicuous. The most extensive ones are associated with the Suffolk scarp. Here and elsewhere on the Croatan the LT appears as irregularly shaped 50-300 acre patches dissected by streams.

Disturbance - Disturbance regimes include frequent, windthrow gaps of one or a few overstory trees and periodic larger-scale disturbances in the form of hurricanes. Under natural fire regimes, fire frequency was between 7-12 years. Significant erosion has been reported on Norfolk soils in this LT (Phillips 1995).

Presettlement Vegetation - This LT was dominated by hardwoods distributed according to a fire-effects gradient. Historical accounts mention upland oaks and hickories on fire protected sites only. On sites completely protected from fire, beech was dominate although these same soils in other fire exposed landscapes would be dominated by longleaf pine. In less fire exposed areas, white oak, southern red, pignut hickory and mockernut hickory were common.

Existing Vegetation - With modern fire suppression, there has been a general increase in the proportion of hardwoods to pines, across all soils and landscape positions. Current forest composition in this LT is variable and may include sites dominated by American beech, tulip poplar, bitternut hickory, pignut hickory and white oak. Understory trees include hop hornbeam, American holly, flowering dogwood, blue beech and sourwood while understory herbs include horse sugar, christmas fern, southern lady fern, partridgeberry, and indian cucumber-root.

Rare Elements - No rare plants have been documented in this LT. Rare animals in or near terraces include pine barrens treefrog, Carter's Noctuid moth, and Southeastern cane borer moth.

Wildlife - This LT can provide habitat for a significant number of wildlife species including southern toad, eastern box turtle, black bear, wild turkey, black-throated green warbler, worm-eating warbler, barred owl, red-eyed vireo, ovenbird, yellow-billed cuckoo, red-bellied woodpecker, downy woodpecker, pileated woodpecker, white-breasted nuthatch, Acadian flycatcher, blue-gray knatcatcher, wood thrush, prothonotary warbler, hooded warbler, summer tanager, and Kentucky warbler.

Management Considerations - Little to no timber management has occurred in this LT during the last 50 years because the hardwoods were considered of low commercial value in comparison to pines and had a higher value as wildlife habitat. There are opportunities for restoration of the hardwoods within the LT on sites that have been converted to loblolly pine.

Variations - This LT includes 2 landtype phases separated on differences in drainage and site protection.

0306 - Partially Protected, Dry Mesophytic Hardwoods On Well-Drained Loamy Sands

This LTP occurs on partially fire-sheltered sites on well-drained soils with mostly sandy subsoil horizons. Soils include: Autryville loamy sand, Norfolk loamy fine sand, State loamy sand, Kenansville loamy fine sand, and Conetoe loamy sand. Included here are also small fire-protected islands on excessively drained Alpin fine sand where fire is important but limited to light surface types. Some of these areas support pyrophytic woodlands and mixed oak-pine types. Productivity of oaks, loblolly pine, and longleaf pine is moderate on sites where soils have not been severely eroded.

0307 - Very Protected, Mesophytic Hardwoods On Mod. Well-Drained To Poorly Drained Loams

This LTP occurs on highly fire-sheltered sites on soils with clayey subsoil horizons. Soils include poorly drained Tomotley fine sandy loam, somewhat poorly drained Altavista fine loamy sand, and moderately well-drained Augusta fine sandy loam. Productivity of oaks, sweetgum, and loblolly pine is high while productivity of longleaf pine and pond pine is moderate.

Drainage Slopes-04

General Description - This LT includes slopes between drainages and uplands dominated by dry-mesic and mesic hardwoods. The LT is small in extent and located in peripheral areas of CNF. It occurs on approximately 1,000 acres within the Forest boundary. The most extensive sites are along the White Oak River, Holston Creek, and Cahooque Creek.

Landscape/Landform Pattern - Although many sites are too small to map, the type is conspicuous on the ground. It consists of narrow sinuous bands on rolling slopes along drainages in highly dissected topography.

Disturbance - Disturbance regimes include frequent, windthrow gaps of one or a few overstory trees and periodic larger-scale disturbances in the form of hurricanes. Most fires reaching this LT are backing fires originating from the uplands. The steep slopes restrict fire flow. The modest degree of fire protection offered by the slopes leads to small narrow bands of forests transitional between the better-protected stream terraces and the fire-exposed uplands. Significant erosion from past land clearing and agriculture has been reported in the Norfolk and Craven soils in this LT (Phillips 1985).

Presettlement Vegetation - In presettlement forests, there were few areas of natural mesophytic upland hardwood on the CNF except for ravines like Island Creek, a few uplands isolated by swamps, and narrow bands of rolling slopes along streams. Typical species were white oak, mockernut hickory, pignut hickory, swamp white oak, cherrybark oak, and beech.

Existing Vegetation - Dry-Mesic Oak-Hickory or Basic Mesic Forests (Schafale and Weakley 1990) where white oak, black oak, pignut hickory, and red hickory dominate. Herbs are usually sparse and include heartleafs, downy rattlesnake orchid, pipsissewa, woodland tick-trefoil, and rattlesnake hawkweed.

Rare Elements - Rare species include eastern diamondback rattlesnake and Carolina spleenwort.
Wildlife - This LT can provide habitat for a significant number of wildlife species similar to those found in the adjacent stream terraces. These include southern toad, eastern box turtle, black bear, wild turkey, red-eyed vireo, ovenbird, yellow-billed cuckoo, red-bellied woodpecker, downy woodpecker, pileated woodpecker, white-breasted nuthatch, Acadian flycatcher, blue-gray knatcatcher, wood thrush, prothonotary warbler, hooded warbler, summer tanager, Kentucky warbler, and barred owl.

Managements Considerations - Little to no timber management has occurred in this LT during the last 50 years, the hardwoods being considered of low commercial value in comparison to pines and having a higher value as wildlife habitat. The slopes are relatively gentle and would not restrict equipment use. Many silvicultural systems for managing hardwoods have proven successful elsewhere and could be used to maintain and improve wildlife habitat in this LT.

Variations - This LT includes 2 landtype phases separated on differences in soil drainage.

0408 - Well-Drained Dry-Mesic Hardwood Slopes

This LTP occurs on somewhat fire-sheltered sites on well-drained soils with loamy sand, surface horizons. They include: Autryville loamy sand, Suffolk loamy sand, and Norfolk loamy fine sand. This LTP occurs on all slope positions. Productivity of oaks, loblolly pine, and longleaf pine is moderate.

0409 - Well-Drained To Mod. Well-Drained Mesic Hardwood Toeslopes

This LTP is very limited in size, occupying less than 25 acres on the Forest. It occurs on somewhat fire-sheltered sites on the moderately well-drained Craven silt loams. This LTP is more oriented to lower slope positions.

Drainage Headlands And Interstream Flats-05

General Description - This LT includes dissected headlands and undissected interstream flats dominated by mixed mesic pine-hardwoods. It is located on the periphery of the CNF occupying approximately 2,300 acres within the Forest boundary.

Landscape/Landform Pattern - Irregular shaped patches hundreds of acres in size. They have more undulating boundaries at the head of drainages where they are dissected by stream tributaries. Between and above drainages they are typically not dissected by stream tributaries and appear broader.

Disturbance - This LT occurs along the broad middle section of the fire frequency/fire effects continuum which ranges from pure longleaf pine, to mixed pine savanna, to somewhat fire-protected

woodlands, to very fire-sheltered forests. Fire was the most common disturbance in this LT and its frequency was variable, probably ranging from every 5 to 12 years. Most of the better soils (finer textured sands and loams) within this LT were converted to agriculture 100 to 200 years ago.

Presettlement Vegetation - This LT supported mixed pine savannas that included hardwoods and the 4 most common pine species on the Croatan, pond pine, longleaf pine, loblolly pine, and shortleaf pine.

Existing Vegetation - Only small remnants of mixed pine-hardwood persist today. In the past, many of these sites were considered loblolly sites, and fire-suppressed or actually converted to loblolly.

Rare Elements - Rare plants include Carolina asphodel, sessile yellow stargrass, Venus's flytrap, scale-leaf gerardia, Carolina triodia, spike triodia, and spring-flowering goldenrod. Rare animals in or near this LT include; red-cockaded woodpecker, and Florida Adder's moth.

Wildlife - Common species include: red-eyed verio, ovenbird, yellow-billed cuckoo, red-bellied woodpecker, downy woodpecker, pileated woodpecker, eastern wood-pewee, brown-headed nuthatch, eastern bluebird, pine warbler, common flicker, bobwhite quail, and eastern screech-owl.

Managements Considerations - Management concerns in this LT relate to past site degradation due to farming and subsequent erosion. Significant erosion from past land clearing and agriculture has been reported in the Norfolk and Craven soils especially along Pine Cliff Road and at Island Creek (Phillips 1985). The relatively high potential site productivity in this LT may have been reduced through truncation of surface soil horizons. These soils may also compact when wet, causing deep ruts, poor surface drainage, and lower productivity.

Variations - This LT includes 3 landtype phases separated on differences in soil drainage and texture.

0510 - Well-Drained Dry-Mesic Mixed Pine-Hardwood On Sands

This LTP occurs on interfluvs and drainage headlands with well-drained soils having a clay loam or sandy loam subsoil. They include: Norfolk loamy fine sand, State loamy sand, Autryville loamy sand, and Conetoe loamy sand. Minor components of Seabrook loamy sand are also included. Loblolly pine and longleaf pine productivity is moderately high; pond pine is low, and oaks and sweetgum productivity is moderate to high.

0511 - Moderately Well-Drained Mesic Mixed Pine-Hardwood With Clayey Subsoils

This LTP occurs on broader interfluvs with moderately well-drained sandy and loamy soils with silty clay or sandy clay subsoils. They include: Goldsboro loamy fine sand, Craven silt loam, Exum very fine sandy loam, and Altivista fine loamy sand. Productivity of longleaf pine, sweetgum, and oaks is high; loblolly productivity is very high.

0512 - Somewhat Poorly Drained Mixed Hardwood-Pine With Clayey Subsoils

This LTP occurs on broad interfluvs with somewhat poorly drained loamy soils with clayey subsoils. They include Nahunta loam, and Augusta fine sandy loam, and small amounts of Johns fine sandy loam. Productivity of loblolly pine and pond pine is high while only moderate for sweetgum and oaks.

Broad Interstream Flats-06
General Description - This LT includes wet, undissected uplands dominated by mixed pines. It is located throughout the Croatan, occupying approximately 8,000 acres.

Landscape/Landform Pattern - Irregular shaped patches from fifty to hundreds of acres in size situated between and above drainages; typically not dissected by stream tributaries. Where stream density is high, this LT appears long and broad and lies adjacent to more well-drained interstream flats or ridges.

Disturbance - Fire was the most common disturbance in this LT and its frequency was variable, probably ranging from every 5 to 12 years. Historically, these moist mineral flats, too wet to farm, were logged, grew up in loblolly pine, and were fire suppressed. Today, hurricanes may cause extensive damage in the overstocked older loblolly stands in this LT.

Presettlement Vegetation - This LT supported mixed pine savannas and flatwoods that included pond pine, longleaf pine, and loblolly pine. It would have experienced fire at only slightly lower frequency than longleaf pine flatwoods, and still would have been a two-layered community, with trees over grass.

Existing Vegetation - Only small remnants of mixed pine savanna persist today. They are hard to distinguish from fire-suppressed former longleaf pine communities that have been logged and invaded by other pine species. Most are dominated by loblolly pine and pond pine with a dense tall shrub and hardwood layer in the understory. Understory species include inkberry, sweetgum, and water oak. Some of the more heavily stocked loblolly pine stands on the CNF occur in this LT.

Rare Elements - Rare plants include Venus's flytrap, whorled loosestrife, Carolina asphodel and spring-flowering goldenrod. Rare animals in or near these broad flats include; red-cockaded woodpecker, Bachman's sparrow, and mimic glass lizard. This LT and the LT-05 have the highest occurrence of spring-flowering goldenrod on the CNF, a species adapted to wet and open conditions.

Wildlife - Common species include: eastern wood-pewee, brown-headed nuthatch, eastern bluebird, pine warbler, common flicker, bobwhite quail, and eastern screech-owl.

Managements Considerations - Management concerns in this LT relate to site wetness and operability, midstory competition, and hurricane damage. Equipment use may be limited to only the drier months since the clayey subsoils on these wet sites are prone to compaction. Site wetness may also limit regeneration of longleaf pine.

Variations - This LT includes 2 landtype phases separated on differences in soil drainage.

0613 - Somewhat Poorly Drained Mesic Mixed Pine On Loams

This LTP occurs on interfluvs with somewhat poorly drained soils having clayey subsoils. They include: Lenoir silt loam and Lynchburg fine sandy loam. Productivity of loblolly pine is very high, while only moderate for longleaf pine, pond pine, oaks, and sweetgum. Compaction may be a concern in the Lenoir soils. Logging when the soil is wet causes compaction that may lead to reduced productivity.

0614 - Poorly Drained Wet Mixed Pine On Loams And Sands

This LTP occurs on broad interfluvs with poorly drained soils with clayey or sandy subsoils. They include: Rains fine sandy loam and Leon sand, and small amounts of Arapahoe fine sandy loam. The Rains is the wettest loam soil that can support longleaf pine. Productivity of loblolly and pond pine is high, while only moderate for longleaf pine, oaks, and sweetgum.

Peat-Mantled Forested Wetlands-07

General Description - This LT includes broad, peat mantled uplands dominated by pond pine. It is located throughout the CNF occupying approximately 31,000 acres, the second largest LT on the Forest.

Landscape/Landform Pattern - This type appears as wide crescents partially encircling the broad, domed peatlands. In the upland interstream zones, this LT is more irregular in shape and is confined by stream courses.

Disturbance - The larger pond pine in this LT was extensively logged at the turn of the century. Cutover sites were quickly reforested since pond pine regenerates by epicormic and basal sprouts as well as by seed from serotinous cones. Under presettlement fire regimes, pond pine forests burned nearly as frequently as the adjacent and often intergrading longleaf pine forest. These forests are considered fire dependent and in the absence of fire may eventually be replaced by hardwoods (Harms 1996).

Presettlement Vegetation - This LT supported a pond pine complex comprising a distinct group of forest and wet savanna communities. Pond pine may have been originally the most abundant pine on the CNF, and there were probably a dozen different pond pine-dominated communities (Frost 1996). Stands of large trees with open to partially closed canopies would have been typical in this LT. Where frequent fires occurred over a long time period, the pond pine forest understory was dominated by giant cane, with few shrubs (Schafaly and Weakley 1990).

Existing Vegetation - Fire suppression has led to dense forest conditions with a thick tree and shrub midstory on most sites. Most pond pine forests in this LT have nearly closed pond pine canopies, sometimes codominant with loblolly bay. Sweet bay, red maple, loblolly pine, and swamp red bay may also be common. The shrub layer is tall (up to 15 feet) and very dense. Shrubs include ti-ti, fetterbush, maleberry, gallberry, inkberry, blue huckleberry, and coastal sweet-pepperbush. Blaspheme-vine is usually abundant. Herbs are generally of low cover or absent.

Rare Elements - Rare plants include spoonflower and Fitzgerald's peatmoss. Rare animals in or near these wetlands include: red-cockaded woodpecker, American alligator, Carolina gopher frog, and Croatan crayfish.

Wildlife - Black bear, marsh rabbit, cottontail, gray squirrel, white-tailed deer, bobcat, gray fox, raccoon, and opposum, pine warbler, eastern wood-pewee, brown-headed nuthatch, Carolina chickadee, white-eyed vireo, prairie warbler, downy woodpecker, hairy woodpecker, prothonotary warbler, common yellowthroat, wooded warbler, eastern screech-owl, and worm-eating warbler.

Managements Considerations - Management concerns in this LT relate to forest community identification, site wetness and operability, and midstory competition. These wet mineral soils can support numerous vegetation types depending upon slight differences in moisture and degree of

protection from fire. Composition may range from pond pine forest, to pond pine savanna, to mixed pine savanna, to wet longleaf pine. In addition, a further complication in site identification occurs where a humic layer is found on these soils. In many cases, this organic layer is an artifact of fire suppression or repeated winter burns. There are seasonally severe equipment limitations due to extreme site wetness. In addition, Leaf soils which comprise approximately 14% of this LT may compact when wet, causing deep ruts, poor surface drainage, and lower productivity.

Variations - This LT includes 2 landtype phases separated on differences in soil drainage and texture.

0715 - Poorly Drained Pond Pine Forests On Fine Sandy And Silt Loams

This LTP occurs on broad flats and depressions in uplands on poorly drained soils having loamy subsoils. They include: Leaf silt loam and Grantham silt loam. Productivity of loblolly pine and pond pine is high and moderate for oaks and sweetgum.

0716 - Very Poorly Drained Pond Pine Forests On Fine Sandy Loams

This LTP occurs on broad flats and depressions in uplands on very poorly drained soils having loamy subsoils. They include: Pantego fine sandy loam, Torhunta mucky fine sandy loam, Arapahoe fine sandy loam, and Deloss fine sandy loam. Productivity of pond pine is high, moderate for loblolly pine, oaks, sweetgum, and low for longleaf pine.

Raised Peatlands-08

General Description - This LT includes peatlands, known as pocosins, that have very deep organic soils, moderately deep organic soils, or poorly drained mineral soils with a mucky surface. It is located throughout the CNF occurring on approximately 74,000 acres and is significantly larger in size than all other LTs. Bog expansion caused by the gradual rising of the water table as peat accumulates has proceeded for several thousand years in these broad interstream areas in which natural drainage was blocked (Daniel 1981, Richardson and others 1981). Today, on the most well developed CNF peatland areas, stunted pond pine occurs with dense, short evergreen shrubs on 2 to 4 feet of white cedar peat overlain with 4 to 5 feet of pocosin peat.

Landscape/Landform Pattern - Most of the larger pocosins of the LT are characterized as broad dome-shaped surfaces.

Disturbance - Historically, vegetation in this LT was burned at regular 2-4 year intervals similar to the adjacent uplands. Overlapping fires are common and may occur in successive years since the blackened but unburned woody stems form part of the fuel for the next burn. Although the water table is high and the soils may frequently be saturated, pocosins occasionally become dry enough to burn and some of the organic surface may be lost in combustion.

Ditching, drainage, and conversion to pine plantations has occurred in some portions of this LT within the Croatan, but significantly less than outside the Croatan. Drainage ditches can alter peatland hydrology for long periods and affect fire regimes in their immediate vicinity. Recent studies have shown that organic soils in the zone adjacent to drainage ditches have a greater probability of igniting during wildfire conditions (Otmar, Bucher 1996). The risk of igniting organic soils during prescribed burning operations also appears to be greater along the old and extensive drainage system in pocosins adjacent the to Catfish Lake Road (Cherry 1997).

Presettlement Vegetation - These communities were dominated by fetterbush, ti-ti, and zenobia with scattered pond pine and loblolly bay. Most of the pocosins were kept to low or medium stature by frequent fire. There is considerable evidence that some of the low pocosins once burned often enough to maintain them in a more open nearly treeless, bog-like condition, with grasses, pitcher plants, and orchids in addition to the dwarfed shrubs (Emmons 1860, Ruffin 1861).

Existing Vegetation - In general, the stature of trees and shrubs in peatlands has increased and obscured the natural patterns of vegetation structure and controlled by nutrient gradients in these systems. Increases have also occurred in the acreage of bay forest, dominated by swamp red bay, loblolly bay, and sweet bay. On the shallower peats, pond pine may form closed canopy woodlands that resemble the Pond Pine Forest community type. Blaspheme vine, loblolly bay, and ti-ti grow to dense and impenetrable thickets.

Rare Elements - Within the pocosin and pine sand lens complex, rare plants include branched gerardia, Fitzgerald's peatmoss, shadow-witch, spoonflower, venus fly trap, Carolina asphodel, Carolina goldenrod, Chapman's arrowhead, feather-bristle beakrush, ponspice, rough-leaf loosestrife, small butter wort, and stalked milkweed; rare animals include American alligator, eastern cougar, mimic glass lizard, argos skipper, Bachman's sparrow, Berry's skipper, Croatan crayfish, two-spotted skipper, and red-cockaded woodpecker. Although no animal species has been recognized as a true pocosin endemic, this system may provide critical habitat for the pine barrens treefrog, spotted turtle, and Dismal Swamp southeastern shrew.

Wildlife - This LT provides valuable habitat for many wildlife species partly because, in some areas, this may be the only habitat available. Black bear, marsh rabbit, cottontail, gray squirrel, white-tailed deer, bobcat, gray fox, racoon, opposum, river otter, mink, and muskrat can be found. Many bird species in the region feed or nest in tall evergreen shrub bogs including bobwhite quail, mourning dove, American woodcock, common yellowthroat, rufus-sided towhee, gray catbird, prairie warbler, white-eyed vireo, hooded warbler, worm-eating warbler, Carolina wren and northern cardinal.

Managements Considerations - Most management concerns in this LT relate to wildfire suppression, impacts to rare species in ecotones, and prescribed burning. Fire suppression during the last 50 years has led to a severe build up of volatile fuels in much of this LT. The ecotones between pocosin and uplands constitute the most significant rare plant habitat on the CNF. These are also the parts of the landscape most vulnerable to damage from fire plows. Recent fire research work on the CNF has shown that the window for safe burning in the pocosins may be greater than previously thought (Otmar 1996)

Variations - This LT includes 3 landtype phases separated on differences in organic layer depth and vegetation stature.

0817 - Low Pocosins On Broad, Very Deep Peatlands

This LTP occurs on approximately 16,000 acres on very poorly drained Dare muck. Typically the soil is organic matter 60 inches thick. The Dare series are the classic pocosin soils, with vegetation stature under the original fire regime mostly limited to dwarf forms by the combination of extreme infertility and fire. In the LTP, Atlantic white cedar occurs in a few clumps around the periphery of some of the lakes.

0818 - High Pocosins And Canebrakes On Broad, Moderately Deep Peatlands

This LTP occurs on approximately 46,000 acres on very poorly drained Croatan muck thay has a 16-51 inch organic surface layer. Vegetation is considered high pocosin with a dense shrub layer 5 to 15 feet tall, except when recovering from recent fire (Schafale and Weakley 1990). The overstory is scattered pond pine and loblolly bay from 20-40+ feet in height. When fire is excluded for long periods of time, they may form a temporary dense canopy. Canebrake, once one of the principal and most extensive vegetation types of presettlement coastal peatlands and fluvial bottomlands, can still be found in this LTP especially on the periphery of the deeper pocosins where nutrients are not as limited; opportunities for its restoration are good in this LTP.

0819 - Low To High Pocosins And Canebrakes On Mucky Mineral Soils

This LTP occurs on approximately 13,000 acres on very poorly drained Murville mucky sand and Bayboro mucky loam. These soils are not organic and therefore there is a low risk of soil ignition, however, they are often associated with deeper organic soils. Murville soils form a large matrix in management area 4 that is scattered with small to medium-sized sand lenses that support longleaf pine. Vegetation in this peatland matrix is typically medium to tall pocosin. The Bayboro occurs as wide bands around the periphery of the large peatlands. Vegetation grades into tall pocosin and pond pine forest in the slightly more fertile situations where this series is bordered by mineral soils.

Wet Savannas And Flatwoods-09

General Description - This LT includes poorly drained savannas and flatwoods dominated by longleaf pine. It is located through the CNF occurring on approximately 11,000 acres within the Forest boundary.

Landscape/Landform Pattern - This type occurs as narrow, linear patches in ridge and swale topography, linear sand lenses within large peatlands, and larger, irregular patches associated with more upland sites.

Disturbance - The major disturbance is frequent low intensity fire at intervals of 2 to 4 years. Under natural fire regimes, fires occurred early in the growing season. Other disturbances include lightening, wind events from tornadoes, tropical storms, and microbursts; periodic droughts may result in intense fire.

Presettlement Vegetation - This LT supported communities defined as savannas and flatwoods. In southeastern fire-adapted communities the term savanna applies to any fire-maintained bilayered community in which the two layers are a tree layer with up to 50% cover, over a continuous, usually grassy herb layer (Frost, Walker and Peat 1986). The term “flatwoods” has been used for just about any Coastal Plain pine forest with a well-developed woody understory, and it is also occasionally used for communities lacking a woody understory. Savannas are generally more open and have a grassy understory while flatwoods have an open to nearly closed canopy with a mixed woody and grassy understory. A low shrub layer of varying density is present in flatwoods and consists of inkberry, blue huckleberry, dwarf huckleberry, sweet bay, and red bay. The herb layer is dominated by wiregrass and bracken fern. Savannas have only scattered inkberry, blue huckleberry, and creeping blueberry. The herb layer is generally dense and diverse. Wiregrass, bushy broomsedge, savanna muhly, and toothache grass usually dominate.

Existing Vegetation - Many of these moist communities, which were truly open savannas under the natural fire regime, have become shrubby or densely wooded as a result of fire suppression. Species diversity in the understory and has been significantly reduced. On many sites, loblolly pine and hardwoods now dominate in the absence of fire. With longer fire suppression some pine savannas may succeed to pond pine woodland.

Rare Elements - Pine savannas are notable for their high plant species richness on a small scale (Walker and Peet 1983) and their large number of rare species. Rare plants include Carolina goldenrod, yellow fringeless orchid, branched gerardia, Carolina asphodel, dwarf bladderwort, Leavenworth's goldenrod, line bulrush, long-beak bald-sedge, pondspice, rough-leaf loosestrife, savanna yellow-eyed grass, shortbristled beakrush, small butterwort, southern bogbutton, spring-flowering goldenrod, stalked milkweed, Venus flytrap, and West Indies meadowbeauty. Rare animals include red-cockaded woodpecker, Bachman's sparrow, mimic glass lizard, and American alligator.

Wildlife - Common flicker, eastern wood-pewee, brown-headed nuthatch, eastern bluebird, pine warbler, bobwhite quail, eastern screech-owl, and Henslow's sparrow.

Management Considerations - These are the wettest soils that longleaf pine can occur on. Slightly greater wetness and organic matter, that may occur even within this ecological type, will discourage longleaf pine and favor pond pine and loblolly pine. Seasonal wetness may also limit equipment use. Periodic fire and reduction of plows lines in ecotones is necessary for maintenance of rare plant and animal species that occur in this zone. Schneider (1988) found that in general spring and summer fires favored grass dominance while fall fires favored shrubs more.

Variations - This LT includes 2 landtype phases separated on differences in soil texture.

0920 - Poorly Drained Longleaf Pine Ridges And Flats On Loams

This LTP occurs on approximately 5,000 acres on the poorly drained Rains fine sandy loam and Woodington fine sandy loam. Longleaf pine and loblolly pine productivity is moderate while pond pine productivity is high.

0921 - Poorly Drained Longleaf Pine Ridges And Flats On Sands

This LTP occurs on approximately 6,500 acres on poorly drained Leon sand. Low-lying areas are subject to flooding, however, this soil may be droughty during the growing season. Longleaf pine and loblolly pine productivity is low to moderate while pond pine productivity is moderate.

Mesic Savannas And Flatwoods-10

General Description - This LT includes moderately well-drained to somewhat poorly drained savannas and flatwoods dominated by longleaf pine. It is located throughout the CNF, occurring on approximately 12,200 acres within the Forest boundary.

Landscape/Landform Pattern - Most sites are Irregular in shape and vary in size from tens to thousands of acres in size. They are most often in a mosaic consisting of medium-sized patches with other longleaf pine dominated LTs and also as small patches in a matrix of pocosin and pond pine forests.

Disturbance - Much of the former longleaf pine lands had been cut over in the early to mid-1800s. In presettlement forests, the major disturbance was frequent low intensity fire at intervals of 2 to 4 years. Under natural fire regimes, fires occurred early in the growing season. Other disturbances include lightening, wind events from tornadoes, tropical storms, and microbursts, and periodic droughts that may result in intense fire (Landers and Boyer in Draft).

Presettlement Vegetation - This LT supported communities defined as Pine Savannas and Mesic Flatwoods by Schafale and Weakley (1990). On the more mesic loam soils in this LT, frequent burning created pure longleaf pine dominated stands with dense wiregrass and high species diversity in the herb layer. Understory species in addition to wiregrass included bracken fern, little bluestem, skeleton grass, switch cane, green sicklescale, pitchfork crown grass, yellow Indian grass, big bluestem, roundhead bushclover, summer farewell, flowering spurge, and sweet goldenrod. On the less fertile Mandarin sands within this LT, species diversity was less and dwarf huckleberry and blueberry were frequent codominants with wiregrass in the herb layer.

Existing Vegetation - Nearly all the loam soils that comprise this LT have long been farmed or converted to loblolly pine, especially outside the CNF. Fire suppression has also led to changes in community structure and composition. Sites in this LT are the most prone to undergo rapid succession from longleaf pine to pond pine, loblolly pine and hardwoods with reduction in fire frequency. Understory trees may be dense and include Southern red oak, black oak, post oak, blackjack oak, turkey oak, sand hickory, mockernut hickory, and sweetgum.

Rare Elements - This LT supports numerous rare species. Rare plants include branched gerardia, Carolina goldenrod, feather-bristle beakrush, Georgia nutrush, giant spiral orchid, graceful goldenrod, Hooker's milkwort, scale-leaf gerardia, spring-flowering goldenrod, and venus's flytrap. Rare animals include red-cockaded woodpecker, Bachman's sparrow, American alligator, Croatan crayfish, and Carolina gopher frog.

Wildlife - Flicker, red-headed woodpecker, eastern wood-pewee, brown-headed nuthatch, pine warbler, bobwhite quail, and eastern screech-owl.

Management Considerations - These are some of the most productive longleaf pine sites on the CNF and the most altered from past land use practices. They have some of the greatest potential for improvement and greatest number of management options. Frequent fire is necessary to maintain savanna structure and control competing shrubs and trees. This LT has the most opportunities for restoration of longleaf pine on sites where it was once dominant.

Variations - This LT includes 2 landtype phases separated on differences in soil drainage.

1022 - Moderately Well-Drained Longleaf Pine Flats On Sands And Loams

This LTP occurs on approximately 7,600 acres on moderately well-drained Onslow, Goldsboro, and Craven soils. Longleaf pine productivity is higher in this LTP than in all other ecological types. Loblolly pine, pond pine, and sweetgum productivity is moderate to high.

1023 - Somewhat Poorly Drained Longleaf Pine Flats On Sands And Loams

This LTP occurs on approximately 4,700 acres on somewhat poorly drained Lynchburg fine sandy loam, Mandarin sand, and Stallings loamy fine sand. Productivity of longleaf pine, loblolly pine, pond pine, and sweetgum is moderate.

Dry-Mesic Savannas-11

General Description - This LT includes dry-mesic savannas associated with well-drained sands and dominated by longleaf pine. It is located in the southern and southeastern portion of the CNF occurring on approximately 2,100 acres within the Forest boundary.

Landscape/Landform Pattern - Sites are irregularly shaped and variable in size, most often occurring as narrow to broad bands associated with small to medium-sized streams or as linear patches associated with ridge and swale topography.

Disturbance - The major disturbance is frequent low intensity fire at intervals of 2 to 4 years. Under natural fire regimes, fires occurred early in the growing season. Other disturbances include lightening, wind events from tornadoes, tropical storms, and microbursts.

Presettlement Vegetation - This LT supports communities defined as savannas or open flatwoods and shares vegetative characteristics with Schafale and Weakley's (1990) Xeric Sandhill Scrub and Mesic Pine Flatwoods. They are intermediate in composition between xeric and mesic longleaf pine savannas. Typical sites were dominated by a somewhat open longleaf pine canopy and moderately dense wiregrass understory. Bluejack oak, a characteristic species on these sites, commonly occurred only as scattered individuals. Other species included dwarf huckleberry, thread-softly, big bluestem, little bluestem, sweet goldenrod, stiffleaf aster, and summer farewell.

Existing Vegetation - Fire suppression has led to changes in community structure and species diversity. Although succession is much slower in this LT than on more mesic sites, the midstory can become very dense where sites are fire-suppressed for long periods (> 10 years). Under these conditions, a multilayered subcanopy can develop that is dominated by southern red oak, loblolly pine, turkey oak, and bluejack oak. Such prolonged exclusion of fire may lead to dense pine needle and oak leaf litter accumulation up to one foot deep, and completely eliminate the herb layer.

Rare Elements - This LT has fewer rare species than others that support longleaf pine communities. Rare plants include Carolina asphodel and Venus's flytrap. Rare animals include red-cockaded woodpecker, Bachman's sparrow, and Carolina gopher frog.

Wildlife - This LT can provide nesting and foraging habitat for the same species that occur in Xeric Savannas (LT 12) if fire is frequent. Species include common flicker, red-headed woodpecker, eastern-wood pewee, brown-headed nuthatch, yellow throated vireo, pine warbler, Chuck-will's-widow, summer tanager, chipping sparrow, bobwhite quail, and Eastern screech-owl.

Management Considerations - Management emphasis should be on maintaining a regular fire regime of understory burning. Although sites have rather low fertility, the litter layer is normally continuous and fires carry well through the stand. If hardmast production is considered critical under a short interval

prescribed burning schedule, then special precautions (wet lines, backburning) may be necessary to maintain a significant component of turkey oak and bluejack oak.

Variations - This LT has not been separated into phases but occurs on 3 soils. They include, the Baymeade fine sand, Marvyn loamy sand, and State loamy fine sand. This LT has the second lowest productivity of all ecological types supporting longleaf pine. Height growth increment in longleaf pine, loblolly pine, and pond pine is only moderate.

Xeric Savannas-12

General Description - This LT represents xeric savannas on excessively drained sands dominated by longleaf pine. This LT is located in the southern portion of the CNF on approximately 1,100 acres within the Forest boundary.

Landscape/Landform Pattern - These savannas are irregularly shaped and variable in size. The most contiguous block at Patsy Pond occurs on an old beach ridge system.

Disturbance - Early use of longleaf pine in this LT for turpentine production during the colonial era was followed by widespread logging near the turn of the century. Abandoned turpentine orchards in the Kureb sands along Highway 24 were logged in 1897. Pinchot and Ashe (1915) noted that "along the great sand hills just within the sounds, the longleaf pine occurs in open forests of small trees, now largely removed".

Natural disturbances include lightening, and wind events from tornadoes and tropical storms. Under natural fire regimes, the major disturbance consisted of frequent low intensity fires at intervals of 2 to 4 years. However, the most xeric and barren sites may have produced too little fuel to sustain extensive fires at this frequency.

Presettlement Vegetation - This LT supports communities defined as savannas. Typically the open canopy of stunted longleaf pine was interspersed with low growing turkey oak and occasional sand post oak, persimmon, and sassafras. An infrequent sparse low shrub layer consisting of dwarf huckleberry and poison oak was common. The sparse herb layer was dominated by wiregrass and was associated with wireplant, Carolina sandwort, sand spikemoss, common prickly pear, and goats-rue. Also common were more open and barren conditions without shrub species and only longleaf pine, scattered turkey oak, and wiregrass. Turkey oak is more abundant in this LT while bluejack oak is a good indicator species of Landtype 11, the Dry-Mesic Savannas.

Existing Vegetation - The open longleaf savanna or Xeric Sandhill Scrub (Schafale and Weakley 1990) communities supported in this LT were originally widespread. Succession is often prolonged on these infertile and dry sites. With frequent fire the turkey oak and other mid canopy trees are sparse, with only a few growing large enough to withstand burning. Most will occur only as sprouts that are killed back by fires. In the absence of fire the oaks become denser and larger, sometimes forming patches with a nearly closed subcanopy. The herb layer is reduced in density and diversity. Fire carries poorly in oak litter, reducing the effectiveness of surface fires to consume woody competition to grasses and herbs.

Rare Elements - This LT supports a considerable number of rare species considering the xeric nature of the sites and naturally low biological diversity. This may be due in part to more moist micro-habitats

that are common throughout the LT and its mosaic arrangement with larger, more mesic sites, or to the open nature of the forests the LT supports. Rare plants include Carolina goldenrod, Carolina asphodel, long-beak bald-sedge, savanna nutrush, small butterwort, southeastern panic grass, and Venus flytrap. Rare animals include red-cockaded woodpecker, Bachman's sparrow, and Carolina gopher frog.

Wildlife - Common flicker, red-headed woodpecker, eastern-wood pewee, brown-headed nuthatch, yellow-throated vireo, pine warbler, Chuck-will's-widow, summer tanager, chipping sparrow, bobwhite quail, eastern screech-owl.

Management Considerations - Longleaf pine savannas within this LT provide important habitat conditions for the red-cockaded woodpecker. Other species such as wild turkey and fox squirrel benefit from the significant production of acorns by turkey oak within this LT. Balancing the needs of these species may require a change in traditional burning methods that emphasize 'blackening' every available acre within a burn unit. A more mosaic type burn that uses the irregular pattern of fuels distribution typical on these xeric sites would retain scattered mast-producing species to develop into larger subcanopy trees.

Variations - This LT has not been separated into phases and occurs on only one soil type. The Kureb sand is excessively drained and has sand horizons 80 inches or more thick. These soils are less productive than other soils within their respective drainage classes partly due to subsoil accumulations of organic matter and aluminum. These spodic horizons can severely affect nutrient availability and therefore productivity is low for all species that occur in this LT.

Maritime Ridge And Dune Forests-13

General Description - This LT includes uplands fringing salt or brackish waters that are dominated by live oak communities. This is the smallest LT on the CNF and has been mapped in only 4 locations on the periphery of the Forest. The type is common outside the Forest but occurs on just 45 acres within the Forest boundary. The most extensive site is at Cedar Point.

Landscape/Landform Pattern - Maritime forests are small and irregular in shape and associated with upland pine sites and marshes near large water bodies.

Disturbance - Under natural fire regimes, most mainland maritime zones experienced frequent fires that spread from interior fire communities. They are susceptible to wind and flooding caused by hurricanes because of their location in low areas near the coast. Furthermore, aerosol salt may be a continuous stress factor and significant source of mineral nutrients.

Presettlement Vegetation - This LT would support vegetation communities ranging from Maritime Evergreen Forest to Coastal Fringe Evergreen Forest (Schafale and Weakley 1990). The Maritime Evergreen Forest has a low to moderately high tree canopy, often stunted and pruned by salt spray. It is dominated by Live Oak, Darlington oak, and loblolly pine. Understory trees include red bay, ironwood, American holly, dogwood, and Virginia red cedar. With these occur shrubs such as yaupon, wax myrtle, and dwarf palmetto. The herb layer is sparse and low in diversity, with species such as partridgeberry, ebony spleenwort, and hairy bedstraw. The Coastal Fringe Evergreen Forest has a similar composition but is more diverse and less affected by salt spray.

Existing Vegetation - Few good examples remain of natural communities within this LT. Sites within the maritime zone have experienced nearly three centuries of human exploitation and disturbance. All the live oak in the region was sought out and removed for ship timber during the 18th and 19th century (Wood 1981). Furthermore, most of the sites, which still have some of the second growth live oak, have been used for houses and farmsteads since the early 1700s. On the Cedar Island peninsula and near the campground, remnants of natural maritime forests remain. There, longleaf pine occurs with small live oaks and clumps of yaupon and a poorly developed to well-developed savanna herb layer.

Rare Elements - Rare species include the liverwort, *Lajeunea dimorphophylla.*

Wildlife - Summer tanager, painted bunting, gray squirrel, Eastern spade-foot toad, Eastern narrow-mouthed toad, ground skink, eastern glass lizard, and Southeastern five-lined skink.

Managements Considerations - Since few intact maritime forests remain in this LT, management should be focused on plant community restoration. Live oak seems to tolerate fires, and may require fire for regeneration in stands away from the immediate coastal fringe. Planting of live oak and control of competing vegetation may be necessary in most areas. Although the high, receding shorelines along the Neuse estuary are within the maritime zone, wave action and bank erosion may be too rapid to permit formation of maritime forest.

Variations - This LT is too small to separate into LTPs but occurs on 3 soil types. They include, in order of importance, the well-drained and moderately well-drained Wando and Seabrook fine sand, and the well-drained Conetoe loamy fine sand.

Use Of The Ecological Classification System (ECS)

Like all maps, those produced by the Ecological Classification System (ECS) are imperfect representations of the land, and accuracy depends upon the application and the scale being used. Landtype Associations accurately describe landscape patterns at the broadest scale on the Croatan and have been used to define management areas based on dominate ecological factors such as topography and landform/vegetation diversity. Since the ECS was derived from soil maps, the major factor controlling map unit reliability at the finer scales is the accuracy of the three county soil surveys. It is important to note that the objective of soil and ecosystem mapping is not to outline pure types but rather to separate the landscape into areas that have similar use and management requirements. As a result, "on site investigation is needed to plan for intensive uses in small areas" (USDA 1987).

Ecological Interpretations

Landtype Associations: LTAs were used by the interdisciplinary Croatan planning team to help define Management Areas. The LTAs clearly defined broad categories of land having distinct management opportunities and limitation such as the large central pocosin and highly dissected landscapes on the Forest's periphery. Some LTAs were split (LTA 1) to reflect differences in human use patterns and some were aggregated (LTA 7) to combine areas having similar limitations due to high water tables. Adjustments are apparent by comparing the LTA map (at the end of ECS section) with the Management Area map.

Landtypes: Landtypes were used to address many issues on the Croatan. They were useful for delineating Management Prescription boundaries since many of these emphasized management of ecosystems, e.g. Cypress-Hardwoods Wetlands and Hardwood Restoration. The LTs were also used to map different RCW capabilities (density objectives), as a tool in setting population objectives, and in designing the RCW Habitat Management Area. They were used in the Scenic Management System to aid in mapping 'inherent scenic quality' and formed the basis for mapping fuel types. They were also used to analyze natural areas representation, and to locate old growth restoration and conservation areas.

Landtype Phases: Landtype Phases were used to set forestwide objectives in silvicultural prescriptions, restoration opportunities, recreation site location, harvest scheduling, thinning guidelines, and in locating suitable sites for pine straw raking. They are currently being used to identify probability of rare species occurrence and restoration potentials within natural areas.

Reliability of Mapping: Although soils occur in an orderly pattern that is related to geology, landform, relief, climate, and plant associations, soil scientists must determine the boundaries based on an understanding of the soil-landscape relationships. Furthermore, the ECS incorporates this boundary along with an understanding of the complex relationships between landscape, vegetation, and fire regimes to determine the boundary of ecological units.

Most ECS map units are dominated by one major soil type having the same potential vegetation and fire regime. Inclusions of other soil-vegetation types mostly have properties and behavior similar to those of the dominant type. However, these differences may be important at the project level and field review and county soil surveys should be consulted to determine how extensive these differences might be. Additional factors may affect mapping accuracy. Soil surveys in the Croatan area are considered to have an 80% mapping reliability (level 2) and the minimum map unit size is 10 acres. The surveys were completed over a 10-year period and there are some minor inconsistencies in soil mapping across county lines. In addition, landscapes with complex patterns, such as along river bluffs or other highly dissected topography, have more inclusions and finer-scale mosaics than have been identified. Soil maps and consequently the ECS, do not therefore identify small swampy floodplains, limestone outcrops, small areas of limestone-influenced soil, or small drainage slopes. Some of these micro-sites may limit management opportunities. Some may contain rare and unique species and could provide opportunities to add to the overall biological diversity of the CNF.

Reliability of Interpretation: Interpretations of ECS map units were derived from county soil surveys, from Frost's "Presettlement Vegetation and Natural Fire Regimes of the Croatan National Forest" (1996), and from overlaying other resource maps (rare species, cultural resources, and CISC) with the ECS. These interpretations are generally rather broad but still applicable for project level planning (Tables A-2, A-3, A-4). For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within a certain depth in most years, but they cannot assure that a high water table will always be at a specific level in the soils on a specific date (USDA 1987). In addition, the relative occurrence of rare species and cultural resources found within ecological units can be used to identify sites where there is a low or high probability of occurrence of these features. They cannot, however, be used to predict with 100 percent accuracy the presence or absence of rare species or cultural sites.

Site index, derived from both CISC data and soil surveys, was used to judge the relative productivity of ecological units at the Landtype Phase level. The major tree species or species groups within an ecological type were placed into four classes, low (L), medium (M), high (H), and unsuitable (U). It was not possible to make a more exact prediction of growth and yield without more intensive field measurements. Still, these relative classes should be useful in determining appropriate stocking levels for different sites and in evaluating species suitability options.

Potential natural vegetation (PNV) types are broad classes of vegetation derived from the presettlement vegetation maps. As with soil types, landscape variability and minimum map unit size will affect the reliability of PNV prediction. Furthermore, where past land use has altered site capability especially through erosion, these potentials may no longer exist. The greatest variability in PNV occurs in Drainage Headlands and Interstream Flats and Broad Interstream Flats (Landtypes 5 and 6). These LTs can support mixed pine-hardwood and mixed pine communities but their exact composition and placement on the landscape is problematic. This is partly because only small remnants persist of these mixed pine communities to help predict their natural pattern and the fact that they are readily confused with fire-suppressed former longleaf pine communities that have been logged and invaded by other pine species. Their interpretation as distinct ecological units is therefore less precise than other types.

Project Level Planning and Analysis: The ECS can be an important tool at the project level for project planning, design, and analysis of the effects of proposed actions. Landtype Phase map units represent the greatest amount of detail on site and biological factors. Because these map units are derived from soil surveys but combine fire disturbance regimes and vegetation potentials, they can be used to interpret each component separately or together as a unit. The ECS is therefore not just an inventory and evaluation of the soils on the Croatan, but also the biological components and potentials of ecosystems. As with a soil survey, "it can be used to adjust land uses to the limitations and potentials of natural resources and the environment" (USDA Soil Conservation Service, 1981, 1987, 1989).

Information in Tables A-2 through A-4 includes soil factors that affect management such as texture, drainage, and water table depth. These factors are interpreted to identify equipment limitations and seedling mortality within map units. The tables also include predictions of potential vegetation type, probability of rare species occurrence, timber productivity, and probability of cultural resources for each of the 25 Landtype Phases. This information can be used to evaluate the feasibility and probable effects of a proposed action in all or part of the Croatan. Combined with the ecological maps and descriptions (ECS Chapter 2), opportunities and limitations are apparent for a variety of proposed actions including wildlife habitat manipulation, timber stand improvement, timber harvest, recreational development, and road or trail location.

Although the ECS identifies and describes distinct land units and their biological potentials, it does not describe the current vegetation condition. This information is provided in the compartment and stand maps of Continuous Inventory of Stand Condition (CISC). By combining the ECS and CISC, one can map areas of the landscape where current condition differs from potential condition and begin to locate opportunities for change and evaluate the range of options available for individual sites. Although the ECS can be used to identify species best adapted to sites and their performance, it is not a prescription for desired future condition. Land use decisions will be improved by use of the ECS, but they should not be dictated by it. These decisions are based on public input, Plan direction, and the balance of uses appropriate for the Croatan.

An example may help to explain this distinction. Pine savannas and flatwoods occur along a wide soil drainage-fertility gradient. They have been described in 6 Landtype Phases and can support a large variety of trees, shrubs, herbs, and their related fauna. Production and longevity of trees adapted to these types is also highly variable. Fewer species are adapted to the harsh conditions at the xeric and less fertile end of the gradient, where well-drained and excessively-drained sands are dominant (LTP 1225). Nearly 90% of these sites are currently dominated by longleaf pine (CISC data). On sites dominated by loblolly pine, pond pine, or hardwoods tree growth is poor, regeneration is sparse, and the long-term sustainability of these species is questionable. At the other extreme, poorly drained sands and loams support savannas and flatwoods dominated by longleaf, pond, or loblolly pine, or a combination of these species (LTP 920-921). Growth is moderate to poor, tree form is good, and natural regeneration is moderate. In the middle of the gradient, mesic sites support loblolly, longleaf, and hardwoods (LTP 1022-1124). Growth is good, tree form is good, and natural regeneration of all species is rapid. The natural vegetation type in all these LTPs is longleaf pine, but it is evident that many species are capable of regenerating, although growth rates differ.

There are many management options in LTPs 1022-1124 since these types will support a variety of species and have few limitations (not poorly drained, not too droughty). The choice of species for management is dependent upon the desired condition. If RCW nest sites are the primary emphasis, then longleaf pine would be the preferred species; if short-rotation fiber production is the emphasis, then loblolly pine might be preferred; if turkey and deer are the primary emphasis, then a mixed oak-hickory-pine composition may be preferable. Fewer options are available at the extremes of the gradient, xeric and wet. However, the same logic applies - the ECS does not determine desired condition but it can determine where a desired condition might best be achieved.

Table A-1. Ecological characteristic

	LTA 1	LTA 2	LTA 3	LTA 4	LTA 5	LTA 6	LTA 7	LTA 8	LTA 9	LTA 10
Proclamation acres	101,800	73,000	35,540	32,650	22,000	{23,000}	82,000	38,300	{27,060}	{16,440}
USFS acres	15,670	63,160	15,980	16,000	4,460	0	45,160	700	0	0
{acres} = not in proclamation boundary										
HYDROLOGY----------										
StrStream density mi./sq.mi	1.8	.13	2.0	1.3	2.4	-	.6	.4	.05	.6
Stream length (miles)	284	15	122	64	83	-	77	25	2	15
Canal density mi./sq.mi.	.1	1.1	1.2	.1	.5	-	.7	1.1	0	0
Canal length (miles)	10	122	65	3	19	-	85	68	0	0
AQUATIC AND DRAINAGE TYPES (acres)----------										
lakes, ponds, sounds	-	6,600	-	-	-	-	2	-	22,700	28
streams & rivers	4,120	-	220	180	130	23,000	-	6,440	-	-
tidal estuaries	850	-	2,090	390	2,190	-	-	2,270	200	445
floodplains	8,88 0	1,680	4,160	1,800	3,790	-	2,180	2,180	-	510
very poorly drained mineral	1,090	1,240	2,060	10,040	2,120	-	49,930	10,930	-	6,060
very poorly drained pocosin	300	62,840	19	325	40	-	6,430	2,890	-	1,715
somewhat poorly drained	31,400	330	13,010	10,730	7,370	-	20,790	11,110	-	6,100
mod. well to well drained	43,950	90	13,580	7,550	6,400	-	2,610	2,490	-	1,130
somewhat excess.drained	5,200	-	400	1,270	-	-	-	-	4,260	360
urban complexes	6,000	-	-	360	-	-	7	-	-	90
SOIL SUBORDER (acres)----------										
aquults	31,040	1,270	12,350	690	6,270	-	50,350	21,110	-	6,100
udults	43,650	90	12,935	2,715	6,360	-	2,610	2,380	-	490
saprists	1,880	64,520	1,600	850	340	-	7,060	2,890	-	2,160
aquods	900	260	2,150	18,130	2,150	-	2,420	940	-	5,220
humods	-	-	-	1,900	190	-	-	-	-	-
aquepts	5,760	130	1,390	1,330	4,360	-	19,270	2,180	-	1,340
aqualfs	60	-	130	40	-	-	100	18,820	-	-
aquents	2,410	-	3,640	390	2,190	-	120	2,270	200	240
psamments	5,970	-	1,110	6,105	40	-	-	110	4,160	1,010
POTENTIAL NATURAL PLANT COMMUNITIES (acres)----------										
tidal marshes	870	-	2,060	450	2,200	-	-	2,270	1,270	460
swamp forests	7,970	1,680	4,200	1,270	3,460	-	3,800	-	-	970
mixed mesic hardwoods	14,870	-	1,480	60	375	-	680	9,090	-	650
mixed hardwood-pine	20,370	-	2,770	1,260	1,450	-	780	2,540	-	670
mixed pines	18,415	-	5,550	110	2,530	-	2,290	10	-	620
pond pine forests	4,745	960	2,725	700	2,150	-	53,680	12,650	-	5,950
pocosin and canebrake	540	63,240	350	10,290	520	-	14,210	3,300	-	5,540
wet longleaf pine	2,600	320	4,320	8,530	3,035	-	4,135	550	-	1,460
mesic longleaf pine	14,870	115	8,230	2,460	5,430	-	2,640	300	-	65
dry longleaf pine	4,645	-	3,245	1,610	1,010	-	-	120	-	350
xeric longleaf pine	100	-	285	4,215	280	-	-	-	-	40
maritime live oak&beach	130	-	260	4,471	10	-	-	720	5,300	230

Table A-2. Soil characteristics in ecological types. Landtypes (LT) 1-13, Landtypes Phases (LTP) 0101-1326)

		SOIL TYPES		[1] SURFACE	[1] SUBSURFACE	
LT	LTP	(mapunit)	ACRES	TEXTURE	TEXTURE	[2] DRAINAGE
1	101-103	HB,CH,LF, Ho	1,200	organic or loamy	organic or sandy	very poorly
2	204	DO	2,100	organic	Organic > 51”	very poorly
	205	MA,MM,Mk,Ba,Me,Sx	5,800	loamy	sandy-loamy	poorly to very poorly
3	306	AuB,NoA-B,StA,KeA,AnB	1,700	sandy	loamy	mostly well
	307	Tm, AaA, Ag, Jo	980	loamy	sandy-loamy	poorly to mod. well
4	408-409	SuD, AuB, CrC, NoA, Crb	1,020	sandy	Loamy-sandy	mostly well
5	510	NoB, NoA, StA, AuB, CnB	750	sandy	loamy	well
	511	GoA, CrB, ExA, AaA, CrC	1,450	sandy or loamy	loamy or clayey-loamy	moderately well
	512	Na, Ag, Jo	180	loamy	loamy	somewhat poorly
6	613	Le, Ly	1,600	loamy	clayey-loamy or loamy	somewhat poorly
	614	Ra, Ln, Ap	6,400	mostly loamy	mostly loamy	mostly poorly
7	715	La, Gr, Ra	4,400	loamy	mostly clayey-loamy	poorly
	716	Pa, To, Ap, De	27,000	loamy	mostly clayey or sandy-loamy	very poorly
8	817	DA	16,600	organic	organic > 51”	very poorly
	818	CT	46,500	organic	organic 16-51”	very poorly
	819	Mu, Ba	16,500	sandy or loamy	sandy-loamy or loamy-clayey	very poorly
9	920	Ra, Wo	4,980	loamy	loamy	poorly
	921	Ln	6,450	sandy	sandy	poorly
10	1022	On, GoA, CrB	7,580	mostly sandy	mostly loamy	moderately well
	1023	Ly, Mn, St	4,670	loamy or saney	loamy loamy-saney	somewhat poorly
11	1124	ByB, MaC, StA	2,140	mostly loamy	sandy	well
12	1225	KuB	1,225	sandy	mostly sandy	eccessively
13	1326	WaB, Se, CnB	50	sandy	mostly sandy	well to mod. well

[1] clayey > 35% clay, loamy < 35% clay, sandy = high percentage sand and texture of sandy or loamy sand.
[2] from SCS drainage classes indicating frequency and duration of periodic saturation during soil formation.

Table A-3.Vegetation and other features in ecological units Landtypes (LT) 1-13, Landtypes Phases (LTP) 0101-1326)

LT	LTP	[1]Current Vegetation	[2] Potential Vegetation	[3] Rare Species	[4] Timber Productivity	[5] Natural Areas	[6]Cultural Resource
1	101-103	marsh – 68	marsh	5/5	U – U – U – U	1/ 175	
2	204	62 – 68 – PP	Cypress swamp	5/5	U – U – M – M	2/ 800	
	205	62 – 68 – 46	Cypress swamp	10/11	M – U – M – M	4/ 100	
3	306	LOB – 46 - 62	dry-mesic hardwood	5/5	M – H – U – M	0	
	307	LOB – 62	mesic hardwood	7/9	H – M – M – H	0	
4	408-409	LOB – 62	dry-mesic hardwood	0	M – M – U – H	1/ 103	
5	510	LOB – 62	dry-mesic hardwood-pine	1/1	M – M – L – M	0	
	511	LOB – 62	mesic hardwood-pine	10/12	H – H – M – H	0	
	512	LOB	wet hardwood-pine	0	H – U – H – M	0	
6	613	LOB – LL	mesic mixed pines	3/5	H – M – M – M	0	
	614	LOB-PP-LL	wet mixed pines	5/18	H – M – H – M	0	
7	715	LOB-46-PP	pond pine forest	5/9	H – M – H – M	2/ 292	
	716	PP-LOB-68-46	pond pine forest	12/20	M – M – H – M	4/ 3,700	
8	817	PP	low pocosin	0	L – U – L – L	1/ 10,000	
	818	PP	high pocosin	9/12	L – U – M – L	3/ 20,700	
	819	PP-68-LOB	low-high pocosin	18 40	L – L – M – L	6/ 2,600	
9	920	LOB-LL-PP	wet LL sav. & flatwoods	6/11	M – M – H – M	3/ 500	
	921	LL-LOB-PP	wet LL sav. & flatwoods	22/58	L – L – M – L	7/ 1,700	
10	1022	LOB-LL-62	mesic LL sav.&flatwoods	15/24	H – H – M – M	4/ 450	
	1023	LOB-LL-PP	mesic LL sav.&flatwoods	19/27	M – H – M – M	7/ 630	
11	1124	LL-LOB-62	dry-mesic LL savanna	6/7	M – M – M – M	2/ 230	
12	1225	LL	xeric LL savanna	10/15	L – L – L – L	4/ 480	
13	1326	not classified	maritime forest	0	L – L – L – L	0	

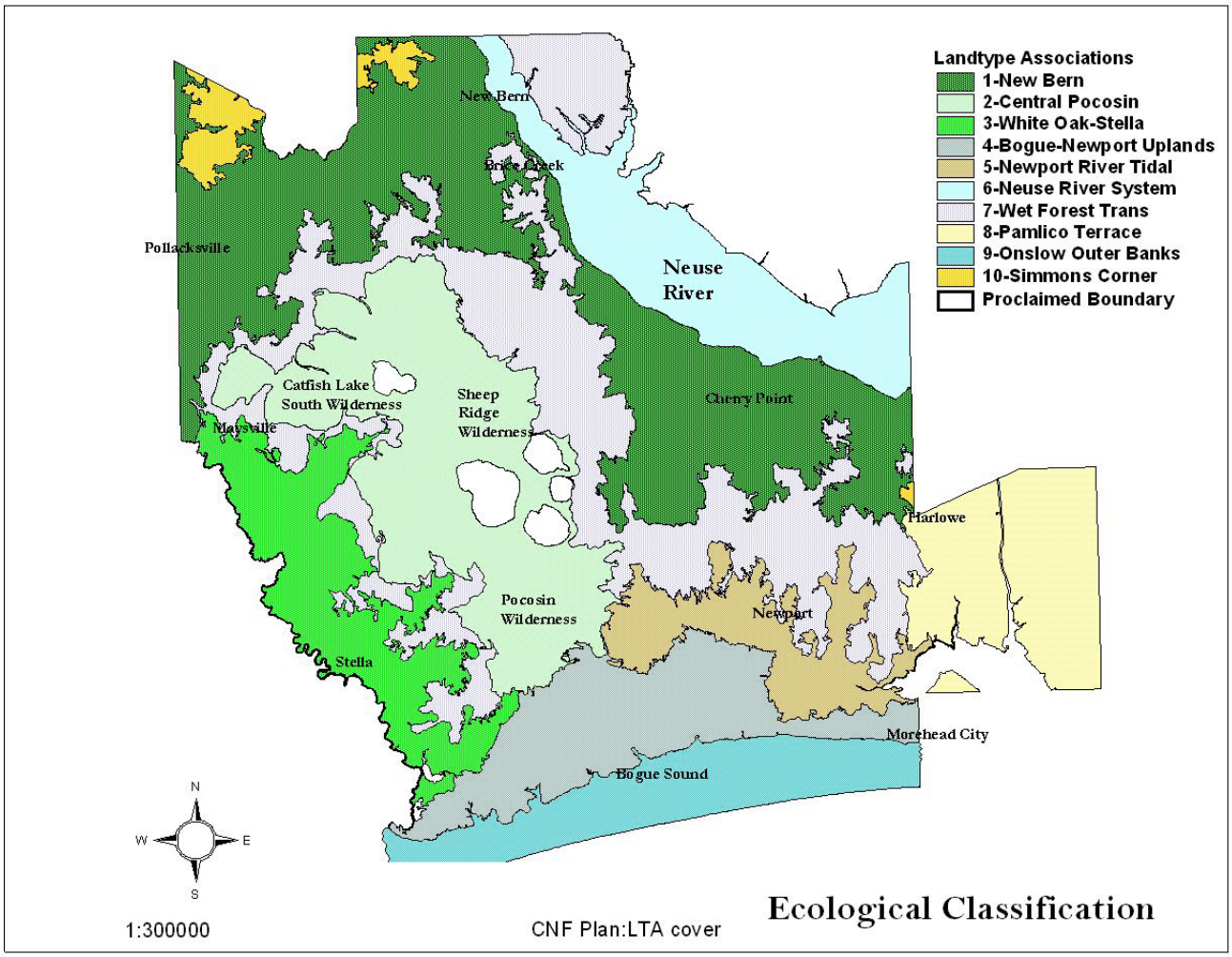
[1] dominant Forest Type, from CISC. Numbers are hardwood types; LL = longleaf pine, PP = pond pine, LOB = loblolly pine
[2] from Frost (1996).
[3] number of T&E, sensitive, and locally rare species / number of occurrences of these rare species
[4] relative productivity, H = high, M = medium, L = low, U = unsuitable (HW = hardwoods)
[5] number of natural areas within the type / area of natural areas within the type
[6] number of documented cultural resource sites within the type

Table A-4. Management limitations in ecological units Landtypes (LT) 1-13, Landtypes Phases (LTP) 0101-1326)

			[1] WATER	[2] EQUIPMENT	[3] SEEDLING	OTHER
LT	LTP	SLOPE	TABLE	LIMITATION	MORTALITY	DISTINGUISHING
			(FT)			FEATURES
1	101-103	level	+3.0-0.0	severe	severe	flooding for brief to long periods
2	204	level	+1.0-0.5	severe	severe	flooding for long periods
	205	level	+1.0-1.0	severe	severe	flooding for brief to long periods
3	306	0-6 %	4.0 > 6.0	slight to mod.	slight to mod.	mostly fire sheltered
	307	0-2 %	0.0-3.0	mod. to severe	slight to severe	very fire sheltered
4	408-409	0-30 %	2.0 > 6.0	slight to mod.	slight to mod.	possible eroded soils
5	510	0-6 %	2.0 > 6.0	slight to mod.	slight to mod.	complex topography
	511	0-8 %	1.5-3.0	moderate	slight	possible eroded soils
	512	level	1.0-3.0	moderate	slight to mod.	problematic classification
6	613	level	1.0-2.0	moderate	slight	soil compaction potential
	614	level	0.0-1.0	mod. to severe	mod. to severe	wettest longleaf pine site
7	715	level	0.0-1.5	severe	severe	may resemble high pocosin
	716	level	0.0-1.0	severe	severe	hardwood invasion
8	817	level	+0.5-1.0	severe	severe	severe ground fire risk
	818	level	+0.5-1.0	severe	severe	high ground fire risk
	819	level	+1.0-1.0	severe	severe	mosaic with deep peats
9	920	level	0.0-1.0	severe	severe	highest density of rare species
	921	level	0.0-1.0	severe	severe	growing season drought
10	1022	0-4 %	1.6-3.0	slight to mod.	slight	none
	1023	level	1.0-3.5	moderate	slight	none
11	1124	0-16 %	4.0 > 6.0	mod. to slight	mod. to slight	droughty
12	1225	0-6 %	> 6.0	severe	severe	patchy surface fuels
13	1326	0-6 %	2.0 > 6.0	moderate	moderate	past disturbance

[1] seasonal high water table (December-April); the highest level of a saturated zone below the soil surface in most years.
[2] limitations due to site wetness, compaction, or drought; slight < 2 month limitation, moderate 2-6 months, severe > 6 months.
[3] slight < 35%, moderate 25-50%, severe > 50% and may be necessary to use larger seedling or bedding

Figure A-1. Map of Landtype Associations



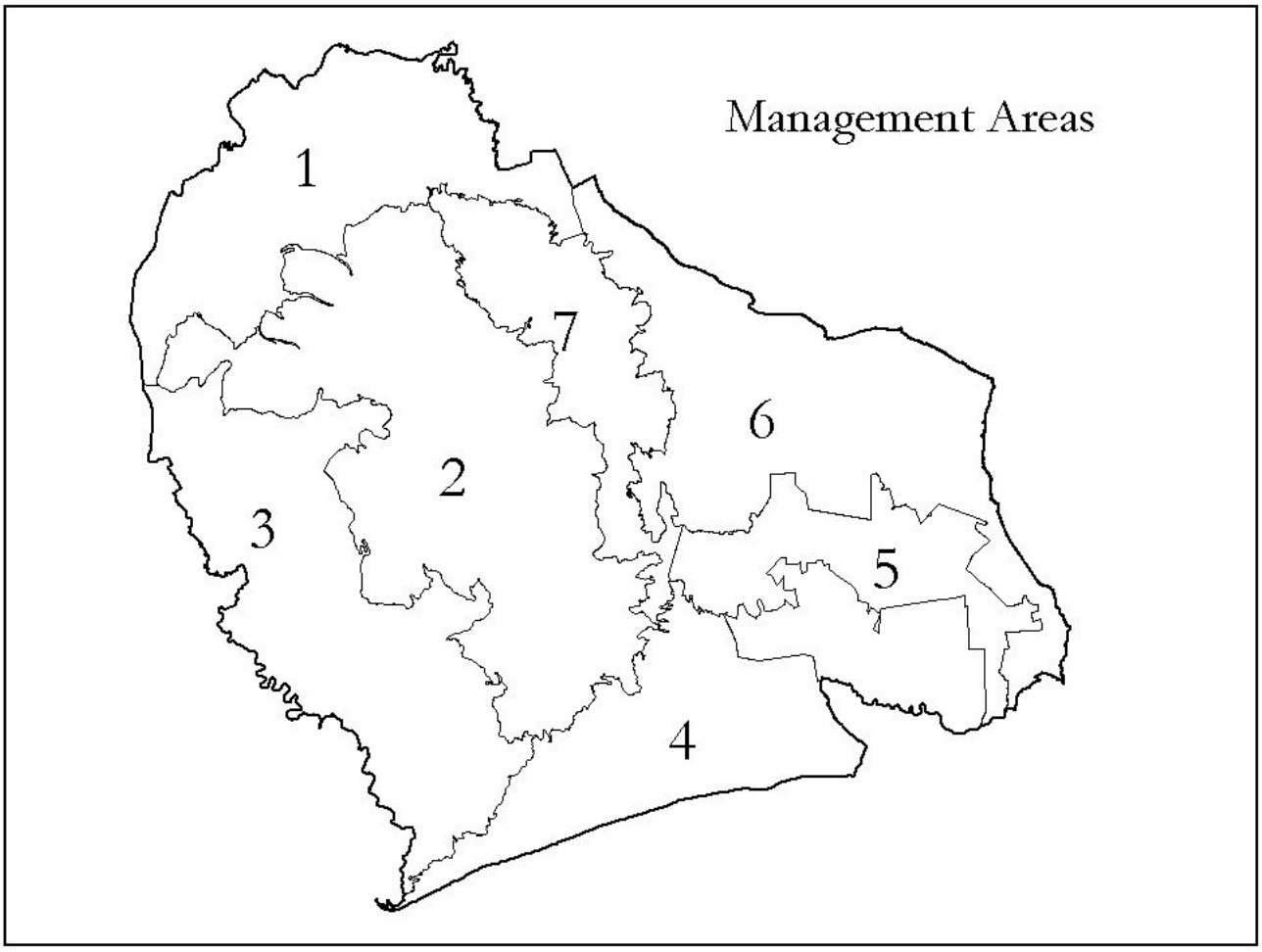
Application of ECS - Management Areas

The units identified in the Ecological Classification System can be used as a basis for identifying large areas, with common characteristics, for management. The landtype associations are the basis of the Management Areas (Figure A-2) because they are aggregations of landtypes that have similar responses to management. These Management Areas on the CNF provide clear aggregations of management prescriptions and how they may be managed collectively. The Management Areas provide another view of how ecological processes are important over a larger landscape, and how human interactions are occurring.

The best management of a piece of land depends on more than its physical and biological characteristics. Appropriate management also depends on a parcel's place in the landscape, which helps determine how people will want to use the land. Each of the seven MAs is a contiguous block of land with sufficiently

uniform physical, biological, and human-use characteristics to permit consistent applications of prescriptions.

Figure A-2 shows Management Areas on the CNF.



A general description is provided for each MA, including the general setting of the MA, its location on the CNF, its approximate size, and the proportion of private land within its boundaries. Next, **a physical and biological profile** describes the landforms, soils, and landscape pattern of the MA. The profile also includes the dominant vegetative types, the fuel conditions, the rare species that may be present, and the common wildlife and aquatic habitats.

A table provides details about landscape composition and configuration. In the ecological classification of the CNF, 15 landtypes (LT) were recognized. Examples of LTs are tidal streams and pine savannas. The areas, frequencies, and average sizes of patches are expressions of landscape structure. The table lists the miles of private land boundaries, the miles of landtype edge, and the miles of such edge per square mile. The mileage of private land boundaries is an indicator of difficulty in applying treatments and confining them to the public land. The amount of habitat edge has considerable significance in wildlife management. Such a table for the CNF as a whole is given below.

Table A-5. Landscape Composition and Configuration on CNF.

Landtype	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Acres	1304	7864	2677	1023	2366	8053	31823	74007	11511	1236	2147	1136	50	5100	98	161474
Frequency	28	126	30	32	80	145	185	155	387	339	67	50	5	32	11	1672
Ave. Patch	47	62	89	32	30	55	172	477	30	36	32	23	10	159	9	97
Private land boundary=392 miles					Total landype edge=1753 miles						Total edge per square mile=7 miles					

1. Tidal Streams and Estuaries
2. Lake and Stream Swamps
3. Stream and River Terraces
4. Drainage Slopes
5. Dissected Interstream Flats
6. Broad Undissected Interstream Flats
7. Peat Mantled Forest Wetlands
8. Raised Peatlands
9. Wet Pine Savanna/Flatwoods
10. Mesic Pine Savanna/Flatwoods
11. Dry Mesic Pine Savanna
12. Xeric Pine Savanna
13. Maritime Ridge/Dune Forests
14. Water
15. Altered Land

Management areas vary considerably in their mosaics of LT units. Individual LT units are referred to as 'habitat patches'. From a timber management perspective, a patch roughly corresponds with a forest stand, but a stand may not function as a patch from a particular organism's perspective. LTs are used to define patches on the CNF because LTs are ecological land units identified and mapped based on similarities in soils, potential natural vegetation, and landforms. These habitat patches may or may not be readily apparent in areas with an extended history of agricultural land use, patches often reflect results of land use rather than the current pattern of vegetation composition and structure. Therefore, from an ecological perspective, patches represent relatively discrete potential habitats. Patch boundaries are distinguished by differences in environmental character.

The type, area, and average patch size of LTs comprising a MA are perhaps the most important and useful pieces of information contained in the landscape. Together, they define the composition, variety, and relative abundance of LTs in an MA. By comparing values in an MA with other MAs and the CNF as a whole, readers can determine where a particular ecosystem type occurs and if it is dispersed or concentrated, can then begin to develop options and strategies for ecosystem management. In general, management options and complexity are greater in MAs with more LTs and higher frequencies of habitat patches (MA 3, 4, 6).

The variety of habitat patch types in an MA affects the diversity of plant and animal communities that may occur. Because many organisms are associated with a single patch type, patch diversity, or richness often correlates well with species richness. For example, tidal streams and estuaries (LT 1) are dominated by needle rush, salt grass, and cordgrass marshlands that support terns, gulls, egrets, herons, osprey, water snakes, raccoons, and river otters. No other LT supports these species, and 85 percent of this LT occurs in MA 3. Similarly, raised peatlands (LT 8) are dominated by unique plant communities that provide habitat conditions for black bears. This LT covers nearly one-half of the CNF but occupies 90 percent of MA 2.

Landscape structure in MAs also influences timber and recreation opportunities. For example, interstream flats (LTs 5 and 6) provide the best opportunities for mixed-pine forests; these types are extensive in MAs 3 and 6. Similarly, lake and stream swamps (LT 2) may provide opportunities for canoe navigation, they occur in every MA, but the most extensive contiguous patch occurs in MA 2. The type and abundance of LTs are therefore important factors to consider when evaluating management options within a MA.

The frequency or number of habitat patches and the pattern of these patches on the landscape also strongly influence ecological characteristics and species populations. In the past, most forest management activities have focused on the individual habitat patch or stand. However, habitat variation

and its effects on ecological processes and plant and animal populations occur at many spatial scales. The size of a landscape differs depending on what constitutes a mosaic of habitat patches meaningful to that particular organism. For example, a salamander and a red-cockaded woodpecker view their environment on different scales. Although each organism defines habitat patches differently and at different scales, MAs generally occupy some spatial scale intermediate between an organism's normal home range and its distribution on the CNF.

The frequency of LT patches may determine the number of subpopulations in a spatially dispersed population. For example, red-cockaded woodpeckers are associated primarily with longleaf pine savannas (LTs 9,10,11,12). Over two-thirds of the total patches comprising these LTs on the CNF are found in MAs 3 and 4. Clearly, the number of subpopulations of red-cockaded woodpeckers in these MAs could influence the dynamics and persistence of the species across the CNF.

The frequency of LT patches and average patch size may also affect the propagation of disturbances across a landscape. A highly subdivided patch type may be more resistant to the spread of fire and insect infestations and thus more likely to persist in a landscape than a patch type that is contiguous. For example, contiguous pine forests that occur in the large patches common in peat mantled forested wetlands (LT 7) in MAs 3 and 5, may be more susceptible to extensive wildfires or bark beetle outbreaks than pine forests in subdivided patches types such as pine savannas in MA 3. Conversely, habitat fragments such as narrow pine savannas in a large matrix of pocosin, common in MA 2, may suffer higher rates of disturbance and mortality than the more contiguous pine savannas in MA 3.

The amount of edge may affect the quality of habitat available in a patch. The forest "edge effect" results primarily from differences in wind and light intensity and quality reaching a forest patch (Ranny and others 1981). A large but narrow patch, for example, could be entirely edge habitat. Some species, such as rough-leaf loosestrife, have an affinity for edges, some are unaffected, and others such as the black-throated green warbler, may be adversely affected (McGarigal and others 1995). Changes in wind, light intensity and quality extend farther into a patch along an edge with high structural contrast. Contrast is high along the edge between wet pine savannas (LT 9) and raised peatlands (LT 8). It is low between mesic pine savannas (LT 10) and peat mantled forested wetlands (LT 7). High-contrast edges may prohibit or inhibit some organisms from using surrounding patches. Conversely, some species, such as hawks, seem to prefer the juxtaposition of patch types with high contrast (Dunning and others 1992).

The private land boundary and total landtype edge is partially a function of scale. Larger MAs generally have longer boundaries with private land and greater landtype edge than smaller MAs, therefore, total edge per square mile provides a more accurate comparison of linear edge among MAs. For example, MA 2 is the largest on the CNF but has the least density of habitat edge. Likewise, MA 5 is similar in size to three other MAs but has significantly less habitat edge per square mile. In general, there is less habitat edge per unit area in MAs with fewer patches and larger patch sizes (MA 2 and MA 5). Furthermore, MAs having a greater component of peat-mantled forested wetlands (LT 7) and raised peatlands (LT 8) have less habitat edge because these LTs commonly occur in large patches.

Overall, the Landscape Composition and Configuration tables offer the reader some idea of the pattern of habitat fragmentation and how it varies between MAs. Fragmentation may be natural, or it may result from past logging, agricultural practices, and urban development. The extent of fragmentation has

implications for a variety of management considerations, including linking animal habitats, the ability to efficiently and safely prescribe burn, the granting of special uses, and the planning of future activities.

Cultural and economic profiles describe the kinds and relative amounts of human uses of the MAs. Recreation opportunities on land and water are summarized for each MA.

Current land uses and the ratio of public to private land are expressions of a landscapes character. A management area with a high proportion of private land in urban and agricultural uses will be quite different from one that is mostly publicly owned and forested. A high ratio of private to public ownership signals special attention: in allocating uses of public land, the planning process must consider the rights and concerns of adjacent private property owners.

Opportunities and Limiting Factors provide the background for the objectives to be achieved in each MA. Opportunities for change from the present condition to the desired condition are identified, as are limitations that may affect the difficulty and rate of change that may occur.

Management Area 1

General Description: This large MA forms the northern boundary of the CNF. It is crescent-shaped and represents the transition between the CNF's very large and mostly inaccessible central pocosin and urban land to the north. National forest land makes up only 22 percent of the MA. It is located in one small isolated tract and three peninsulas that protrude into the predominately rural landscape. The boundary between the CNF and private land is approximately 40 miles.

Physical and Biological Profile: The topography is generally level except where stream tributaries dissect the landscape. The landform pattern is complex and on the CNF land includes 11 landtypes represented in 124 separate patches. Soils are generally very poorly drained to moderately well drained and have a loamy or claylike texture. Most productive and well-drained sites in the area are privately owned.

Table A-6. Landscape composition & configuration (MA-1)

Landtype	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Acres	0	615	55	116	769	1029	2388	1980	403	1511	127	0	0	24	0	9018
Frequency	0	13	4	3	16	14	21	9	16	23	3	0	0	2	0	124
Ave. Patch	0	47	14	39	48	74	114	220	25	66	43	0	0	12	0	73
Private land boundary = 40 miles					Total landtype edge = 140 miles						Total edge per square mile = 10 miles					

1. Tidal Streams and Estuaries
2. Lake and Stream Swamps
3. Stream and River Terraces
4. Drainage Slopes
5. Dissected Interstream Flats
6. Broad Undissected Interstream Flats
7. Peat Mantled Forest Wetlands
8. Raised Peatlands
9. Wet Pine Savanna/Flatwoods
10. Mesic Pine Savanna/Flatwoods
11. Dry Mesic Pine Savanna
12. Xeric Pine Savanna
13. Maritime Ridge/Dune Forests
14. Water
15. Altered Land

Habitat edge and patch size are very similar to adjoining MA 7 but very different from the adjacent MA 2, which contains large pocosin patches. Dominant landtypes include peat mantled forested wetlands, raised peatlands, mesic longleaf pine savannas and flatwoods, broad undissected interstream flats, and dissected interstream flats. Both mesic longleaf pine savannas and flatwoods, and dissected interstream flats occur in more extensive patches than found in other MAs on the CNF.

Loblolly pine is the most common species and occupies many acres more suitable for longleaf pine. Many of the productive sites in the area were logged and farmed in the past and regenerated to loblolly pine. Pond pine is common on poorly drained forest and pocosin sites. Most of the pond pine forests are in the wildland urban interface. Hardwood and cypress swamps form linear stands along major waterways, and are especially well developed along Brice Creek. Marl outcrops, uncommon on the CNF, occur in small patches in the northern portion; they support unique plant communities.

Fuel types in this MA include hardwood/pine leaf litter fuels, highly volatile high-pocosin fuels, southern rough fuels, and grass fuels. Wildland Urban Interface is identified in this MA, including a small portion of the Catfish Lake Wilderness.

Portions of this MA are included in the RCW habitat management area. More than half of the suitable RCW nest and forage areas are currently occupied by breeding birds, and the annual rate of fledgling production is 2nd highest among CNF populations.

This MA provides a diversity of wildlife habitats and wildlife recreation experiences.
Except for Brice Creek, most streams in MA 1 are not on the CNF. The middle and upper reaches of Brice Creek are relatively undisturbed and serve as reference conditions for ecological types in the Neuse and White Oak River Basins.

Cultural and Economic Profile: There is relatively little national forest land in the MA, but it is close to the high population area of New Bern and to major highways. About 25 percent of the land is used for farming, pasture, or development. The remaining 75 percent of MA 1 land use is split between pine forest and hardwood swamps. Recreationists have easy access to CNF land and water; and activities are primarily water based along Brice Creek, and hiking of the trail at Island Creek.

The wide diversity of wildlife and bird species, scenic marshes, and meandering blackwater stretches and side creeks are unique because of their proximity to population centers and major travelways. Recreation activities are mostly low impact and dispersed. The boat-launching area and fishing pier are the only developments.

Island Creek is the only isolated national forest tract in the MA. A developed trail traverses through a natural area registered with the North Carolina Natural Heritage Program. It highlights the hardwood-dominated stream and river terraces and unique marl outcrops. The trailhead is along a well-developed highly used road, but is in a fairly rustic setting. About 40 people can park and use the trail at one time.

Opportunities and Limiting Factors: Opportunities exist to expand the RCW population by five clusters in suitable and potential suitable habitat. There is potential for longleaf restoration on wet savannas and flatwoods (LT 09) as well as mesic savannas and flatwoods (LT 10). Opportunities exist for expanding wildlife and fisheries recreation opportunities.

Since Brice Creek is eligible for wild and scenic river status, opportunities exist to manage those portions on NF land for their outstandingly remarkable values. Limiting factors in this MA include high water tables, dense vegetation in the WUI, rare species sensitive to disturbance, and ownership patterns.

Management Area 2

***General Description*:** This centrally located MA is the largest on the CNF and national forest land accounts for 87 percent of its acreage. It consists of a very large rectangular pocosin that is higher than the surrounding landscape and extends nearly the full length of the CNF. Access is poor, with only one east-west road crossing the upper portion of the area. This MA has the most contiguous Forest Service ownership. The wilderness and the black bear habitat management prescription comprise a majority of the MA.

Physical and Biological Profile: The topography is dominated by a broad, domed peatland that is bounded on all sides by lower, better-drained landscapes. Five medium- to large-sized blackwater lakes, small linear sand ridges, and drainages form distinct patches in the matrix of extensive pocosin. Soils in these raised peatlands are very poorly drained and have organic layers 3 to over 6 feet deep. They are infertile and most nutrients come from rainwater. Soils are more fertile along the edge of the MA and vegetation is more diverse and productive in this transition zone. This is the largest contiguous block of pocosin wetlands on the Croatan and one of the oldest pocosins in the State.

Table A-7. Landscape Composition and Configuration (MA-2)

Landtype	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Acres	0	673	0	0	0	0	908	56276	267	131	0	0	0	4891	0	63146
Frequency	0	1	0	0	0	0	9	8	14	8	0	0	0	3	0	43
Ave. patch	0	673	0	0	0	0	101	7036	19	16	0	0	0	1630	0	1469
Private land boundary=25 miles					Total landtype edge=121 miles					Total edge per square mile=1.2 miles						

1. Tidal Streams and Estuaries
2. Lake and Stream Swamps
3. Stream and River Terraces
4. Drainage Slopes
5. Dissected Interstream Flats
6. Broad Undissected Interstream Flats
7. Peat Mantled Forest Wetlands
8. Raised Peatlands
9. Wet Pine Savanna/Flatwoods
10. Mesic Pine Savanna/Flatwoods
11. Dry Mesic Pine Savanna
12. Xeric Pine Savanna
13. Maritime Ridge/Dune Forests
14. Water
15. Altered Land

This is the smallest edge and patch density found on the CNF. Like other extensive pocosin ecosystems in the Southeast, pocosins in the Croatan area have been altered and fragmented by drainage ditches and agricultural practices.

The most contiguous and extensive raised peatlands and lakes, and one of the largest lake and stream swamp patches on the CNF occur in this MA. Two of these landtypes—raised pocosins and lakes—dominate the landscape. Other landtypes such as wet longleaf pine savannas and flatwoods, mesic longleaf pine savannas and flatwoods, and peat-mantled forested wetlands account for only 2 percent of the landscape area but nearly 75 percent of the total number of habitat patches. These small pine-dominated patches are dwarfed by the pond pine and evergreen shrub pocosins but do provide habitat and scenic diversity in the MA.

Small stands of longleaf pine and medium-sized stands of pond pine forest support trees much taller than those found in the pocosin. An extensive swamp and hardwood forest exceeding 100 years in age forms a prominent stand on the southern shore of Great Lake; portions of this stand have never been harvested. Because the forests in this MA are isolated, remote, or on relatively poor sites, most were passed over during early logging. As a result, virgin longleaf pine stands still exist.

Fuel types in this MA include highly volatile high pocosin fuels, volatile low pocosin fuels, hardwood/pine leaf litter fuels, southern rough fuel, and grass fuel.

Two Wildland Urban Interface zones are identified in this MA, occurring in Catfish Lake Wilderness, Pocosin Wilderness, and Sheep Ridge Wilderness.

There are currently no active RCW clusters in the MA. The large pocosin represents the highest quality habitat for black bear. Disturbances associated with public use and land management are low in most of the MA. The lakes in this MA empty into streams that feed the White Oak, Trent, Neuse, and Newport Rivers.

Cultural and Economic Profile: Only 1 percent of this MA is used for agriculture. Catfish Lake Road is a heavily traveled Forest Service road that crosses through the MAs center and connects population areas on either side of the forest. Access in this MA can cause impacts to the wilderness experience, to North Carolina Natural Heritage areas, and to black bear habitat from the proximity and number of open roads. The need for fire suppression access is a potential conflict with the roadless character of the area.

Semi-primitive non-motorized setting dominates the MA with four large blocks of roadless area. Most wilderness and roadless areas on the CNF are in this MA. They offer solitude, challenge, and a sense of remoteness for the visitor. The pocosins that dominate the area are very difficult to penetrate on foot, and there are no designated trails in these areas. The designated Black Swamp OHV area contains approximately 8-10 miles of OHV routes, which are outside the wilderness.

Opportunities and Limiting Factors: High water tables, highly flammable vegetation, ignitable soils, poor access, and low fertility complicate management opportunities. A high percentage of the MA could present extreme fire management concerns. The tremendous size of habitat patches, relatively small habitat edge, and ownership fragmentation of the Croatan pocosins greatly affect management opportunities and limitations on the CNF. Extensive pocosins, although regionally rare, locally support only moderate levels of biological and scenic diversity. Diversity will remain low if fire disturbance is excluded for more than a decade.

There is potential for longleaf restoration on wet savannas and flatwoods (LT 09), currently occupied by loblolly pine and pond pine types. There is also potential for longleaf pine restoration on mesic savannas and flatwoods (LT 10). These sites are currently occupied by loblolly pine, pond pine, and hardwoods.

Opportunities exist for further reducing human associated disturbances in the black bear habitat management prescription by implementing year-round or seasonal road closures. Closing of unauthorized access routes, some existing degraded OHV trails, and several dead-end spur roads would reduce open-road density. Also, opportunities exist to improve bear habitat through prescribed burning of pocosins and establishing roadside softmast buffers on the closed roads.

Since Brice Creek, including portions of West and East Prong Creeks, is eligible for wild and scenic river status, opportunities exist to manage those portions on NF land for their outstandingly remarkable values.

Management Area 3

General Description: Management Area 3 is the third largest, 55 percent of which is national forest. It forms almost the entire western boundary of the forest and includes a transition zone between the large central pocosin and rural land along the White Oak River. The CNF occupies about half of the MA and is fragmented by ownerships in the western part. Boundaries between the CNF and private land are over 90 miles long, the most extensive of all management areas. Two management prescriptions dominate the MA: Red-Cockaded Woodpecker HMA, and hardwood-cypress wetlands.

Physical and Biological Profile: The topography is generally level except along the four major streams that dissect the area. This MA has the highest diversity of ecological types on the CNF, including all 14 landtypes identified on the forest. These landtypes are represented in 427 separate patches; only MA 4 has more patches. Soils are generally poorly to very poorly drained, but many acres are better drained sites. In general, soil texture is loamy or claylike, and sites are productive.

Table A-8 - Landscape Composition and Configuration for MA 3.

Landtype	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Acres	1094	2393	318	320	478	2796	9172	2227	3505	4757	1105	93	9	135	0	28402
Frequency	12	36	7	7	20	29	53	29	93	90	37	4	1	9	0	427
Ave. patch	91	66	45	46	24	96	173	77	38	53	30	23	9	15	0	67
Private land boundary=91 miles					Total landtype edge=473 mile						Total edge per square mile=11 miles					

1. Tidal Streams and Estuaries
2. Lake and Stream Swamps
3. Stream and River Terraces
4. Drainage Slopes
5. Dissected Interstream Flats
6. Broad Undissected Interstream Flats
7. Peat Mantled Forest Wetlands
8. Raised Peatlands
9. Wet Pine Savanna/Flatwoods
10. Mesic Pine Savanna/Flatwoods
11. Dry Mesic Pine Savanna
12. Xeric Pine Savanna
13. Maritime Ridge/Dune Forests
14. Water
15. Altered Land

Habitat edge and patch size are significantly different from the adjacent MAs 2 and 4. Dominant landtypes include: peat-mantled forested wetlands, mesic longleaf pine savannas and flatwoods, wet longleaf pine savannas and flatwoods, broad undissected interstream flats, lake and stream swamps, raised peatlands, and dry-mesic longleaf pine savannas.

Four landtypes are more common in this MA than elsewhere on the CNF: Tidal streams and estuaries (85 percent of CNF total), Dry-mesic longleaf pine savannas (50 percent of CNF total), mesic longleaf pine savannas and flatwoods (39 percent of CNF total), and lake and stream swamps (30 percent of CNF total). Three landtypes occur in more extensive patches than in other MAs: tidal streams and estuaries (91 acre average patch), broad undissected interstream flats (96 acre average patch), and drainage slopes (46 acre average patch).

Loblolly pine is the most common species and occupies many acres more suitable for longleaf pine. Longleaf occupies about one-third of the potentially-suited longleaf acres. The most extensive swamp forests on the CNF occur in this MA, and extensive hardwood forests occur near drainages. Nearly half of the cypress- and hardwood-dominated forests exceed 70 years in age and many of the more remote swamps have much older patches of trees. Pond pine forests, including some approaching old-growth condition, dominate in the transition to the central pocosin and large marshlands along the western boundary.

Due in part to an aggressive prescribed burning program in this MA, almost half has hardwood/pine leaf litter fuels. No low pocosin is located here, and only a small percentage of the MA is in a high pocosin fuel condition. There are no designated wildland urban interface areas in MA 3.

Currently, this MA has both active RCW clusters with eight breeding pairs. Their annual rate of fledgling production is the highest for the Croatan population.

MA 3 provides a wide range of wildlife habitats. Wildlife openings and agricultural fields provide high-quality habitat for upland game species and nongame bird species that depend on early successional old-field habitat. The pine and pine hardwood forests provide good habitat for turkeys and deer, and the network of hardwood cypress wetlands provides travel corridors, denning sites, and hardmast for a variety of game and nongame species.

Cultural and Economic Profile: The junction of Highway 58 and Highway 24 is an area of high-traffic use and a concentrated population center. Roads also have high impact on ecotones and Special Interest Areas (natural areas).

The landscape changes from the remote land of MA 2 to roaded natural appearing landscapes of MA 3. The forests on private and public land appear cultivated due to the symmetric rows of loblolly pine plantations. Land-based recreation opportunities feature motorized use in a forest setting. Most recreation use is water-based, focusing on the White Oak River corridor and adjacent streams. Cedar Point campground is nestled in a mixed pine-hardwood forest with an open understory. The recreation area also serves as take-off points for hikers and canoeists who want to experience the estuary.

Recreation development will be concentrated near water, primarily along the White Oak River. Hardwood-cypress wetlands will be key travel corridors for wildlife, linking the remote pocosin habitats with the White Oak River. These wetlands will provide much of the undisturbed habitat for neotropical migratory birds.

Opportunities and Limiting Factors: Poor drainage and high water tables limit equipment use in much of the area. Rapid growth of hardwoods and shrubs on these productive sites adds to the difficulty of midstory control in RCW management. However, RCW augmentation is greater here than in all other MAs; a small percentage of the suitable RCW nest and forage areas are occupied.

This MA presents the most complex management situation on the CNF, due to its high habitat diversity, extent of landtypes, habitat fragmentation, and length of the boundaries with private land. Only MA 6 has experienced more fragmentation of habitats. A potential exists to restore longleaf pine on wet savannas and flatwoods (LT 09) occupied by loblolly and pond pine types. There is also potential for longleaf restoration on mesic savannas and flatwoods (LT 10) and dry-mesic savannas (LT 11).

Opportunities exist to use short-interval, low-intensity fires in longleaf pine savannas to increase the grass fuel type.

The high percentage of heavily used public roads limits the feasibility for road management to improve wildlife habitat conditions. However, seasonal or year-round closure of several roads would reduce

wildlife disturbance, improve opportunities for still hunting and walk-in spring turkey hunting, and expand the availability of linear grass-forb wildlife openings.

Since the White Oak River corridor is eligible for wild and scenic river status, opportunities exist to manage those portions on NF land for their outstandingly remarkable values.

Management Area 4

General Description: This MA forms much of the southern boundary of the forest. It contains one of the more distinctive landscapes on the Croatan. Although nearly half of the MA is in private land, this MA has a very large contiguous block of national forest land. Portions of the eastern edge are fragmented by urban areas and highways. The boundary between CNF and private land is approximately 66 miles long. Pine savanna and flatwoods and small to medium pocosin patches dominate the public land.

Physical and Biological Profile: The topography is dominated by ridges and swales that reflect an old ocean shoreline. This landform pattern is highly variable and supports 13 of the 14 landtypes described on the CNF. Soils range from very poorly drained to excessively drained sands. Productivity is typically poor due to low fertility or excessive drainage.

Table A-9. Landscape Composition and Configuration for MA-4.

Landtype	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Acres	11	1386	0	2	92	105	709	8026	4643	2334	665	1025	34	27	53	19112
Frequency	2	16	0	1	9	5	23	62	195	117	22	43	3	6	5	509
Ave. patch	6	87	0	2	10	21	31	129	24	20	30	24	11	5	11	38
Private land boundary=66 miles						Total landtype edge=437					Total edge per square mile=15 miles					

1. Tidal Streams and Estuaries
2. Lake and Stream Swamps
3. Stream and River Terraces
4. Drainage Slopes
5. Dissected Interstream Flats
6. Broad Undissected Interstream Flats
7. Peat Mantled Forest Wetlands
8. Raised Peatlands
9. Wet Pine Savanna/Flatwoods
10. Mesic Pine Savanna/Flatwoods
11. Dry Mesic Pine Savanna
12. Xeric Pine Savanna
13. Maritime Ridge/Dune Forests
14. Water
15. Altered Land

Within this MA, total habitat edge is 437 miles in length or 15 miles of edge per square mile. Only MA 6 has greater habitat edge density but much of its edge is due to private land boundaries. The edge in MA 4 is due more to ecological diversity. Patch size is significantly different from adjacent MAs 2 and 3. Dominant landtypes include raised peatlands (mostly with mineral soils), wet longleaf pine savannas and flatwoods, mesic longleaf pine savannas and flatwoods, lake and stream swamps, and xeric longleaf pine savannas. Wet longleaf pine savannas and flatwoods, xeric longleaf pine savannas, and maritime ridge and dune forests are more extensive here than elsewhere on the CNF.

Longleaf pine and pond pine are the predominate species, with longleaf pine occupying a greater share of the average here than in any other MA. The Newport River forms an extensive network of swamp to the north and east. Nearly one-third of all sites supporting longleaf pine occur in this MA. Density of RCW clusters is also highest in this MA, with over half of the active clusters occurring here.

The extensive patches of longleaf pine savannas and flatwoods are represented by a grass fuel model in about a quarter of the area. Pond pine is interspersed among these longleaf patches. Fuel types found in

this MA include high pocosin fuels, pocosin fuels, southern rough fuels, and hardwood and pine leaf litter.

The MA supports more longleaf pine and more RCW clusters than all other MAs, but their annual rate of fledgling production is the second lowest among the Croatan population.

Cultural and Economic Profile: About 12 percent of the MA is in urban or rural agricultural land. Highway 24, a primary highway, traverses the entire southern boundary.

The open stands, sandy soil, unique ecosystems, and plant communities attract hikers and naturalists. Most of the recreational use and demands are for dispersed activities like nature hikes, horse and mountain bike trails, and hunting.

The RCW HMA dominates the MA and provides the landscape matrix. Its boundary was designed to maintain the character of longleaf pine ridges and flatwoods in connected blocks. The greatest number and diversity of Special Interest Areas (natural area) occurs in this MA and reflects the variety, distribution, and concentration of high-quality ecological conditions found in the southern portion of the CNF.

More than all other MAs, the desired condition in this MA emphasizes maintaining the unique character of existing natural-appearing landscapes. The continued emphasis on prescribed burning as the primary management tool in the MA will further improve habitat for RCW and stimulate moderate increases in their population.

Opportunities and Limiting Factors: There are few limitations to equipment use or prescribed burning in this MA. However, a large amount of wildland-urban interface and pocosin fuels are common. The concern with organic soil ignition is not critical because pocosins occur on mineral soils with only a thin peat layer.

This MA presents one of the most complex management situations on the CNF, due to small, average patch size and habitat diversity. Most of the extensive habitat edge in the MA is between longleaf pine savannas and high pocosins. This ecotone supports many rare species, which affects fire behavior because of the abrupt change in fuel types.

Management Area 5

General Description: This management area represents an important physical and biological link to fragmented habitats to the north and south. The boundaries between the CNF and private land are approximately 42 miles long. Access through most of the MA is limited.

Physical and Biological Profile: The topography is level and dissected by only shallow streams. Landform pattern is not complex and includes 11 landtypes represented in 141 patches. However, the MA is dominated by just two landtypes. Soils are mostly very poorly to poorly drained and have coarse to fine loamy textures or deep organic horizons.

Table A-10. Landscape Composition and Configuration MA-5.

Landtype	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Acres	79	823	243	0	6	908	11456	4808	537	390	249	18	0	5	8	19539
Frequency	2	12	2	0	1	20	19	20	35	19	5	3	0	2	1	141
Ave. patch	39	69	122	0	16	45	603	240	15	21	50	6	0	3	8	139
Private land boundary=42miles					Total landtype edge=159 miles						Total edge per square mile=5 miles					

1. Tidal Streams and Estuaries
2. Lake and Stream Swamps
3. Stream and River Terraces
4. Drainage Slopes
5. Dissected Interstream Flats
6. Broad Undissected Interstream Flats
7. Peat Mantled Forest Wetlands
8. Raised Peatlands
9. Wet Pine Savanna/Flatwoods
10. Mesic Pine Savanna/Flatwoods
11. Dry Mesic Pine Savanna
12. Xeric Pine Savanna
13. Maritime Ridge/Dune Forests
14. Water
15. Altered Land

This MA has the second largest average patch size on the CNF. Edge and patch size are significantly larger than in adjacent MA 6. Dominant Landtypes include peat-mantled forested wetlands and raised peatlands. Peat-mantled forested wetlands occur in larger patch sizes and are more common in this MA than elsewhere on the CNF (36 percent of CNF total). On the other hand, wet longleaf pine savannas and flatwoods have the smallest patch size in this MA.

Pond pine is the most common species and typically forms extensive old stands with nearly closed canopies. It also occurs in two moderate-sized pocosins with dense evergreen shrubs. Four creeks form swamplands dominated by hardwoods. Mixed stands of loblolly, longleaf, and pond pine also occur. Pond pine and pocosin communities dominate the vegetation in this MA. The most extensive old stands of pond pine occur in this MA. Some of these forests are in or near the wildland-urban interface and therefore old-growth restoration opportunities may be limited in these areas. Longleaf pine occurs in small stands on the fringes of pond pine forests, and occupies nearly all suitable longleaf sites.

Fuel types found in this MA include grass fuel, high pocosin fuel, low pocosin fuel, southern rough fuel, and hardwood/pine leaf litter fuel. This management area has designated wildland urban interfaces.

Much of this area is suitable bear habitat and links the interior of the CNF with riverine habitats to the northeast. Therefore, this area serves as a travel corridor for bears.

Cultural and Economic Profile: There are no agricultural or urban uses of this land, but adjacent to this MA is the town of Havelock and Highway 70, which creates a wildland-urban interface along the northwest boundary. The number of people living near this MA is growing and placing an increased demand on national forest land to help provide community facilities.

A major road corridor, highway 70, separates large roadless tracts with high traffic levels. This road corridor in a rural setting creates a band that splits the MA and provides views of natural appearing pond pine stands that contrast with the extensive development on private land in the road corridor. Most recreation use is dispersed and centers on the 22-mile Neusiok Trail. Hunting occurs primarily in the pocosin roadless areas. Developed use is low and occurs at the water-based Oyster Point primitive camp area.

The pattern of management prescriptions reflects the natural composition and configuration of large contiguous habitat patches found in the MA. The black bear prescription is designed to maintain the integrity of forested wetlands and raised peatlands. The most extensive wildland-urban interface prescription occurs in this MA.

Prescribed burning will be the primary tool used to create a mosaic of vegetation structures within large pocosin patches. MA 5 is less remote than MA 2 and major highways and residential roads afford greater visibility of landscapes.

Opportunities and Limiting Factors: Limiting factors in this MA include high water tables, dense pocosin in the WUI, and high fuels. Management concerns due to landscape composition and configuration are similar to MA 2. Large wetland patches with little interior edge but significant private land boundary present a fairly homogenous landscape having relatively low biological diversity and scenic value. Fire suppression in ecosystems such as these, where volatile pocosin fuels occur in such large patch sizes, significantly increase the probability of uncontrolled wildfire and risk to human health. Conditions dictate the need for an extensive fuel break in the wildland-urban interface zone that can be used to slow the rate and spread of wildfire.

Management Area 6

General Description: This large MA forms the eastern boundary of the CNF. It is irregular in shape and contains uplands along the Neuse River and its tributaries. Forest Service ownership is highly fragmented and consists of numerous isolated tracts. Only 23 percent of the MA is managed by the CNF. The boundaries between the CNF and private land are nearly 90 miles in length. This MA and MA 3 have the longest private land boundaries on the CNF.

Other land is essentially a mixture of urban tracts, a military base, a major highway, and scattered rural farmland. The largest block of contiguous Forest Service ownership is bounded by the Neuse River to the north and Marine Corps Air Station (MCAS)-Cherry Point to the west.

Physical and Biological Profile: The topography is generally level but highly dissected by two large creeks and their extensive tributaries. These areas have some of the steepest slopes on the CNF. Landform pattern is very complex and only two ecological types identified on the CNF are absent from the area (dry-mesic longleaf pine and xeric longleaf pine savannas). The 13 landtypes occurring in the MA are represented in 268 separate units or patches. Soils are highly variable but mostly very productive. Most of the better drained sites are in private ownership.

Table A-11. Landscape Composition and Configuration for MA-6.

Landtype	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Acres	120	835	1973	564	983	2836	1389	102	845	2142	0	0	7	17	37	11850
Frequency	12	31	14	19	30	55	32	7	6	46	0	0	1	10	5	268
Ave. patch	10	27	141	30	33	52	43	15	141	47	0	0	7	2	7	44
Private land boundary=84 miles					Total landtype edge=256					Total edge per square mile=14 miles						

1. Tidal Streams and Estuaries
2. Lake and Stream Swamps
3. Stream and River Terraces
4. Drainage Slopes
5. Dissected Interstream Flats
6. Broad Undissected Interstream Flats
7. Peat Mantled Forest Wetlands
8. Raised Peatlands
9. Wet Pine Savanna/Flatwoods
10. Mesic Pine Savanna/Flatwoods
11. Dry Mesic Pine Savanna
12. Xeric Pine Savanna
13. Maritime Ridge/Dune Forests
14. Water
15. Altered Land

Edge density is highest here and in MA 4. Much of the edge here is due to fragmentation of landtypes. Total habitat edge and density are significantly different from the adjacent MAs 5 and 7. Dominant landtypes include broad undissected interstream flats, mesic longleaf pine savannas and flatwoods, stream and river terraces, dissected interstream flats, and lake and stream swamps.

Four landtypes are more common in this MA than elsewhere on the CNF: stream and river terraces (75 percent of CNF total), drainage slopes (55 percent of CNF total), dissected interstream flats (42 percent of CNF total), and broad undissected interstream flats (35 percent of CNF total). Two landtypes occur in more extensive patches than in other MAs: stream and river terraces and wet longleaf pine savannas and flatwoods. Raised peatlands and lake and stream swamps have the smallest average patch size found on the CNF.

Loblolly pine and longleaf pine are the most common species and may occur with pond pine in mixed stands. This MA has the most extensive young loblolly plantations on the forest and most of these are on sites with poor drainage. Most National Forest land is dominated by loblolly pine or scattered mesic longleaf pine. This MA has the smallest percentage of stands exceeding 80 years in age and the most extensive young loblolly plantations. However, the largest block of contiguous upland hardwood forests and potential hardwood sites on the Croatan occurs in this MA. Also of significance are the longleaf stands that could link the forest's northern and southern RCW populations.

Fuel types on this MA include grass fuel, high pocosin, southern rough fuel, and hardwood and pine leaf litter fuel. A small portion of the pocosin wildland urban interface is in this MA, and none of the MA is in wilderness.

This MA contains low numbers of RCWs. Loblolly pine is the most common species on upland sites and occupies many acres suitable for longleaf pine. This MA consists of two moderately large patches of mixed-pine wet flatwoods, hardwood forests, and longleaf pine savannas highly dissected by two large creeks and their extensive tributaries. This area is highly fragmented by developments on private land.

Cultural and Economic Profile: About 21 percent of this land is used for agricultural or urban purposes. This MA has the highest road mileage. Population centers include Havelock, the Highway 70 corridor, and MCAS-Cherry Point.

Recreation use and demand are high, particularly along the Neuse River. The developed recreation capacity range from rustic at Siddie Fields to high amenities at Flanners Beach. Activities include fishing, boating, camping, swimming, and hunting.

This MA contains an important corridor for RCW between the northern and eastern portions of the CNF. Although this linkage would consist of a narrow corridor of small habitat patches, it could provide a passageway for RCW and a scenic forest landscape along Highway 70.

Opportunities and Limiting Factors: High water tables limit equipment use and forest management activities. The wildland-urban interface zone is extensive and isolated stands are difficult to manage. A very small percentage of the potentially suitable RCW habitat is occupied, but more than half is suitable for the species. Many stands dominated by loblolly pine are on suitable hardwood or hardwood-pine sites.

CNF ownership in this MA is significantly fragmented into small isolated tracts or those having long and irregular boundaries. This fragmentation severely affects the physical and biological linkages

between adjacent MAs. Potential black bear travel corridors are limited, and RCW populations in the northern part of the CNF may potentially become isolated from those in the south. There are few management options available that can reduce this fragmentation and reestablish biological linkages. The extensive boundary also reduces management options such as the use of prescribed burning because of the risk of fire escape and potential excessive smoke.

Management Area 7

General Description: This MA is the smallest on the CNF. It is linear in shape and represents the transition in drainage and land use between the highly fragmented MA 6 to the east and the contiguous central pocosin in MA 2. Over half of the land in the MA is privately owned; 45 percent is national forest land. The boundary between the CNF and private land is nearly 44 miles long. The RCW HMA, river corridors eligible for wild and scenic river status, and short-rotation pine production will dominate the MA.

Physical and Biological Profile: The topography is level, and only shallow streams dissect the landscape. Landform is highly patterned, but not complex. Only nine landtypes occur, and forested wetlands dominate over half of the MA. All landtypes are represented in 158 separate units or patches, about the same number as found in adjacent MA 6. Soils are mostly poorly drained to very poorly drained and have a claylike or loamy texture. Most sites are productive.

Table A-12. Landscape composition and configuration for MA 7.

Landtype	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Acres	0	1130	88	21	38	376	5800	588	1311	1051	0	0	0	0	0	10403
Frequency	0	17	3	2	4	21	27	20	28	36	0	0	0	0	0	158
Ave. patch	0	66	29	10	10	18	215	29	47	29	0	0	0	0	0	66
Private land boundary=44 miles						Total landtype edge=167 Total edge per square mile=10 miles										

1. Tidal Streams and Estuaries
2. Lake and Stream Swamps
3. Stream and River Terraces
4. Drainage Slopes
5. Dissected Interstream Flats
6. Broad Undissected Interstream Flats
7. Peat-Mantled Forest Wetlands
8. Raised Peatlands
9. Wet-Pine Savanna/Flatwoods
10. Mesic-Pine Savanna/Flatwoods
11. Dry-Mesic-Pine Savanna
12. Xeric-Pine Savanna
13. Maritime-Ridge/Dune Forests
14. Water
15. Altered Land

Average patch size is significantly greater than in adjacent MA 2 and patch density is significantly less than in adjacent MA 6. Dominant landtypes include peat-mantled forested wetlands, wet-longleaf-pine savannas and flatwoods, lake and stream swamps, and mesic-longleaf-pine savannas. Two landtypes have the smallest average patch size found on the CNF: Broad undissected intersteam flats (18-acre average patch size) and dissected interstream flats (10 acre average patch size).

Loblolly pine, pond pine, and hardwoods dominate the MA and occur on some sites more suitable for longleaf pine. Longleaf pine dominates the sand ridges. Many stands are comprised of mixed pine species, including pond pine and longleaf pine. This MA has a matrix of mixed-pine-mesic flatwoods, and bottomland hardwood sites and a moderate-sized pocosin dissected by an extensive series of sand ridges. These sand ridges are dominated by longleaf-pine savannas.

Fuel types found in this MA include grass fuel, high pocosin fuel, southern rough fuel, and hardwood/pine leaf litter fuel.

This MA contains numerous RCW clusters that are currently active, including breeding pairs. The annual rate of fledgling production is highest among the Croatan population.

Cultural and Economic Profile: Less than 1 percent of the land is used for agriculture or urban purposes. This MA is adjacent to wilderness, roadless areas, and black bear habitat, but road use in the area influences the character of these resources. Highway 70 runs through the MA and there is concentrated commercial and residential development nearby. Catfish Lake Road, a heavily traveled rural corridor, divides the MA.

Recreation use is moderate, and demands are growing for horse and mountain bike trails. This dispersed use currently occurs on open and closed roads. There is also high hunting use. The portions of Brice Creek and East Prong Creek that are eligible for wild and scenic river status flow through the MA. Opportunities exist to add minimum development access points to these creeks.

The large amount of ownership fragmentation will affect the range of recreation opportunities in this MA. This area, along with the naturally appearing scenery in the river corridor eligible for wild and scenic river status, will improve the scenic quality of the landscape. Dispersed recreation trail use may increase, and the experience of the trail users will be enhanced by the quality of the scenery.

Ownership fragmentation in the eastern and southern portion of this MA result in isolated habitat and prescription patches. A primary desired condition is to link MA 1 to MA 5 through the RCW HMA management prescription within MA 7. This linkage would serve a critical biological need of the expanding RCW population. It would also provide a protective buffer from wildfires that begin in the central pocosin (MA 2) and spread toward urban areas in MA 6.

Opportunities and Limiting Factors: Poor drainage and high water tables severely limit equipment use and forest management practices in most of the MA. Although RCW cluster density is high, less than half of the suitable RCW nest and forage areas are occupied. Many rare species occur along the linear sand ridge and ecotones in this MA.

Except for one isolated CNF tract, the southern part of the MA is entirely within private land. As with the adjacent MA 6, habitat fragmentation has severely affected the biological linkages for black bear and RCW. Few management options, except land acquisition, are available that would reestablish these important biological linkages.

APPENDIX B: Fuel Models and Fire Compartments

Fuel Model Description

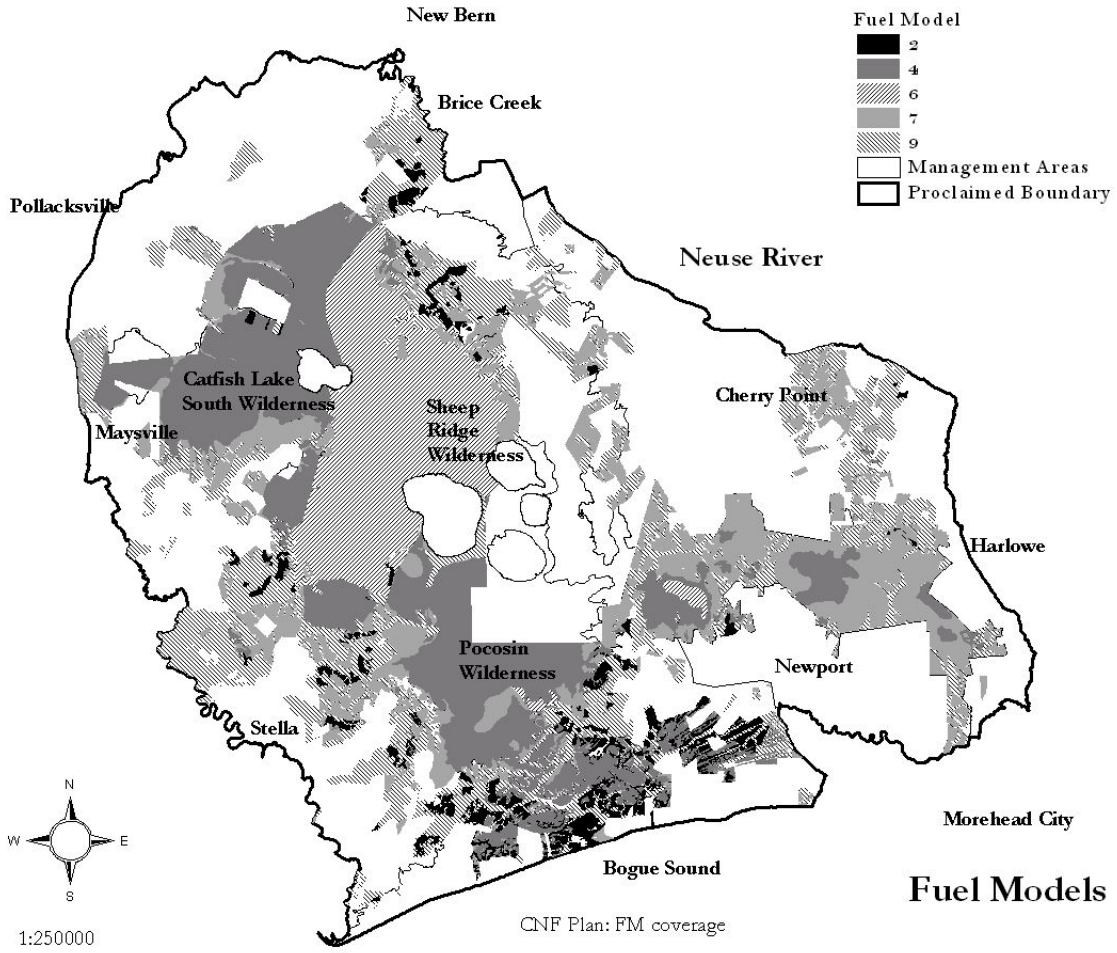
Several variables were incorporated in the development of a fuels analysis on the Croatan National Forest. The primary variables included forest type and fire history (1979-1996). Complete prescribed fire records only dated back to 1979. District personnel were interviewed to outline large wildfires from 1979 to 1996. "Fire occurrence" is used to describe both prescribed fire and wildfire activity in this analysis. Other variables used in the analysis included potential natural vegetation (PNV), soil map units, site index, and thinning treatments.

Fuel models (Anderson, 1982) were selected to best describe these conditions. A fuel model is a list of numbers that describe the fuel bed in such terms as fuel bed depth, load and heat content. It provides a means of organizing fuels data for input into the fire behavior model. The fire behavior model is used to help predict characteristics that a fire might display under specified conditions. The following fuel models (FM), based on Anderson's AIDS TO DETERMINING FUEL MODELS FOR ESTIMATING FIRE BEHAVIOR (1982), were determined to be of interest .

Fuel Model 2	A grass fuel model (FM2) occurring in longleaf pine stands that have been in a "3-year or less" burning rotation for several years. In FM 2, fire is spread primarily through the fine herbaceous fuels, either curing or dead. These are surface fires where the herbaceous material, besides litter and dead-down stemwood from the open shrub or timber overstory, contribute to the fire intensity (8,200 acres current).
Fuel Model 4	High pocosin conditions (FM4) occur in areas of very poorly drained soils including Croatan, Murville and Bayboro, which support pond pine and loblolly pine forest types, and have a Potential Natural Vegetation (PNV) of Pocosin, but have had no fire occurrence in at least 17 years (since 1979). Fire intensity and fast-spreading fires in this fuel type involve the foliage and live and dead fine woody material in the crowns of a nearly continuous secondary overstory. In addition to flammable foliage, dead woody material contributes significantly to fire intensity. The height of stands qualifying for this model depends on local conditions. There may also be a deep litter layer or organic soil that confounds suppression efforts. (42,400 acres current)
Fuel Model 6	Low pocosin (FM 6) represents areas of deep organic soils (organic > 51") such as Dare, which support pond pine forest types and have a PNV of Pocosin. Fire carries through the shrub layer where the foliage is generally flammable, but requires moderate winds (8mi/h at midflame height). Fire will drop to the ground at low windspeeds or openings in the stand. The shrubs are older, but not as tall as shrub types of FM 4, nor do they contain as much fuel as FM 4. However, once the deep organic soil ignites, fires become very difficult to extinguish, and causes severe smoke management problems (26,100 acres current).

Fuel Model 7 A southern rough fuel condition (FM 7) exists in pine forest types, which have had infrequent fire occurrences. Also included in FM 7 are pine stands that are fairly productive or have had thinning treatments. These stands are assumed to have somewhat open canopies which allow for substantial shrub layer development. Fires burn through the surface and shrub strata with equal ease and can occur at higher dead fuel moisture contents because of the flammable nature or live foliage and other live material. Stands of shrubs are generally between 2 and 6 ft. high. (36,500 acres current)

Fuel Model 9 A hardwood/pine leaf litter fuel model (FM 9) is found in hardwood drainages and swamps, and mixed hardwood/pine types. This fuel model also captures other pine forest types with relatively closed canopies, as well as those that have had regular prescribed fire treatments. In general, these stands do not have the well-developed shrub understories found in those depicted by FM 7. Fires run through the surface litter at moderate rates of spread, but high winds will actually cause higher rates of spread than predicted by the fire behavior model. This is due to spotting caused by rolling and blowing leaves. Concentrations of dead-down woody material will contribute to possible torching out of trees, spotting, and crowning. (39,300 acres current)



Deriving Fuel Models

The CNF database contains ArcInfo coverage of fuel models called "FM". Parameters were selected to query the Croatan database. Overlap occurs within fuel models, but the queries were developed to prohibit overlap among fuel models. The following criteria were used to derive CNF fuel models. The spatial arrangement of fuel models is shown in Figure B-2.

Fuel Model 2: Longleaf pine forest types that have been prescribed burned in the last 3 years (1993-1996).

Fuel Model 4: Pond pine or loblolly pine forest types; PNV equal to Pocosin; soils of Croatan, Murville, or Bayboro; and no fire occurrence in the last 17 years (1979-1996).

Fuel Model 6: All Dare soils. Also includes pond pine or loblolly pine forest types with PNV equal to Pocosin and soil Map Units which are either Croatan, Murville, or Bayboro that burned during the 1994 Fish Day Fire. These areas are expected to succeed back to FM4 by the end of the current 10-year planning period.

Fuel Model 7: Loblolly pine forest types with no fire occurrence in the last 17 years (1979-1996); or:

- Loblolly pine plantations planted prior to 1983 (15+ years old) that have been thinned, have one fire occurrence in 5 years or greater (prior to 1991).
- Pond pine forest types with Site Index greater than or equal to 50, that have no fire occurrence in the last 17 years (since 1979) and soil Map Units not equal to Croatan.
- Longleaf pine forest types with Site Index greater than or equal to 70 and that have had one fire occurrence in the last 17 years (1979-1996).
- Longleaf pine forest types with no fire occurrence in the last 17 years (1979-1996).
- Pond pine or loblolly pine forest types with PNV of Pond Pine, Longleaf Savanna, or Mixed Pine.
- Loblolly pine forest types with no fire occurrence in the last 3 years (1993-1996), and only one fire occurrence prior to 1993.
- Loblolly/hardwood, slash pine, and shortleaf forest types with no fire occurrence 1979-1995, or one fire occurrence in 1996.
- Pond pine forest types with fire occurrence in the last 3 years (1993-1996), but no fire occurrences prior to 1993.
- Pond pine forest types with no fire occurrence since 1994.

Fuel Model 9:

- Longleaf pine forest types with Site Index less than 70, no fire occurrence in the last 3 years (1993-1996), but one fire occurrence from 1979-1993.
- Loblolly pine plantations planted prior to 1983 (15+ years old) that have been thinned and have had at least one fire occurrence in the last 5 years (since 1990).
- Loblolly pine plantations planted prior to 1983 (15+ years old) that have not been thinned, but have had fire occurrence in the last 17 years (since 1979).
- Loblolly pine forest types with more than one fire occurrence, the last occurrence being since 1991.
- Loblolly pine forest types with fire occurrence in the last 3 years (1993-1996).
- Pond pine forest types with more than one fire occurrence, the last occurrence being in the last 3 years (1993-1996).
- Hardwood forest types.

This analysis represents the current fuel conditions on the Croatan. With additional fire treatments, fuels can be expected to transition towards those fuel models that produce less intense fire behavior characteristics. As fire is excluded from the landscape, fuels will transition towards those models which produce more intense fire behavior characteristics in many areas.

Fire Behavior Analysis

These fuel models were then analyzed and rated relative to risk using BEHAVE, a Fire Behavior Prediction System. Fire behavior models require certain inputs including weather, fuel model, topography, and fuel moisture. Outputs are quantitative and include Rate of Spread (ROS), fire size, flame length, and fireline intensity. BEHAVE uses Rothermel's Fire Spread Model (Rothermel, 1972) to calculate fire behavior. There are several assumptions associated with the Fire Spread Model:

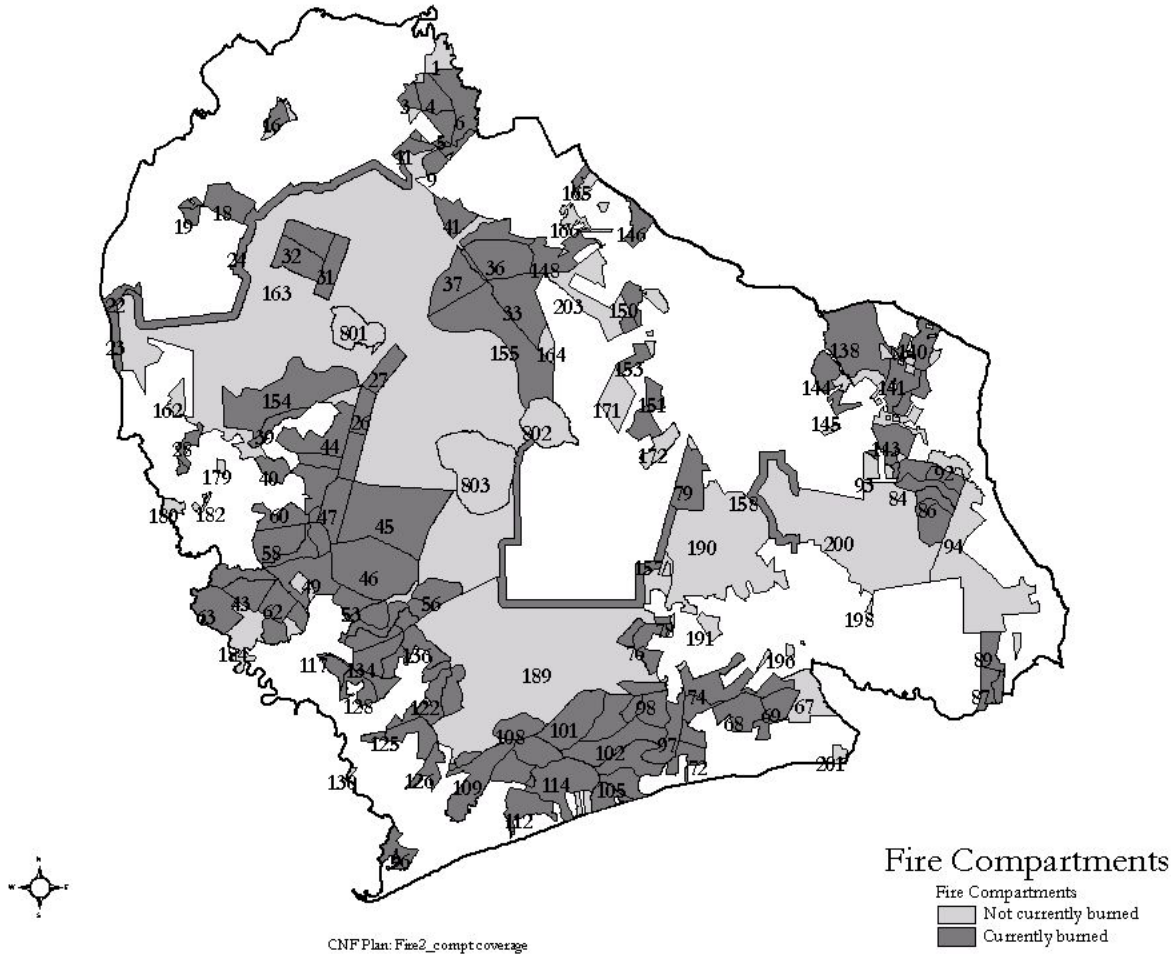
- Fire spread is predicted at the flaming front. It does not predict behavior for pile burning, or burnout after the fire front has passed.

- Fire spread is predicted for surface fire that is burning in a single layer near the ground. When the spread model is combined with other models within the BEHAVE program, it can help predict torching, spotting, or crowning fire behavior characteristics.
- The fire is free burning. It is no longer affected by the source of ignition or suppression action.
- Fire behavior is heavily weighted toward fine fuels. Fuels larger than 1 inch in diameter have little effect on ROS, and fuels larger than 3 inches in diameter have no effect.
- Only the foliage and fine stems of living plants are considered fuels. When moisture content is high, such plants can dampen fire spread. When moisture content drops below a critical level, however, living plants can increase the rate of fire spread.
- Fuels are continuous and uniform. While there are very few situations that will meet this assumption, the more uniform the fuel, the better the model predict the fire behavior.
- Fire spread is predicted for uniform weather and topography.
- The fire-spread model is designed for peak fire season usage. (NWCG, 1993).

Several runs were made using a range weather inputs for low, moderate, and high fire danger days as they might occur on the CNF. As expected, Fuel Models 2, 6, and 7 exhibited relatively rapid rates of spread and high flame lengths on high fire danger days, suggesting that fire suppression would best be accomplished using indirect attack methods. BEHAVE runs using these same fuel models on moderate and low fire danger days produced manageable rates of spread and flame lengths, making direct attack a viable suppression option.

BEHAVE runs for Fuel Model 9 predicted relatively manageable rates of spread and flame lengths, suggesting that direct attack would be an effective suppression method, even during high fire danger days. However, it is generally agreed that high winds can actually cause higher rates of spread in hardwoods due to blowing leaves, particularly during the fall. Concentrations of dead-down woody materials increases the possibility of torching, spotting, and crowing in fires occurring in Fuel Model 9.

Fuel Model 4 exhibited the most extreme fire behavior throughout the range of fire danger days. Predicted flame lengths greater than 8 ft. and rates of spread greater than 20 ch/hr., even on low fire danger days, make direct attack impossible in this fuel type. On high fire danger days, the model also predicted spotting distances up to ½ mile, increasing the risks associated with wildfire occurrences in Fuel Model 4.


Fire Compartments
Fire Compartments
Not currently burned
Currently burned
CNF Plan: Fire2_compt coverage

APPENDIX C: Rare Species

*Table C.1: Occurrence and status of rare (threatened, endangered, sensitive, and locally rare) species on the CNF. (Species with a documented occurrence on the CNF are **highlighted**).*

		STATUS			RANK		DOMINANT	LIFE-
SCIENTIFIC NAME	**COMMON NAME**	**F.S.**	**U.S.**	**N.C.**	**GLOBAL**	**N.C.**	**HABITAT**	**FORM**
Acipenser oxyrhinchus	Altantic sturgeon	S		SC	G3	S3	water	fish
Aeschynomene virginica	Sensitive jointvetch	T	T	E	G2	S1	marshes	plant
Agalinis aphylla	**scale-leaf gerardia**	**LR**		**SR-P**	**G3G4**	**S3**	**savanna**	**plant**
Agalinis virgata	**branched gerardia**	**LR**		**SR-P**	**G3G4Q**	**S2**	**savanna**	**plant**
Aimophila aestivalis	**Bachman's sparrow**	**S**	**FSC**	**SC**	**G3**	**S2S3**	**savanna**	**bird**
Alasmidonta undulata	triangle floater	LR		T	G4	S2	rivers	mollusk
Alligator mississippensis	**American alligator**	**T/SA**	**T/SA**	**T**	**G5**	**S3**	**water**	**reptile**
Ammodramus henslowii	**Henslow's sparrow**	**LR**		**SR**	**G4**	**S2S1**	**pocosin**	**Bird**
Andropogon mohrii	**bog bluestem**	**LR**		**SR-P**	**G4?**	**S1**	**savanna**	**Plant**
Anhinga anhinga	**anhinga**	**LR**		**SR**	**G5**	**S2SZ**	**water**	**Bird**
Asclepias pedicellata	**stalked milkweed**	**LR**		**SR-P**	**G4**	**S2**	**savanna**	**Plant**
Asplenium heteroresiliens	**Carolina spleenwort**	**S**	**FSC**	**E**	**G2Q**	**S1**	**marl**	**plant**
Atrytone arogos arogos	**arogos skipper**	**S**	**FSC**	**SR**	**G4T1T2**	**S1**	**savanna**	**insect**
Baetisca laurentina	a mayfly	LR		SR	G5	SU	rivers	insect
Botaurus lentiginosus	American bittern	LR		SR	G4	S1B,S3N	marsh	bird
Calopogon multiflorus	Many-flower grass pink	S	FSC	E	G2G3	S1	savanna	plant
Campylopus carolinae	savanna campylopus	S	FSC	SR-T	G1G2	S1	savanna	moss
Canus rufus	Red wolf	E-XN	E-XN	SR	G1	S1	swamps	mammal
Cardamine longii	Long's bittercress	S		SR-T	G3	S1	marsh	plant
CarexWildenowii megarrhyncha	**Southern Willdenow's Sedge**	**LR**		**SR-T**	**G5T3?**	**S1**	**marl**	**plant**
Circus cyaneus	Northern harrier	LR		SR	G5	S1B,S4N	marsh	bird
Cladium mariscoides	Twig-rush	LR		SR-O	G5	S2	bogs	plant
Cleistes bifaria	Small spreading pogonia	S		W7	G3G4	S2?	savanna	plant
Corynorhinus rafinesquii	Rafinesque's big-eared bat	S	FSC	(PT)	G3G4	S3	variable	mammal
Coturnicops noveboracensis	Yellow rail	LR		SR	G4	S2N	marsh	bird
Crotalus adamanteus	**E. diamondback rattlesnake**	**LR**		**(PE)**	**G4**	**S1**	**savanna**	**reptile**
Cylindrocolea rhizantha	a liverwort	S		SR-P	G3?	SH	marl	liverwort
Cystopteris tennesseensis	**Tennessee bladder-fern**	**LR**		**E-SC**	**G5**	**S1**	**marl**	**plant**
Dichanthelium hirstii	Hirst's panic grass	S	C	E	G1	S1	savanna	plant
Dionaea muscipula	**Venus flytrap**	**S**	**FSC**	**SR-L**	**G3**	**S3**	**savanna**	**plant**
Eleocharis robbinsii	**Robbins's spikerush**	**LR**		**SR-P**	**G4G5**	**S2**	**ponds**	**plant**
Eleotris pisonis	Spinycheek sleeper	LR		SR	G5	S2	water	fish
Euphyes berryi	**Berry's skipper**	**LR**		**SR**	**G3G4**	**S1?**	**ponds**	**insect**
Euphyes bimacula	**two-spotted skipper**	**LR**		**SR**	**G4**	**S2**	**marsh**	**insect**
Euphyes dukesi dukesi	Duke's skipper	S		SR	G3T3	S1S2	marsh	insect
Evorthodus lyricus	lyre goby	LR		SR	G5	S2	water	fish
Ferrissia hendersoni	blackwater ancylid	LR		SC	G?	S1	Lake margin	gastropod
Fissidens hallii	Hall's pocket moss	S		SR-T	G2	S1	swamp	moss
Frullania donnellii	A liverwort	S		SR-T	G3?	SH	marsh	liverwort

Table C.1: continued

		STATUS			RANK		dominant	LIFE-
SCIENTIFIC NAME	COMMON NAME	F.S.	U.S	N.C.	GLOBAL	N.C.	HABITAT	FORM
Fusconaia masoni	Atlantic pigtoe	S	FSC	(PE)	G2	S1	water	mollusk
Haliaeetus leucocephalus	**Bald eagle**	**T**	**T**	**(PT)**	**G4**	**S3B,S3N**	**near water**	**bird**
Hemipachnobia subporphyrea	Venus flytrap cutworm moth	S	FSC	SR	G1	S1?	savanna	insect
Helinium pinnatifidum	dissected sneezeweed	LR		SR-P	G4	S2	savanna	plant
Hesperia attalus slossonae	dotted skipper	S		SR	G3G4T3	S2S3	savanna	insect
Heterodon simus	Southern hognose snake	LR	FSC	(PSC)	G2	S2	sandhills	reptile
Himantopus mexicanus	black-necked stilt	LR		SR	G5	S2B	pond	bird
Hypsoblennius ionthas	freckled blenny	LR		SR	G5	S2	water	fish
Ictinia mississippiensis	Mississippi kite	LR		SR	G5	S2B	bottomland	bird
Isoetes microvela	quillwort	S		SR-L	G1	S1	riverbanks	plant
Kalmia cuneata	white wicky	S	FSC	SR-L	G3	S3	pocosin	plant
Lachnocaulon beyrichianum	**Southern bogbutton**	**S**		**W1**	**G2G3**	**S3**	**sandhills**	**plant**
Lampetra aepytera	least brook lamphrey	S		(PT)	G5	S2	water	fish
Lampsilis radiata radiata	Eastern lampmussel	LR		(PT)	G5	S1S2	water	mollusk
Lampsilis species 2	a bivalve	LR		SR	G1	S1	water	mollusk
Lanius ludovicia migrans	migrant loggerhead shrike	S		SC	G5T3Q	S3B,S3N	fields	bird
Lasmigona subviridus	green floater	S	FSC	E	G3	S1	water	mollusk
Lejeunea bermudiana	**a liverwort**	**LR**		**SR-P**	**G3G4**	**SH**	**swamp**	**liverwort**
Lejeunea dimorphophylla	a liverwort	S		SR-L	G2G3	S1	maritime	liverwort
Lithacodia sp.	a bird-dropping moth	LR		W3	G4	S1S3	pocosin	insect
Lithophane lemmeri	Lemmer's pinion	LR		SR	G3G4	S1S3	wetlands	insect
Litsea aestivalis	**pondspice**	**S**	**FSC**	**SR-T**	**G3**	**S2**	**pond**	**plant**
Lobelia boykinii	Boykin's lobelia	S	FSC	SR-T	G2G3	S1	savanna	plant
Ludwigia linifolia	**flaxleaf seedbox**	**LR**		**SR-P**	**G4**	**S2**	**pond**	**plant**
Ludwigia ravenii	Raven's seedbox	LR		SR-T	G2?	S2?	savanna	plant
Lynceus gracilicornis	graceful clam shrimp	LR		SR	G?	S2?	temp.water	crustacean
Lysimachia asperulifolia	**rough-leaf loosestrife**	**E**	**E**	**E**	**G3**	**S3**	**ecotones**	**plant**
Lythrurus matutinus	pinewoods shiner	LR	FSC	SR	G3	S3	water	fish
Macbridea caroliniana	Birds-in-a-nest	S	FSC	PT	G2G3	S2	swamp	plant
Malaxis spicata	**Florida adder's mouth**	**LR**		**SR-P**	**G4?**	**S1**	**swamp**	**plant**
Melanoplus attenuatus	slender-bodied melanoplus	S		SR	G2G3	S1S3	wet swales	insect
Melanoplus nubilus	a short-winged melanoplus	S		SR	G3?	S2S3	savanna	insect
Meropleon diversicolor sullivani	an owlet moth	LR		SR	G4T1T3	S1S3	marsh	insect
Metzgeria uncigera	a liverwort	S		W7	G3	S1	maritime	liverwort
Minuartia godfreyi	Godfrey's sandwort	S	FSC	E	G1	S1	marsh	plant
Myriophyllum laxum	**loose watermilfoil**	**S**	**FSC**	**T**	**G3**	**S1**	**pond**	**plant**
Necturus lewisi	Neuse river waterdog	LR		SC	G3	S3	water	amphibian
Neotoma floridana pop. 1	Eastern woodrat-coastal pop.	LR		T	G5T5	S1	forests	mammal
Nerodia sipedon williamengelsi	Carolina salt marsh snake	S		SC	G5T3	S3	marsh	reptile
Notropis bifrenatus	bridle shiner	LR		SC	G5	S1	water	fish

Table C.1: continued.

		STATUS			RANK		dominant	LIFE-
SCIENTIFIC NAME	COMMON NAME	F.S.	U.S.	N.C.	GLOBAL	N.C.	HABITAT	FORM
Nopturus furiosus	Carolina madtom	S		SC	G3T2Q	S2	water	fish
Nuphar saggitifolia	narrowleaf cowlilly	S		W1	G5T2	S2	water	plant
Ophisarus mimicus	**mimic glass lizard**	**S**	**FSC**	**SC**	**G3**	**S2**	**savanna**	**reptile**
Orconectes carolinensis	N.C spiny crayfish	LR		(PSC)	G3	S4	water	crustacean
Oxpolis ternata	Piedmont cowbane	S	FSC	W1	G3	S3	savanna	plant
Panicum tenerum	**Southeastern panic grass**	**LR**		**SR-P**	**G3**	**S3**	**savanna**	**plant**
Panopea bitruncata	Atlantic geoduck	LR		W3	G3?	S?	water	mollusk
Parietaria praetermissa	large-seed pellitory	S		SR-P	G3G4	S1	maritime	plant
Parnassia caroliniana	Carolina grass of parnassus	S	FSC	E	G3	S2	savanna	plant
Peltandra sagittifolia	**spoonflower**	**LR**		**SR-P**	**G3G4**	**S2S3**	**pocosin**	**plant**
Phalacrocorax auritus	**double-crested cormorant**	**LR**		**SR**	**G5**	**S1B,S5N**	**lake**	**bird**
Phragmitiphila interrogans	an owlet moth	LR		SR	G3G4	S2?	canebrake	insect
Picoides borealis	**Red-cockaded woodpecker**	**E**	**E**	**E**	**G3**	**S2**	**savanna**	**bird**
Pinguicula pumila	**small butterwort**	**LR**		**SR-P**	**G4**	**S2**	**savanna**	**plant**
Plagiochila miradorensis mirador.	A liverwort	LR		SR-P	G4?T4	SH	maritime	liverwort
Plantago sparsiflora	pineland plantain	S	FSC	E	G3	S1	savanna	plant
Platanthera integra	**yellow fringeless orchid**	**LR**		**T**	**G3G4**	**S1**	**savanna**	**plant**
Platanthera nivea	**snowy orchid**	**LR**		**T**	**G5**	**S1**	**savanna**	**plant**
Polygala hookeri	**Hooker's milkwort**	**S**		**SR-T**	**G3**	**S2**	**savanna**	**plant**
Polygonum hirsutum	**hairy smartweed**	**LR**		**SR-P**	**G4G5**	**S1**	**ponds**	**plant**
Ponthieva racemosa	**shadow-witch**	**LR**		**SR-P**	**G4G5**	**S2**	**swamp**	**plant**
Procambarus medialis	Tar River crayfish	S	FSC	W3	G2	S2	water	crustacean
Procambarus plumimanus	**Croatan crayfish**	**LR**	**FSC**	**W3**	**G3**	**S2S3**	**water**	**crustacean**
Ptichodis bistrigata	southern ptichodis	S		SR	G3	S2S3	savanna	insect
Puma concolor couguar	Eastern cougar	E	E	E	G5TH	SH	remote area	mammal
Pyreferra ceromatica	annointed swallow moth	LR	FSC	SR	GU	S1S2	near stream	insect
Rana capito capito	**Carolina gopher frog**	**S**	**FSC**	**(PT)**	**G3T3**	**S2**	**savanna**	**amphibian**
Rhexia aristosa	awned meadow-beauty	S	FSC	T	G3	S3	pond	plant
Rhexia cubensis	**West Indies meadow beauty**	**LR**		**SR-P**	**G4G5**	**S1**	**pond**	**plant**
Rhynchospora Harperi	**Harper's beakrush**	**LR**		**SR-P**	**G4?**	**S1**	**pond**	**plant**
Rhynchospora oligantha	**feather-bristle beakrush**	**LR**		**SR-P**	**G4**	**S2S3**	**savanna**	**plant**
Rhynchospora pleiantha	**coastal beaksedge**	**S**		**SR-T**	**G2**	**S1**	**pond**	**plant**
Rhynchospora scirpoides	**long-beak bald-sedge**	**LR**		**SR-O**	**G4**	**S2**	**pond**	**plant**
Rhynchospora thornei	Thorne's beaksedge	S	FSC	E	G1G2	S1	savanna	plant
Sagittaria graminea Chapmanii	**Chapman's arrowhead**	**S**		**SR-P**	**G5T3?**	**S1**	**pond**	**plant**
Sagittaria graminea weatherbiana	Chapman's arrowhead	S		SR-T	G5T2	S2	marsh	plant
Scirpus lineatus	**drooping bulrush**	**LR**		**SR-P**	**G4**	**S2**	**marl**	**plant**
Scleria baldwinii	**Baldwin's nutrush**	**LR**		**SR-P**	**G4**	**S1**	**savanna**	**plant**
Scleria Georgiana	**Georgia nutrush**	**LR**		**SR-P**	**G4**	**S2**	**savanna**	**plant**
Seminatrix pygaea	**black swampsnake**	**LR**		**SR**	**G5**	**S2**	**ponds**	**reptile**

Table C.1: continued.

		STATUS		RANK				
SCIENTIFIC NAME	COMMON NAME	F.S.	U.S.	N.C.	GLOBAL	N.C.	HABITAT	LIFE-FORM
Semotilus lumbee		S			G3	S3		fish
Solidago gracillima	**graceful goldenrod**	**LR**			**G4?**		**savanna**	**plant**
Solidago Leavenworthii	**Leavenworth's goldenrod**				**G3G4**	**S1**	**savanna**	
Solidago pulchra	**Carolina goldenrod**	**S**	**FSC**	**E**	**G3**	**S3**	**savanna**	**plant**
Solidago verna	**spring-flowering goldenrod**		**FSC**	**SR-L**		**S3**	**pinelands**	
Solidago villosacarpa	Coastal goldenrod			SR-L	G1	S1	maritime	
Spariniphaga carterae	Carter's spariniphaga	S	FSC	SR	G2G3	S2S3	savanna	insect
Sphagnum fitzgeraldii	**Fitzgerald's peatmoss**	**S**			**G2G3**		**pocosin**	**plant**
Spiranthes longilabris	**giant spiral orchid**	**S**		**SR-T**	**G3**	**S1**	**savanna**	**plant**
Strophitus undulatus	squawfoot	LR		T	G5G4	S2S3	water	mollusk
Synoptomys cooperi helaletes	Dismal Swamp S. bog lemming			SR	G5T3	S2	pocosin	mammal
Teloschistes flavicans	sunrise lichen	S		SR-P	G3G4	S1	maritime	lichen
Thalictrum macrostylum	Piedmont meadowrue	S		W7	G3G4	S2?	bog	plant
Tofieldia glabra	**Carolina asphodel**	**S**	**FSC**	**W1**	**G3**	**S3**	**savanna**	**plant**
Toxolasma pullus	Savannah lilliput	S	FSC	(PE)	G2	S1	water	mollusk
Utricularia olivacea	**dwarf bladderwort**	**LR**		**T**	**G4**	**S2**	**pond**	**plant**
Xyris flabelliformis	**savanna yellow-eyed grass**	**LR**		**W1**	**G4**	**S3**	**savanna**	**plant**
Xyris stricta	**a yellow-eyed-grass**	**LR**		**SR-P**	**G3G4**	**S1**	**savanna**	**plant**

Rare Species Habitat Groups

Maritime Forests
Lejeunea dimorphophylla - **liverwort** - on bark in maritime forests
Metzgeria uncigera – **liverwort** - bark of trees in maritime forests
Parietaria praetermissa - **vascular plant** - shell middens, maritime forests
Plagiochila miradorensis var. miradorensis - **liverwort** - on bark in maritime forests and swamps
Teloschistes flavicans – **lichen** - twigs in maritime forests

Marl associated
Asplenium heteroresiliens - **vascular plant** - coquina limestone (marl) outcorps
Carex willdenowii var. megarrhyncha - **vascular plant** - moist forests over marl
Cylindrocolea rhizantha - **liverwort** - on marl outcorps
Cystopteris tennesseensis - **vascular plant** - calcareous rock outcrops
Lejeunea bermudiana - **a liverwort -** marl outcrops, decaying logs in swamps
Minuartia godfreyi - **vascular plant** - marl outcorps?
Scirpus lineatus - **vascular plant** - low rich woods over marl

Marshes
Aeschynomene virginica - **vascular plant** - tidal marshes and wet ditches
Botaurus lentiginosus – **bird** - fresh or brackish marshes
Cardamine longii - **vascular plant** - tidal marshes and tidal cypress-gum forests
Circus cyaneus – **bird** - extensive brackish marshes
Cladium mariscoides - **vascular plant** - bogs- fens- brackish marshes- sandhill seepage bogs
Coturnicops noveboracensis – **bird** - fresh or brackish marshes, wet fields
Euphyes bimacula - **butterfly** - marshes- sedgy areas near wet woods; host plants—sedges (Carex)
Evorthodus lyricus – **fish** - Shallow tidal water
Frullania donnellii - **a liverwort** - on bark of Ilex in marshes
Hypsoblennius ionthas – **fish** - Shallow bays, estuaries, tidal creeks
Meropleon diversicolor sullivani – **insect** - coastal marshes
Minuartia godfreyi - **vascular plant** - tidal marshes
Nerodia sipedon williamengelsi - **reptile** - salt or brackish marshes
Sagittaria graminea var. weatherbiana - **vascular plant -** brackish marshes, swamps
Solidago villosacarpa (Solidago sp. 1) - **vascular plant** - edge of Coastal Plain evergreen forest

Pine Savannas and Sandhills
Agalinis aphylla - **vascular plant** - wet savannas, pocosin ecotones
Agalinis virgata - **vascular plant** - savannas
Aimophila aestivalis - **bird** - open Longleaf pine forests- old fields (breeding season only)
Andropogon mohrii - **vascular plant** - wet savannas
Asclepias pedicellata - **vascular plant** - dry savannas
Atrytone arogos arogos - **butterfly** - savannas- open pinewoods- and other relatively undisturbed grasslands; host plants grasses- mainly broomsedge
Calopogon multiflorus – **vascular plant** - savannas
Campylopus carolinae - **moss** - savannas
Cleistes bifaria – **vascular plant** - savannas
Crotalus adamanteus - **reptile** - pine flatwoods- savannas- pine-oak sandhills

Dionaea muscipula - **vascular plant** - savannas- seepage bogs- pocosin edges
Hemipachnobia subporphyrea – **insect** -savannas
Hesperia attalus slossonae – **insect** - pine-oak sandhills, flatwoods
Heterodon simus - **reptile** - sandy woods- particularly pine-oak sandhills
Lobelia boykinii - **vascular plant** - clay-based Carolina bays- wet pine savannas
Ludwigia ravenii - **vascular plant** - savannas, swamps
Lysimachia asperulaefolia – **vascular plant** – savanna-pocosin ecotone
Melanoplus attenuatus – **insect** - wet swales in pinewoods
Melanoplus nubilus – **insect** - flatwoods, savannas, sandhills
Ophisaurus mimicus - **reptile** - pine flatwoods- savannas- pine/oak sandhills
Oxypolis ternata - **vascular plant** - pine savannas, seeps
Panicum tenerum - **vascular plant** - wet savannas- sandhil seeps
Parnassia caroliniana - **vascular plant** - wet savannas
Picoides borealis - **bird** - mature open pine forests- mainly in longleaf pine
Pinguicula pumila - **vascular plant** - savannas
Plantago sparsiflora - **vascular plant** - wet savannas
Platanthera integra - **vascular plant** - savannas
Platanthera nivea - **vascular plant** - wet savannas
Polygala hookeri - **vascular plant** - savannas
Ptichodis bistrigata – **insect** -xeric sandhills
Pyreferra ceromatica – **insect** - flatwoods and pocosins with Fothergilla
Rana capito capito - **amphibian** - breeds in temporary fish-free pools: forages in sandy woods- especially pine-oak sandhills
Rhynchospora oligantha - **vascular plant** - savannas- seepage bogs
Rhynchospora scirpoides - **vascular plant** - wet savannas
Rhynchospora thornei - **vascular plant** -wet savannas
Scleria baldwinii - **vascular plant** - wet savannas
Scleria georgiana - **vascular plant** - savannas
Solidago gracillima -**vascular plant** - savannas, boggy sites
Solidago leavenworthii -**vascular plant** - savannas, pocosin borders, bays
Solidago pulchra - **vascular plant** - savannas
Solidago verna - **vascular plant** - dry pinelands
Spariniphaga carterae - **moth** - wet savannas; host plant—Calamovilfa- perhaps other grasses
Sphagnum fitzgeraldii - **moss** - pocosins and savannas
Spiranthes longilabris - **vascular plant** - savannas
Tofieldia glabra - **vascular plant** - savannas- sandhill seeps-moist sandhill, pocosin ecotones
Xyris flabelliformis - **vascular plant** - savannas
Xyris stricta - **vascular plant** - savannas

Pocosins
Ammodramus henslowii - **bird** - clearcut pocosins and other damp weedy fields (breeding season only)
Kalmia cuneata - **vascular plant** - pocosins
Lithacodia sp. – **insect** - pocosins, wetlands
Peltandra sagittifolia - **vascular plant** - pocosins- other wet- peaty sites
Synaptomys cooperi helaletes – **mammal** - early successional wet places, low pocosins

Swamps
Canis rufus – **mammal** - swamps, pocosins, extensive forests
Euphyes dukesi - **butterfly** - swamps (often near tupelo)- marshes; host plants—sedges
Fissidens hallii - **moss** - on bark in cypress-gum swamps
Macbridea caroliniana - **vascular plant** - blackwater swamps- savanna/pocosin ecotones
Malaxis spicata - **vascular plant** - swamp forests- calcareous but mucky outer coastal plains swamps
Ponthieva racemosa - **vascular plant** - blackwater forests and swamps- especially over marl

Ponds
Eleocharis robbinsii - **vascular plant** - limesink ponds- clay-based Carolina bays- peat-burn lakes
Eleotris pisonis – **fish** - fresh to brackish ponds, river mouths
Euphyes berryi - **butterfly** - wet areas near ponds- canals- or marshes; host plant not known; adults feed on pickerelweed (Pontederia)
Himantopus mexicanus – **bird** - fresh or brackish ponds
Ludwigia linifolia - **vascular plant** - limesink ponds
Myriophyllum laxum - **vascular plant** - limesink ponds- waters of natural lakes
Polygonum hirsutum -**vascular plant** - limesink ponds, bays, riverbanks
Rhexia aristosa - **vascular plant** - clay-based Carolina bays and limesink ponds
Rhexia cubensis - **vascular plant** - limesink ponds
Rhynchospora harperi - **vascular plant** - limesink ponds and cypress savannas
Rhynchospora pleiantha -**vascular plant** - limesink ponds
Sagittaria graminea var. chapmanii - **vascular plant** - limesink ponds
Utricularia olivacea - **vascular plant** - limesink ponds, beaver ponds

Other Water Bodies (in or near)
Acipenser oxyrhinchus oxyrhinchus - **fish**-coastal waters, large rivers
Alasmidonta undulata – **mollusk** - most river systems in Coastal Plain
Alligator mississippiensis - **reptile** - fresh to slightly brackish lakes- ponds- rivers- and marshes
Anhinga anhinga - **bird** - wooded lakes or ponds- or open swamps (for nesting)
Baetisca laurentina - **insect (aquatic)** -Trent River
Ferrissia hendersoni – **mollusk** - margins of Carolina Bay lakes
Fusconaia masoni - **freshwater bivalve** - upper Coastal Plain drainages
Haliaeetus leucocephalus - **bird** - mature forests near large water bodies (for nesting); lakes and sounds
Isoetes microvela – **vascular plant** - emergent riverbanks
Lampetra aepytera - **freshwater fish** - Tar and Neuse drainages
Lampsilis radiata – **mollusk** - number of river sytems
Lampsilis species 2 – **mollusk** - Neuse and Tar River drainages
Lasmigona subviridus - **freshwater bivalve** - Tar- Neuse- and Cape Fear systems downstate
Lynceus gracilicornis - **crustacean** - temporary ponds- pools- and ditches
Lythurus matutinus – **fish** - Tar and Neuse River drainages
Necturus lewisi - **amphibian** - rivers and large streams in Neuse and Tar drainages (endemic)
Notropis bifrenatus – **fish** - streams near lower Neuse River
Noturus furiosus - **freshwater fish** - Tar and Neuse drainages (endemic)
Nuphar saggitifolia - **vascular plant** - blackwater streams, rivers
Orconectes carolinensis – **crustacean** - Neuse River drainages
Panopea bitruncata – **mollusk** - marine
Phalacrocorax auritus – **bird** - lakes with scattered trees

Procambarus medialis - **crustacean** - sluggish streams and ditches in Tar and Neuse drainges (endemic)
Procambarus plumimanus - **crustacean** - rivers- ponds- ditches- and borrow pits in eastern Coastal Plain (endemic)
Seminatrix pygaea – **reptile** - lush vegetation of ponds, ditches or streams
Semotilus lumbee - **freshwater fish** - streams in the sandhills
Strophitus undulatus - **freshwater bivalve** - Tar- Neuse- Cape Fear- and Pee Dee systems
Toxolasma pullus – **mollusk** – a number of Atlantic drainages

Other Habitats

Corynorhinus rafinesquii – **mammal** - hollow trees, under bridges
Dichanthelium hirstii - **vascular plant** - cypress savannas
Ictinia mississippiensis – **bird** - mature bottomland forests
Lanius ludovicia migrans - **bird** - fields and pastures
Lithophane lemmeri – **insect** - cedar glades, Atlantic white cedar forests
Neotoma floridana pop. 1 – **mammal** - forests in moist areas
Phragmitiphila interrogans – **insect** - canebrakes
Puma concolor couguar – **mammal** – extensive forests, remote areas
Thalictrum macrostylum (=T.subrotundum) - **vascular plant** - bogs and wet woods

Attachment A. Status and Rank of Sensitive and locally rare species on the CNF.

Forest Service Status (F.S.) is designated by the U.S. Forest Service. Sensitive and locally rare species are protected under provisions of the National Forest Management Act and direction set forth in FS manual 2670.

Status Code	Status	Definition
S	Sensitive	Species at risk of extinction in a portion of their range as evidenced by downward trends in population numbers or density, or downward trends in habitat capability.
LR	Locally Rare	Species not at risk of extinction, even in a portion of their range, and not showing a downward population trend over their range as a whole but uncommon on the CNF and within NC.

United States Status (U.S.) is designated by the U.S. Fish and Wildlife Service. Federally listed Endangered and Threatened species are protected under the provisions of the endangered Species Act of 1973, as amended.

Status Code	Status	Definition
C	Candidate	"Taxa for which the [Fish and Wildlife] Service has on file enough substantial information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened." (Federal Register, February 28, 1996). Taxa formerly considered as 'Category 1' are now considered as 'Candidate'.
FSC	(Federal) Species of Concern	"Such species are the pool from which future candidates for listing will be drawn." (Federal Register, February 28, 1996).

North Carolina Status is designated by the North Carolina Natural Heritage Program. Endangered, Threatened, and Special Concern species have legally protected status in North Carolina through the North Carolina Plant Conservation Program.

Status Code	**Status**	**Definition**
E	Endangered	"Any native or once-native species of wild animal whose continued existence as a viable component of the State's fauna is determined by the Wildlife Resources Commission to be in jeopardy or any species determined to be an 'endangered species pursuant to the Endangered Species Act." (Article 25 of Chapter 113 of the General Statues; 1987). "Any species or higher taxon of plant whose continued existence as a viable component of the State's flora is determine to be in jeopardy" (GS 19B 106: 202.12).
T	Threatened	"Any native or once-native species of wild animal which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range, or one that is designated as a threatened species pursuant to the Endangered Species Act."(Article 25 of Chater 113 of the General Statutes;1987). "Any resident species of plant which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (GS 19B 106:202.12).
SC	Special Concern	"Any species of wild animal native or once-native to North Carolina which is determined by the Wildlife Resources Commission to require monitoring but which may be taken under regulations adopted under the provisions of this Article." (Article 25 of Chapter 113 of the General Statutes; 1987). " Any species of plant in North Carolina which requires monitoring but which may be collected and sold under regulations adopted under the provisions of [the Plant Protection and Conservation Act]" (GS 19B 106:202.12).
P_	Proposed	Species has been proposed by a Scientific Council as a status (Endangered, Threatened, Special Concern, Watch List, or for Delisting) that is different from the current status, but the status has not yet been adopted by the General Assembly as law. In this document, these proposed statuses are listed in parentheses.
SR	Significantly Rare	Any animal species which has been listed by the N.C. Wildlife Resources Commission as an Endangered, Threatened, or Special Concern species, but which exists in the state in small numbers and has been determined by the N.C. Natural Heritage Program to need monitoring – OR - Plant species which are very rare in North Carolina, generally with 1-20 populations in the state, generally substantially reduced in numbers by habitat destruction (and sometimes also by direct exploitation or disease).
-L	Limited	The range of the species is **limited** to North Carolina and adjacent states (endemic or near endemic).
-T	Throughout	These species are rare **throughout** their ranges.
-D	Disjunct	The species is **disjunct** to North Carolina from a main range in a different part of the country or world
-P	Peripheral	The species is at the **periphery** of its range in North Carolina. These species are generally more common somewhere else in their ranges, occurring in North Carolina peripherally to their main ranges, mostly in habitats which are unusual in North Carolina
-O	Other	The range of the species is sporadic or cannot be described by the **other** Significantly Rare categories

North Carolina Status *continued*

Status Code	Status	Definition
W	Watch List	Any other species believed to be rare and of conservation concern in the state but not warranting active monitoring at this time
W1		**Rare, but relatively secure:** includes rare species whose status in North Carolina is relatively well known and which appear to be relatively secure at this time.
W3		**Rare, but uncertain documentation:** includes species which have been reported from North Carolina without adequate documentation. This category includes sight records, old and vague reports for which no documentation has appeared, and, in a few cases, more recent literature reports for which the North Carolina Natural Heritage Program has not yet received documentation.
W7		Rare and poorly known: includs species with inadequate information about their distribution and rarity in North Carolina. These are generally species which have not been previously listed as rare in North Carolina, but which appear to be so, based on herbarium records and field experience of North Carolina Natural Heritage Program staff, contractees, and cooperating scientists.

Global Rank. A measure of rarity and threat that apply to the status of a species throughout its range, and are based on data on the species' status rangewide.

Rank	Number of Extant Populations	Description
G1	1-5	Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction.
G2	6-20	Imperiled globally because of rarity or because of some factor(s) making it very vulnerable to extinction throughout its range.
G3	21-100	Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single physiographic region) or because of other factors making it vulnerable to extinction throughout its range.
G4	100-1000	Apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery.
G5	1000+	Demonstrably secure globally, though it may be quire rare in parts of its range, especially at the periphery.
GU	--	Possibly in peril range-wide, but status uncertain; need more information
G_Q	--	Questionable taxonomic assignment
T_	--	The rank of a subspecies or variety.

North Carolina Rank. A measure of rarity and threat that apply to the status of a species within the State.

Rank	Number of Extant Populations	Description
S1	1-5	Critically imperiled in NC because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the state.
S2	6-20	Imperiled in NC because of rarity or because of some factor(s) making it very vulnerable to extirpation from the state.
S3	21-100	Rare or uncommon in NC.
S4	100-1000	Apparently secure in North Carolina, with many occurrences
SH	0?	Of historical occurrence in NC, perhaps not having been verified in the past 20 years, and suspected to be still extant.
_B	1-?	Rank of the breeding population in the state. Used for migratory species only.
_N	1-?	Rank of the non-breeding population in the state. Used for migratory species only.
SZN	---	Population in the non-breeding seasons (generally in migration or in winter) is transitory, without any regular locales of occurrence whereby the species can be protected.

APPENDIX D: Land Adjustment

The strategy for a land adjustment plan is dependent on the conditions desired for natural resources, and the needs of the local communities. The Croatan National Forest's land adjustment plan consists of a map (Figure D-1) that projects where land adjustments are likely to occur and which objectives the land adjustment would fulfill. The Plan is a guide and can be changed by the Forest Supervisor without an amendment to the Land and Resource Management Plan. If parcels are identified that are outside of the areas currently depicted on the map, but through acquisition would satisfy one or more of the objectives, these parcels may be pursued. Lands that are acquired during land adjustment will be from willing sellers.

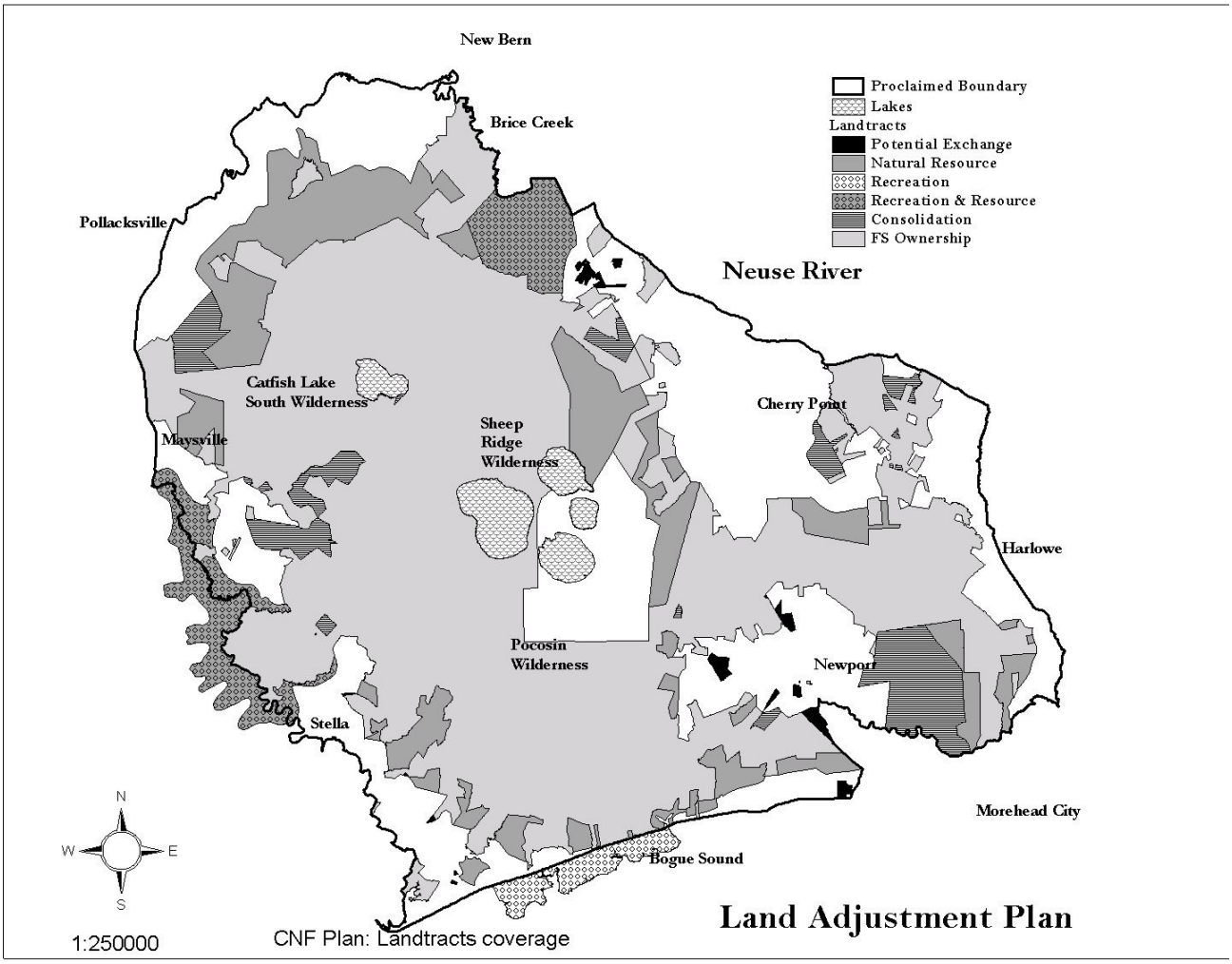
Land adjustment on the Croatan National Forest will focus on meeting the following three objectives:

- Natural Resource Management Objective: lands that would protect or promote the management of natural resources. Examples include the protection of riparian areas, wetlands, critical habitats for TES species, unique historical or cultural resources, Congressionally designated areas, and vegetative management.
- Recreation Management Objective: lands that would enhance or promote the effective management of recreation resources. This includes areas that are visually sensitive, trail systems, and public recreation areas.
- Consolidation Objective: lands that would reduce the expenses of both the Forest Service and the public in administration and utilization. This includes lands that would reduce maintenance expenses and the consolidation of isolated tracts.

Areas available for exchange are small parcels intermingled with private land, parcels isolated from other national forest lands, and parcels with thin, narrow strips of land.

Changes to the land adjustment plan (adding or deleting areas) do not require an amendment to the Forest Plan. The Forest Supervisor can approve changes to the plan as long as Forest Plan goals, objectives, standards, and guidelines are met.

Figure D-1. Land Adjustment Map



APPENDIX E: Silvicultural Methods

This section describes the restoration and forest regeneration methods for various site conditions on the Croatan. These silvicultural methods are not intended to be the only regeneration solution for a given species and site condition. Instead, they are offered as proven silvicultural tools to help meet specific goals and objectives, which considers all resources that are unique to the coastal plain of North Carolina. The methods described below are considered most appropriate for different landtypes (refer to Appendix A for landtype descriptions). However, more than one method may be appropriate for a particular species and landtype.

The following is a description of even and uneven-aged silvicultural methods deemed most useful for meeting the goals and objectives in the Croatan Plan. However, based on the existing ages of longleaf pine stands and the rotation age established, it is highly unlikely that longleaf regeneration techniques will be used in the next 10 years. These methods may be used alone or in combination to meet the needs of specific sites to restore longleaf pine and hardwoods. Some methods will be adapted for each site, based on experience and changing circumstances. Some methods are included in this section to provide a variety of tools, but may not be used when site-specific decisions are made.

Longleaf Pine Management

Artificial Regeneration for Longleaf Restoration

Wet Savannas and Flatwoods Landtype (09)

This method provides for longleaf pine restoration through mechanical site preparation and planting of longleaf seedlings on poorly drained sites.

After the current stand is harvested by clearcutting, apply a broadcast prescribed burn to facilitate site preparation and to reduce fuel loading for burns after seedling establishment. After the broadcast burn, shear the remaining stems using a 14-foot-wide V blade, prepare beds with bedding plow, and apply fertilizer. The beds should be about 7 feet wide, and 200 pounds per acre of 0-46-0 fertilizer should be applied to the beds.

The bedding operation will elevate seedlings above ground water, reduce competition, and incorporate organic material and fertilizer to the planting bed. Beds will be spaced 14 feet apart and longleaf seedlings will be planted on 6- foot spacing along the beds. The planting density will be 500 seedlings per acre. Bare-root seedlings can be planted by machine or containerized seedlings can be hand planted. Survival rates with machine-planted bare-root stock have historically averaged about 70 percent. Survival rates for hand planted containerized seedlings should equal or exceed those for machine-planted bare-root stock.

Prescribed fire will be the predominant tool for controlling competition and maintaining growth and development of the planted seedlings. Prescribed fire should be used on a 2- to 4- year cycle, preferably during the growing season. Fire should not be used in the newly planted stands until root collar diameter is greater than 0.5 inches. Fire should also be avoided during early height growth development

until seedlings are at least 4 feet. Other approved methods may be used to control competition and maintain growth and development of planted seedlings.

This method establishes longleaf on sites where there is no adequate seed source for natural regeneration. It ensures survival of planted seedlings on wet sites by temporarily elevating the seedling bed above the water table long enough for the root systems to become established. Planting on sites without the bedding treatment where the water table is near the surface often results in poor survival and development of the planted seedlings. This method also facilitates machine planting which results in good seedling survival rates when using bare root seedlings and is less expensive than hand planting containerized seedlings.

This method requires more mechanical site preparation than other methods, will have the largest amount of site disturbance, and will be the most costly. Results from this method have proven very successful in seedling survival, growth, and development of the new stand. The site tends to recover from the disturbance over time, however, beds are still noticeable 15 years after the activity.

Mesic Savannas and Flatwoods (10), Dry Mesic Savannas (11), and Xeric Savannas (12) Landtypes

This method provides for longleaf pine restoration through mechanical site preparation and planting longleaf seedlings on moderately well drained and well drained sites. After the current stand is harvested by clearcutting, apply a broadcast prescribed burn to facilitate site preparation and to reduce fuel loading for burns after seedling establishment. After the broadcast burn shear the remaining stems with a 14-foot-wide V blade. Since these landtypes are moderately well drained to well drained, elevated planting beds are not needed. Machine plant bare-root longleaf seedlings or hand planted containerized seedlings at a rate of 500 to 550 seedlings per acre.

Prescribed fire will be the predominant tool for controlling competition and maintaining growth and development of the planted seedlings. Burn on a 2- to 4- year cycle, preferably during the growing season. Fire should not be used in the newly planted stands until root collar diameter is greater than 0.5 inches. Fire should also be avoided during early height growth development or until seedlings are at least 4 feet in height. Other approved methods may be used to control competition and maintain growth and development of planted seedlings.

This method also provides for the establishment of longleaf pine on sites where there is an inadequate seed source for natural regeneration. The level of disturbance is less with this method because bedding is not used. It is successful where sites are better drained and seedling root systems are not in danger of coming in contact with ground water. Seedlings can either be machine planted, using bare root stock, or hand planted using containerized material.

Although mechanical site preparation is used, bedding is not required and there is less overall site disturbance and cost than in the previous method.

Natural Regeneration of Longleaf

Wet Savannas and Flatwoods (09), Mesic Savannas and Flatwoods (10), Dry Mesic Savannas (11), and Xeric Savannas (12) Landtypes

Uneven-aged management
This prescription provides for natural regeneration of longleaf pine using uneven-aged cutting methods to achieve a stand structure where there are 3 or more age classes.

Longleaf pine seedlings become established when mineral soil is exposed by site preparation treatments such as prescribed fire or other mechanical methods. Seedlings can survive for years under an overstory of parent pines but growth is very slow (Boyer 1990). Seedlings respond promptly with an increased rate of growth when competition is reduced and exposure to sunlight is increased. For this reason, successful regeneration is expected to occur in the small openings created where multiple tree groups are harvested. Opening size will likely range from ¼ acre up to 1 acre.

Use a cutting cycle of 10 to 20 years. Since currently most stands have an even-aged structure it may take several entries before an uneven-aged structure becomes apparent.

Periodic prescribed burning will continue after the harvest to ensure control of loblolly and hardwood seedlings. If prescribed burning has been accomplished on a regular schedule, a burn within 1 year of predicted seed fall will be sufficient for seed bed preparation. If burning is not possible, mechanical disturbance to expose mineral soil for seed bed preparation may be considered.

This method of regeneration can be accomplished with minimal site disturbance. However, timing of seed crops and seedbed preparation is critical. With this method, seedlings will become established, grow, and develop in small openings distributed throughout the stand. Natural regeneration of longleaf pine is dependent on good seed crops, which may occur at irregular intervals. Timing of seed production with seed bed preparation is critical. After seedlings become established, longleaf requires full sunlight to grow and develop. Without full sunlight seedlings may take many years to establish height growth.

Even-aged and 2-aged management
The shelterwood method seems to resemble examples of successful regeneration in nature. It appears to be the most appropriate for longleaf pine (Croker 1956). The shelterwood method and the shelterwood with reserves method, which achieve a two-aged structure, are effective where longleaf seed sources are adequate. The following silvicultural prescription for natural regeneration of longleaf pine for the Croatan National Forest was adapted from NATURAL REGENERATION OF LONGLEAF PINE by William D. Boyer and John B. White.

The two approaches to shelterwood regeneration for longleaf pine are the three-cut method and the two-cut method. They are the same except that the three-cut method has a preparatory cut to reduce basal area and develop crowns for seed production. The preparatory cut will be used in stands that have not been thinned or prescribed burned through the life of the stand and may have basal areas of 80 square

feet or more. Stands with less than 80 square feet of basal area can eliminate the preparatory cut and begin with the seed cut. The discussion of this prescription will include the preparatory cut.

1.) Preparatory Cut - The preparatory cut should take place about 10 years prior to the final cut and 5 years prior to the seed cut in stands with 80 or more square feet of basal area.

Basal area should be reduced to a maximum of 70 square feet of dominant and codominant longleaf pine. The overall average basal area may be less if gaps occur in the stand. If loblolly pine or hardwoods too large to control with fire exist in the stand, these should be removed during the preparatory cut. The reduction of basal area will allow for development of the crowns of residual longleaf pine, thus increasing cone production. Prescribed burning schedules should continue after the preparatory cut is completed to control hardwoods and loblolly pine seedlings.

2.) Seed Cut - The seed cut should take place about 5 years prior to the final cut. Basal area of residual dominant and codominant longleaf pines should not exceed 30 square feet, and these trees should be evenly distributed across the regeneration area. Residual trees should have well developed crowns and evidence of past cone production. The resulting shelterwood condition will have adequate needle production to continue prescribed burning to control hardwoods and loblolly seedlings. Mortality among overstory pines remains about the same per acre after the seed cut as it was before. Long-term observations indicate an average annual mortality of one tree per 2.5 acres, although half of observed stands average less than one tree per 5 acres (Boyer 1974). Mortality in shelterwood stands can be salvaged in the final removal cut.

3.) Monitor Cone Crops - After the seed cut, cone production should be monitored to take advantage of the first good seed crops. Cone crops are best assessed in the spring, by counting flower and conelets on 50 sample trees in the shelterwood. The flowers will become the crop for next year. The conelets will become the seed crop for the coming fall. Conelet counts are much more reliable than flower counts (Boyer 1975). When binocular counts indicate a cone crop of 750 or more cones per acre, seedbed preparation by prescribed burning can be scheduled. An average cone production per acre can be estimated by doubling the average conelet count per tree and multiplying by the number of trees per acre (Croker and Boyer 1975).

4.) Seedbed Preparation - If prescribed burns have been scheduled regularly for control of woody vegetation, a burn within 1 year of seed fall should be sufficient for seedbed preparation. If prescribed fire cannot be used for seedbed preparation, the area can be disked or roller chopped to expose mineral soil.

5.) Regeneration Survey - A regeneration survey is necessary prior to the removal cut to determine if adequate seedlings exist to assure establishment of a new age class of longleaf pine. Regeneration surveys are easiest in the dormant season when seedlings are most visible. Boyer recommends 6,000 seedlings per acre, 1 year prior to removal of the overstory to provide for expected seedling mortality during logging. The goal after overstory removal is from 500 to 750 seedlings per acre. The recommended 6,000 seedlings per acre can be adjusted downward with good sale administration during logging and if the overstory is due for removal and less than adequate seed crops are predicted.

Boyer recommends a detailed regeneration survey with 100 samples of nested, circular plots at ¼ milacre (1.9 foot radius), 1-milacre (3.7 foot radius), and 2-milacre (5.3 foot radius). The ¼ milacre plot is used to determine seedlings per acre. The 1 milacre and 2 milacre plots are used to determine quality and size of seedlings.

As a minimum, survey one plot per acre. Circular milacre (3.7 foot radius) plots could be used on a 3-chain grid. Seedlings per acre would be estimated by multiplying the average number of seedlings per plot by 1000.

6.) Removal Cut - Once it is determined that adequate seedlings are present, the overstory can be removed. Removal can be within 5 years of the seed cut if the operation goes according to schedule. However, if the overstory removal needs to be delayed due to low seedling numbers, poor timber markets, or other reasons, the established seedlings can survive under the parent trees for 7 years or more. Growth and development of longleaf seedlings will be slow under the shelterwood canopy. For the two-aged structure, 10 square feet of basal area will be maintained either in clumps or distributed across the stand.

Prescribed burning may need to be delayed to protect small seedlings (root collar less than 0.4 inches in diameter). Burning should be done shortly after the needles drop from the overstory trees.
The best time to remove the parent overstory, in terms of minimizing seedling mortality, is at seedling age 1 or 2. Mortality at this time has averaged 35 to 40 percent (Boyer 1974). By ages 3 to 5, mortality from overstory removal has increased to 50 to 55 percent. Logging related seedling mortality also increases with increasing density of the parent overstory (Maple 1977). Where the overstory is greater than 40 square feet of basal area per acres, it is recommended that the overstory be removed in two cuts. According to Boyer (1974b), this reduces the load of logging slash on the ground at any one time, and can also result in additional seedling establishment between cuts. Logging damage becomes more serious once seedling height growth begins.

7.) Post-Harvest Treatments - Longleaf pine seedlings are subject to competition from loblolly pine seedlings, hardwood sprouts, and woody shrubs. Prescribed fire is the most common method of release for the longleaf pine seedlings. Other approved methods may be used to control competition and maintain growth and development of planted seedlings.

Boyer recommends that regeneration areas not be burned until at least 2 years after the removal cut because of the large fuel load and the vulnerability of small, suppressed seedlings to fire. Two years are enough time for both logging slash and accumulated pine needle litter to decay and the seedlings to respond to release.

This method of natural regeneration requires the least amount of site disturbance and is cost efficient. It does require adequate seed trees be in place, frequent monitoring for seed production, and timing seed bed preparations with seed crops. This method removes trees in two to three stages and up to 10 square feet of basal area will be left on the site after the final harvest. Longleaf pine is very intolerant of shade conditions and will grow and develop at a very slow pace without full sunlight.

Establishing longleaf pine using natural methods takes longer than artificial methods due to infrequent seed crops. In Eastern North Carolina good seed crop years may be up to 7 years apart. It is critical to

evaluate and monitor cone production to predict these good seed years and time the site preparation burn to coincide with seed fall. Growth and development of individual seedlings may be slower with natural seedlings rather than planted seedlings because the planted seedlings are much larger. Rate of growth also will be slower with increased number of residual trees, especially where seedlings are close to residuals.

Natural and Artificial Regeneration for Longleaf Restoration in Mixed Pine Stands

Mesic Savannas and Flatwoods (10), Dry Mesic Savannas (11), and Xeric Savannas (12) Landtypes

The shelterwood with reserve trees method (two-aged), described in the previous section, can be modified and used to restore longleaf pine on sites that are composed of mixed pine species, which do not have an adequate number of mature longleaf pine to leave as seed trees. Retaining reserve trees during the restoration process is necessary to maintain structure in the canopy for species dependent on mature pine trees for nest and/or forage (i.e. RCW), as well as to provide a source of seed. Modifications to the standard shelterwood techniques include leaving a lower basal area of seed trees to avoid leaving species other than longleaf pine as seed sources, underplanting with longleaf seedlings where gaps of regeneration occur, more frequent prescribed burning, and using adaptive management depending on each site and the conditions that exist.

The previous section described a standardized approach to regenerating pine. The approach described in this section requires more adaptive management and site-specific decisions. In an attempt to describe some of the techniques without prescribing specific steps, the following list highlights some of the differences between the technique described in this section and the standard shelterwood with reserve trees technique described previously.

1) Preparatory Cut – Same as previous section
2) Seed Cut – The seed cut would focus on retaining all longleaf pine in the stand, including those without ideal form. However, diseased longleaf trees would be removed. If necessary other pine species would be retained to conserve canopy structure within the stand for potential RCW nesting or foraging. The basal area could be lower than 30 square feet depending on the number and distribution of existing longleaf pines (or as prescribed in the most current RCW Recovery Plan and RCW Management Standards and Guidelines). Prescribed burning could take place after the seed cut to control woody competition and any loblolly pine seedlings from getting established prior to a good longleaf cone crop. However, if burning reduces the fuels too much so that it limits the intensity of a prescribed burn for seedbed preparation, fire should not be used at this time in the process.
3) Monitor Cone Crops – Same as previous section
4) Seedbed Preparation – Same as previous section, with the exception that prescribed fire should be used after the seed cut as frequently as fuels can support it, to control "volunteer" loblolly seedlings and woody competition.
5) Regeneration Survey – Monitoring the species composition of regeneration growth in the stand is vital to the success of this technique. Monitoring will provide the necessary information to schedule prescribed burning and to decide if planting portions of the stand with longleaf seedlings may be necessary. The desired condition of the stand 5 years after the seed cut is 150-200 seedlings per acre, free of competition, and evenly distributed across the area. Frequent monitoring of the site may be necessary to accomplish this desired condition since planting

seedlings and applying prescribed fire may be needed to reach the condition described. The techniques for regeneration surveys described in the previous section may be used, with the exception of frequency.

6) Removal Cut – Depending on the basal area of the longleaf seed trees, some seed trees may be removed once the stand is certified to have adequate seedlings. The basal area of mature longleaf pine (i.e. seed trees) in the stand should be no lower than 10 square feet and no higher than 30 square feet (or as prescribed in the most current RCW Recovery Plan and RCW Management Standards and Guidelines).
7) Post Harvest Treatments – Same as previous section, with added emphasis on controlling competition from loblolly seedlings, hardwoods and woody shrubs using fire or other approved methods.

The method of restoring longleaf pine using shelterwood with reserve trees requires the least amount of disturbance, but will require more time and attention than the standard shelterwood method. This makes it less cost efficient than other standard techniques. Since longleaf pine is highly intolerant of shade conditions, leaving reserve trees in the overstory will affect the growth rate and survival of seedlings. Ensuring adequate seedling survival is important to the ecosystem and species dependent on the longleaf pine, specifically the RCW. If adequate seedling survival does not occur, supplemental planting becomes very important. The rate of growth, however, is not as important a consideration due to the longevity of the longleaf pine species.

Mixed Pine, Mixed Pine/Hardwood, and Pond Pine Management

Natural Regeneration

Drainage Headlands and Interstream Flats (05), Broad Interstream Flats (06), and Peat-Mantled Forested Wetlands (07) Landtypes

This method provides for natural regeneration of mixed pine and hardwood in landtype 05 and mixed pine in landtype 06. The hardwood component in Landtype 05 can be up to 31% of the total stocking. Species common to Landtype 05 are cherrybark oak, post oak, blackjack oak, water oak, white oak, swamp white oak, southern red oak, laurel oak, mockernut hickory, bitternut hickory, sand hickory, and pignut hickory. In both landtypes, loblolly, pond, and longleaf pines may occur singly or in combinations on the same site.

Regeneration methods best suited to these landtypes are the seedtree or the shelterwood method. Prioritize leave trees for seedtree or shelterwood regeneration as follows:

- Existing longleaf pines.
- 8 to 14 loblolly or pond pine seedtrees depending on diameters; as diameter increases, the number of seedtrees required declines.
- Up to 30 percent of the basal area in mast producing hardwoods.

Site preparation treatments should include prescribed burning, roller chopping, or both. Fuels from the logging operation can result in intense heat buildup with prescribed fire and cause damage to the residual seed trees. In some cases, heavy concentrations of fuel may have to be moved away from the seedtrees.

Loblolly pine is a prolific and consistent seeder in the eastern coastal plain. As a result, natural regeneration efforts often lead to overstocked stands, especially on poor sites. On better sites loblolly pine will readily express dominance, even in heavily stocked stands. At age 5, the number of seedlings should be between 500 and 600 per acre to allow crown classes to develop and individuals to express dominance.

In severely overstocked stands, precommercial thinning may be necessary to reduce seedling numbers to 500 to 600 seedlings per acre by age 5. This can be accomplished by roller chopping rows in the regeneration area. Prescribed fire can also be used, but the risk of excessive mortality is high if burning takes place while regeneration is less than 4 inches in diameter. After the average diameter reaches 4 inches, the risk of mortality from burning is greatly reduced.

This method of natural regeneration requires approximately the same level of site preparation as the prescription for longleaf natural regeneration above. Where prescribed fire is not possible due to proximity of developed areas or poor burning conditions, roller chopping may be used to reduce competition and facilitate a seed bed Adequate seed crops are much more frequent for loblolly pine and pond pine than longleaf and these seedlings become established soon after the harvest. When the seedtree regeneration method is used for mixed pines, some residual trees are left until seedlings become established. The seedtrees could be removed when adequate stocking of seedlings is reached. If it is not feasible or desirable to remove the seedtrees little or no negative impacts to the new stand will occur. When using the shelterwood method, any residual hardwood trees would be left in place indefinitely. In some instances this will reduce the growth and development of the pine seedlings where they occur close to the residuals.

Hardwood Management

Natural Regeneration for Hardwood Restoration

Stream and River Terraces (03) and Drainage Slopes (04) Landtypes

This method provides for restoration of hardwoods on sites now occupied by loblolly pine. On many of these sites, there is a component of hardwood, including regeneration in the form of small seedlings and saplings. These sites are protected from fire because of topography or wet conditions and may burn on a frequency of 5-12 years, enough time to allow hardwood establishment. Hardwood species found on these landtypes are water oak, cherrybark oak, white oak, swamp chestnut oak, hickory, yellow-poplar and American beech.

Hardwood restoration on these sites will be accomplished by favoring existing hardwoods, including regeneration, when thinning loblolly pine. In cases where loblolly or pond pine is competing with hardwood regeneration, release should be considered using herbicide applications, mechanical treatments, or prescribed fire.

Supplemental planting of hardwood species, especially oaks, may be considered where oak seed sources are not available. However, the best results for hardwood restoration will come from natural regeneration by seedlings or coppice regeneration from roots or small stumps.

Loblolly pine should be removed in increments by thinning at 5- to 10-year intervals, leaving a minimum basal area of 50 to 60 square feet of both pine and hardwood.

If these landtypes are included in the prescribed fire program, burning intervals should be lengthened to provide for the establishment and development of the hardwood component.

This method relies on partial cutting to remove merchantable pine that is competing with existing hardwood seedlings and saplings. Disturbance to the site is limited to periodic removal of pine and releasing hardwood by hand/mechanical methods, herbicides, or prescribed fire. Restoring hardwood to these sites will be gradual shift as the pine is removed with minimal disturbance.

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APPENDIX F: Scenery Management System

For inventory and analysis of the aesthetic values of national forest lands, the Forest Service uses a system called the Scenery Management System (SMS), Agriculture Handbook 701, *Landscape Aesthetics*: *A Handbook for Scenery Management*. This system, released in 1996, evolved from and replaces the Visual Management System, Agriculture Handbook 462, National Forest Landscape Management, Volume 2, Chapter 1, which was used for the existing Croatan and Uwharrie Land and Resource Management Plan, 1986. The SMS differs from the VMS in that it borrows from and is integrated with the basic concepts and terminology of ecosystem management. SMS integrates aesthetics with biological, physical and other social/cultural resources in the planning process.

SMS Components

The Scenery Management System process involves identifying scenery components as they relate to people, mapping these components, and developing a value unit for aesthetics from the data gathered. This value unit provides information for planning and leads to rational decisions relative to scenery as a part of ecosystems. These components include:

Existing Landscape Character
Landscape character is the visual and cultural image of a geographic area and consists of the combination of distinct physical, biological and cultural attributes that make each landscape identifiable or unique. Landscape character descriptions use base information from ecological unit descriptions supplemented with existing land use patterns or themes. These existing landscape character descriptions are used to:

- establish the current overall visual impression of a landscape, the physical appearance that contributes to an identity and "sense of place".
- provide a reference from which to compare existing landscape character to desired landscape character.
- provide a reference for changes in landscape character as the landscape progresses toward the character goal.
- establish a baseline from which to measure scenic quality.

CNF is part of the Atlantic Coastal Flatlands Section in one of the largest subdivisions called the Lower Terraces Subsection. This subsection is a flat, weakly dissected alluvial plain with marine sediments.

The vegetation is predominantly needle-leaved evergreen and evergreen broadleaf forest and shrubland. Wildfire and hurricanes have caused large scale disturbances, leaving areas of blow down and trees growing at an angle. Although centuries of human settlement have altered most of the land and plant communities, a large portion of the CNF has shrubland and forest comparable to presettlement conditions.

Pocosin vegetation is the most extensive on the CNF. The overstory is pond pine and loblolly with mixed evergreen deciduous shrubs in a peat base understory. They are characterized as dense and impenetrable. Therefore, open park-like stands of longleaf pine on sand ridges are highly valued as a positive scenic feature. Unique habitats and inhabitants include pocosin, Carolina bays, long leaf pine savannas, insectivorous plants, alligators and red-cockaded woodpeckers.

Natural-appearing areas of the forest with a noted "sense of place" include Cedar Point tidal marshes, Island Creek hardwood forest, White Oak River, Brice Creek and Cahooque Creek with their black water cypress swamps, and Great Lake and Catfish Lake that feed the pocosins.

The following landtypes and landtype phases were documented in Croatan National Forest Ecological Classification, Mapping, and Inventory, May, 1997. They are the basis for the landscape character description for the Croatan.

1. Tidal Streams and Estuaries - Salt, brackish, and brackish-fresh water marshes associated with the coastal estuarine system, dominated by sedges, grasses, and herbs.
2. Lake and Stream Swamps - swamps associated with small to moderately large streams, and nonriverine wetlands on lake margins, and upland depressions.
3. Stream and River Terraces - partially fire-protected terraces associated with stream swamps and rivers and dominated by mesophytic hardwoods.
4. Drainage Slopes - slopes between drainages and uplands dominated by dry-mesic and mesic hardwoods.
5. Drainage Headlands and Interstream Flats - dissected headlands and undissected interstream flats dominated by mixed mesic pine-hardwoods.
6. Broad Interstream Flats - wet, undissected uplands dominated by mixed pines.
7. Peat-mantled Forested Wetlands - broad, peat mantled uplands dominated by pond pine.
8. Raised Peatlands - peatlands, known as pocosins, that have very deep organic soils, moderately deep organic soils, or poorly drained mineral soils with a mucky surface.
9. Wet Savannas and Flatwoods - includes poorly drained savannas and flatwood dominated by longleaf pine.
10. Mesic savannas and Flatwoods - moderately well-drained to somewhat poorly drained savannas and flatwoods dominated by longleaf pine.
11. Dry-Mesic Savannas - dry-mesic savannas associated with well-drained sands and dominated by longleaf pine.
12. Xeric Savannas - xeric savannas on excessively drained sands dominated by longleaf pine.
13. Maritime Ridge and Dune Forests - uplands fringing salt or brackish waters that are dominated by live oak communities.

Scenic Attractiveness

Scenic attractiveness classes are developed to determine the relative scenic value of the lands within a particular landscape character. They are the primary indicator of the intrinsic beauty of the landscape and the positive responses it evokes in people. The three classes are Class A, Distinctive; Class B, Typical; Class C, Indistinctive. The landscape elements of landform, vegetation, rocks, water features and positive cultural features, are described for each of these classes. Class A landscapes are areas where these features combine to provide unusual, unique or outstanding scenic quality. Class B landscapes are areas where these features combine to provide ordinary or common scenic quality. They have generally positive, yet common, attributes. Class C landscapes are areas where natural and cultural features have low scenic quality. These landscapes have weak or missing attributes.

Table F-1. Scenic attractiveness classifications for the Croatan.

Class	Acres	Percent	Description
A	33,080	21	Rivers, lakes, and sounds; marshes and tidal influence areas; swamp forests; low pocosin; longleaf pine savannas with wire grass understory; hardwood slopes.
Ap	12,500	8	Potential restoration area for longleaf pine savannas.
B	113,565	71	High pocosin; pond pine forest; mixed pine forest; mixed pine and hardwood forest.
C	393	<1	Areas where vegetation and/or landform has been significantly altered by human activity.

Existing Scenic Integrity

Scenic integrity is a measure of the degree to which a landscape is visually perceived to be intact or whole. It indicates the current status of a landscape; and indicates the existing degrees of alteration from the attributes - form, line, color, and texture - of the landscape character. The highest scenic integrity ratings are given to those landscapes which have little or no deviation from the existing character valued by people for its aesthetic appeal. Scenic integrity is used in forest planning to describe an existing situation, standard for management or desired future conditions. The six scenic integrity levels are:

Very High (VH), unaltered; High (H), appears unaltered; Moderate (M), slightly altered; Low (L), moderately altered; Very Low (VL), heavily altered; Unacceptably Low (UL), appears extremely altered.

Existing scenic integrity levels for the Croatan are determined as viewed from the air, which is more revealing than typical on-the-ground observer positions. The inventory was derived using stand data and aerial photographs.

Table F-2. Existing scenic integrity levels for the Croatan.

Level	Acres	Percent	Includes	Common Deviations
VH	80,073	50	Wilderness, low pocosin; other undisturbed areas	None; or very few old fire plowlines may be discernible on aerial photographs.
H	39,375	24	Stands > 60 years old	May be some evidence of prescribed burning, old skid roads or fire plow lines.
M	16,863	11	Stands 41-60 years old; some drainage ditches	May be some evidence of prescribed burning including crown scorch and bark char. Rows generally not apparent in timber plantations.
L	8,644	5	Wildlife openings; stands 21-40 years old; recreation sites; summer home sites; administrative sites	Wildlife openings tend to be geometric in shape. Rows evident in timber plantations. Structures evident.
VL	15,438	10	Stands 1-20 years old; roads, transmission lines; multiple drainage ditches or fire plow lines	Rows very evident in timber plantations. Roads appear mostly straight with drainage ditches. Transmission lines straight but have vegetation understory.
UL	108	>1	Borrow pits; railroads; landfill; urban development	Landform/vegetation highly modified; straight lines; geometric forms

Landscape Visibility

Landscape visibility is composed of two parts: human values as they relate to the relative importance to the public of various scenes and the relative sensitivity of scenes based on distance from the observer.

Human Values - Constituent Analysis serves as a guide to perceptions of attractiveness, helps identify special places, and helps to define the meaning people give to a landscape. It discusses visitor values, desires, and expectations for what they'll encounter in terms of landscape character and scenic integrity in the Forest. These are defined by sites, travelways, and special places and use a rating of high, medium or low.

Constituent use of the Croatan Forest - The Forest is becoming an important tourist draw along the mid-section of North Carolina coast because of its year-round recreation opportunities. The developed campgrounds are staging areas for visitors' pursuits and the dispersed areas are valued for their quiet, low-key activities.

Constituents scenic preferences - People living near the forest seem to have little interest in the impact large scale activities like timber harvest have on scenic quality. In the past, and probably still, the local public has opposed wide-spread use of surface water management. Visitors to the Forest have preconceived images of what they expect to see and are sometimes initially disappointed with the CNF's dense, impenetrable, jungle-like environment. Therefore, the open, park-like stands created by thinning and repeated prescribed burning are highly valued as a positive scenic feature.

Landscapes are viewed to varying degrees from different locations and subsequently differ in scenic importance to the public. The level of interest in scenery that people are likely to have in the surrounding landscape is expressed as a Concern Level. Travelways, use areas, special places and the general forest are assigned a Concern Level of 1, 2 or 3 to reflect the relative High, Medium or Low interest in scenery.

Concern levels on the Croatan are based on long-term observations of use patterns by district personnel and input from public meetings during the scoping process. Highly used roads usually on the perimeter of the forest are concern level 1. Other areas with high concern are roads accessing recreation sites, campgrounds and trails, and roads with high residential development along or as a destination from the road. Level 2 areas are roads that have less traffic with less residential access. Level 3 areas are seldom used roads or seldom seen areas of the forest.

Seen Areas and Distance Zones - These are mapped from the areas determined by constituent analysis as having a level of concern. Mapping indicates the relative sensitivity of scenes based on their distance from an observer, and the zones are Foreground (up to ½ mile from the viewer), Middleground (up to 4 miles from the foreground), and Background (4 miles from the viewer to the horizon). The Croatan has only foreground and middleground viewing distances.

Table F-3. Landscape visibility for the Croatan - acres by distance zones and concern levels

Distance Zone	Acres by Concern Levels			Totals	Percent
	1	2	3		
Foreground	25,266	27,426	44,362	97,054	78
Middleground	0	6,807	20,864	27,671	22
Totals	25,266	34,233	65,226	124,725	
Percent	20	28	52		

Scenic Classes

All national forest landscapes have value as scenery - some more than others. Scenic classes measure the relative importance, or value, of discrete landscape areas. These classes are used during forest planning to compare the value of scenery with the value of other resources. The higher the scenic class, the more important it is to maintain the highest scenic value.

Scenic classes are determined by combining the three classes of scenic attractiveness with distance zones and concern levels. A numerical Scenic Class rating (1 - 7) is assigned to all lands. Generally Scenic Classes 1-2 have high public value (table F-4), Classes 3-5 have moderate value, and Classes 6-7 have low value. This does not include Wildernesses since they are managed to allow natural processes to occur.

Table F-4. Acres of scenic classes

Class	Acres	% of Forest
1	25,266	16
2	47,109	29
3	13,201	8
4	1,174	1
5	29,265	18
6	8,710	6
7	0	0

Scenic Integrity Objectives

The components described above are the inventory phase of the Scenery Management System. Development of Scenic Integrity Objectives moves into the implementation phase that integrates SMS into the forest plan revision process. As stated earlier, the concept of scenic integrity can be used to describe varying degrees of wholeness or completeness and level of scenic condition from very high to unacceptably low. Scenic Integrity Objectives describe the long-term level of integrity achievable or the desired condition.

For the Croatan Plan Revision, Scenic Integrity Objectives were assigned to Scenic Classes by Prescription. This was determined to be the most logical approach because prescriptions are actual boundaries on the ground and have desired conditions described for each. This way the management concern for scenery is linked closely to assigned desired condition and prescriptions. Table F-5 illustrates the assigned Scenic Integrity Objectives.

Table F-5. Scenic integrity objectives within management prescriptions.

Management Prescription	Landscape Character Theme[1]	Scenic Integrity Objective[2] (numbers refer to scenic classes)			
		Very High	High	Moderate	Low
Pocosin lakes	NA		1-2	3-5	6-7
Wilderness	NE	1-7			
Wild & Scenic Rivers					
• Wild	NE	1-7			
• Scenic	NA		1-7		
• Recreational	NA		1-2	3-7	
Hardwood Cypress Wetlands	NA		1-3	4-5	6-7
RCW HMA	NA		1-2	3-4	5-7
• Mixed pine	NA			1	2-7
• Pocosin patches	NA			1-2	3-7
Wildland Urban Interface	NA		1-3	4-7	
Upland Hardwoods	NA		1-3	4-5	6-7
Black Bear Habitat	NA		1	2	3-7
Developed Areas	NA		1	2-5	6-7
• Offices/Work Centers	NA			1-7	
• Electronic/Other Administrative Sites				1-2	3-7
• Roaded natural	NA		1	2-5	6-7
• Motorized	NA		1-2	3-5	6-7
• Rural, and roaded natural & semi-primitive	NA		1-2	3-4	5-7
Special Interest Areas					
• Natural Areas	NA		1-2	3-7	
• Heritage Resources	H/C		1-7		
Old Growth	NA		1-3	4-7	
OHV System	NA			1-3	4-7

[1]*Landscape Character Themes: C—Cultural; NE – naturally evolving; NA – natural appearing; H/C – historic/cultural*
[2]*Scenic Integrity Objectives:*

- *Very High – (33,000 acres) Generally provides for ecological change only.*
- *High – (70,000 acres) Human activities are not visually evident. In high SI areas, activities may only repeat attributes of form, line, color, and texture found in the existing landscape character.*
- *Moderate – (14,000 acres) Human activities must remain visually subordinate to the attributes of the existing landscape character. Activities may repeat form, line, color, or texture common to these landscape characters, but changes in quality of size, number, intensity, direction, pattern, and so on, must remain visually subordinate to these landscape characters.*
- *Low – (44,000 acres) Human activities may dominate the existing landscape character. Activities must repeat form, line, color, or texture common to these landscape characters.*
- *Very Low - Human activities of vegetative and landform alterations may dominate the original, natural landscape character, but should appear as natural occurrences when viewed at background distances.*

ROS and SMS Compatibility

There is no systematic approach to establish a value for attractiveness for different landscapes and recreation opportunities within a single ROS class. There are, though, some combinations of scenic integrity objectives and ROS classes that are more compatible than others. Page F-3 of the SMS handbook contains a chart that links ROS class and scenic integrity objectives.

APPENDIX G: Recreation Opportunity Spectrum

A recreation opportunity is the availability of a choice for a user to participate in a preferred activity within a preferred environmental and social setting in order to realize desired experiences. By managing the natural resource setting, and the activities which occur within it, the Forest Service manager is providing the opportunities for recreation experiences to take place.

The Recreation Opportunity Spectrum (ROS) is a way to classify the types of outdoor recreation opportunities and experiences the public may desire and to identify the capabilities of the Forests to provide these opportunities. The ROS describes and groups compatible recreational, environmental and social settings, activities and experiences. It also provides the basis for coordinating recreation opportunities with other resource needs and objectives.

Recreation Settings And Experiences

Landscapes are available for people to use in recreation pursuits. Landscapes are characterized by settings, which provide the physical and social environment needed to produce experiences. ROS provides setting descriptors that integrate physical and social characteristics to classify the landscape.

There are seven classes of ROS settings in the system. Five are represented on the Croatan National Forest, with the most developed end of the spectrum, urban, not present. Those represented include: primitive (P), semi-primitive non-motorized (SPNM), semi-primitive motorized (SPM), roaded natural (RN), and rural. The characteristics of these classes are described below:

Primitive (P) areas generally exceed 5000 contiguous acres and are 3 miles away from roads. These areas are characterized by an essentially unmodified natural environment. Evidence of humans is unnoticed by someone wandering through the area. Examples of this setting are the designated Wildernesses. They do not always meet the acre minimum and distance from roads requirement but are managed to enhance the primitive characteristics because of their wilderness designation.

Semi-primitive non-motorized (SPNM) areas generally exceed 2500 contiguous acres and are ½ mile or more from roads, railroads, trails and waterbodies used by motorized vehicles and watercraft. These areas are characterized by a high degree of remoteness and a naturally evolving landscape where human influence is minimal. Contact between people within the area is generally low.

Examples of this setting include the larger expanses of Wildernesses and unroaded areas in MA2 and 5. These are primarily pocosin areas with very little development.

Semi-primitive motorized (SPM) areas generally exceed 2500 contiguous acres and are within ½ mile of primitive roads, trails or waterbodies used by motorized vehicles and watercraft; but not closer than ½ mile from better than primitive roads. Some of the area may be accessible by low-standard roads. These areas are characterized by a high degree of remoteness or potential for it, and a predominantly natural-appearing landscape where human influence is minimal. Contact between people within the area is generally low to moderate.

Examples of this setting include the area around Great Lake and south into the pocosins, the White Oak and Brice Creek river corridors, and the more rustic developments along waterbodies including Catfish Lake and Great Lake Boat Ramps, Long Point, Oyster Point, and Siddie Fields. Although these rustic developments don't meet the size requirement on their own, they do when combined with the adjacent waterbodies.

Roaded natural (RN) areas are predominantly natural appearing forested landscapes around roads with conventional motorized use. Resource modification and utilization practices may be evident, but usually occur in clusters. There is about equal probability for experiencing contact with or isolation from other people. RN areas occur within ½ mile of roads, railroads, trails or waterbodies used by motorized vehicles and watercraft. No size criteria are imposed.

Examples of this setting include land areas adjacent lower standard development roads like the Impoundment, the longleaf pine savannas in MA4, OHV areas, and Black Swamp Road. Developed sites include Brice Creek and Cahooque Creek Boat Ramps, Fishers Landing, Haywood Landing, Island Creek, and Pine Cliff Day Use area.

Rural areas are characterized by a culturally influenced landscape with forest cover. Structures may be present but usually occur in clusters. Contact with other people is normal. No size criteria is imposed. This class includes corridors for roads with high traffic volume or emerging development patterns. These corridors are ¼ mile wide on each side of a road.

Examples of this setting include in part, the ¼ mile corridor along major roads like NC Hwy 70, 24, 58 and 17, and Catfish Lake Road. Developed sites have many amenities and include Cedar Point and Neuse River recreation areas.

The following table summarizes and displays the acres on the Croatan that currently meet the setting conditions for each ROS class. The spatial arrangement of settings is shown in table G-1, and documented in the CNF database as "Settings".

Table G-1. ROS class, ROS acres, and percent of total acres.

ROS Class	Acres	% of Total
P*	31,912	19
SPNM	17,966	11
SPM	6,642	4
RN	92123	57
R	15,195	9
Total	162,362	100

** Though the setting approaches a Primitive ROS Class, technically it meets the criteria for the Semi-Primitive non-motorized ROS Class because there are few parts of the area three miles or more from roads or motorized trails. Croatan Wildernesses will be managed to provide as primitive an experience and setting as possible.*

Recreation Activities
Recreationists choose a setting and activity to create a desired experience. Facilities are supplied to assist uses of settings and to support recreation activities. Two types of facilities are used by recreationists: corridors and places. Corridors provide for transporting people through the setting. They include roads, trails, lakes and streams. Places are where people spend some period of time engaged in a recreation activity. Examples of places are campgrounds, picnic areas, beaches, favorite spots along rivers and hunting grounds.

There are limits to the use of settings. When use is too intensive for recreationists to achieve desired experiences, the carrying capacity has been exceeded. Providing additional support facilities may increase the capacity of settings.

Some places are also Special Places or Hot Spots. Special Places are those sites whose specific locations, attractions or features are identified and valued as unique, different, distinctive and extraordinary to people. These places range in size from a small area, such as a pool on a stream, to a large area, such as an entire stream basin. This physical area or the perception of the place has special meaning to people and they form an attachment to the land. People frequently share a communal interpretation of these places or a "sense of place". Hot Spots are places where capacities are reached or exceeded during peak weekends. People are drawn to these places more than others because the resource attributes or facilities accommodate their needs and desires for specialized settings, activities or experiences.

Special places on the CNF include many water-based areas like Brice Creek, Cahooque Creek, White Oak River, and Catfish Lake Sand Ridges. Hot Spots are some of the less developed and more rustic areas like Long Point and Siddie Fields.

Recreation Use Patterns
On the CNF, many sites from rural ROS to SPM have use almost to capacity on weekends and holidays. These include Cedar Point Campground, Pine Cliff Day Use area, and Siddie Fields dispersed camping area.

Hunting use is heavy, and every road that isn't gated is impacted. The largest percentage of hunters are road hunters, with a small but growing number of still hunters. Many of the hunters desiring still hunting opportunities are from other areas like the piedmont. During the season, there is also a large influx of bear hunters from western NC. Waterfowl hunting is popular at the Catfish Lake Impoundment with about 80 percent capacity during peak season. Catfish Lake, Great Lake and the larger rivers and creeks are also used for waterfowl hunting.

Hiking is popular at the Impoundment, Island Creek and the Tidelands Trail at Cedar Point. People are interested in high quality scenery, interesting vegetation, and wildlife. Most of the popular trails are water oriented. Demand for mountain biking, horseback riding, and canoeing areas is growing.

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APPENDIX H: Aquatic Classification

With the recent emphasis on ecosystem management in the Forest Service and many other agencies, there has been a heightened interest in the classification or characterization of terrestrial and aquatic ecosystems. The Forest Service began development of an aquatic ecosystem in 1995 (Maxwell and others 1995). The system employs a hierarchical approach which builds on the concept that smaller-scale systems develop within constraints set by the larger-scale systems of which they are part.

For example, in North Carolina, physiographic conditions in the Coastal Plain produce aquatic habitats that support a very different assemblage of fish than would be found within streams in the Piedmont plateau. Piedmont fish communities in turn would differ significantly from assemblages in trout streams of the mountainous Blue Ridge province. Among all the streams and lakes on the Croatan National Forest, and indeed anywhere in the Coastal Plain physiographic province, one can further distinguish like and unlike systems (i.e., streams or sections of streams and individual lakes and ponds) based on degree of tidal influence, whether the systems originate from pocosin or upland areas, and size of the stream.

The aquatic classification uses the zoogeography of fresh water fishes as a basis for categorizing aquatic systems from the highest levels of the hierarchy (world zones such as North America, South and Central America, Africa, the Orient, Eurasia north of the Orient, and Australia) through successively smaller geographical areas called subzones, regions, and subregions down to individual river basins. For example, the Neuse River Basin is part of the "Pamlico-Albemarle Sound Subregion", which is nested in the Atlantic Region, which in turn is part of the Arctic-Atlantic Subzone, which is one of three subzones (Pacific, Arctic-Atlantic, and Mexican Transition) in the North American or Nearctic world zone.

This approach allows individual systems and their attributes (such as number of fish species, species of freshwater mussels or other benthic macroinvertebrates, species of aquatic plants, or any other biological information that may have been attributed to a given system) to be viewed at a number of different scales. This can be especially beneficial for broad regional planning purposes. At finer scales such as within the boundaries of the Croatan National Forest, the upper levels of the hierarchy become less pertinent and aquatic classification is more useful in displaying the range of ecological types across a landscape and in using biological and habitat inventory information developed at reference sites to extrapolate to similarly classified but uninventoried sites at other locations.

Aquatic Ecological Types on the Croatan National Forest

The aquatic classification is part of the CNF database. The "streams" coverage includes 6 attributes for classifying aquatic ecological types. These types are described below.

1. **Salt Water Sound**. Examples include Bogue, Pamlico, and Albemarle Sounds. All are estuarine biologically productive mixing zone of fresh and salt waters.

2. **Large Tidal Rivers**. The lower White Oak and Neuse Rivers, and the Newport and Trent Rivers are examples of this ecological type. These rivers are influenced by wind tides and salt-water intrusion. Chloride concentrations are often several thousand parts per million and the fish assemblage is usually

dominated by marine species in the lowermost reaches. Some freshwater fish species co-occur with the marine species except in the most saline reaches of these rivers.

3. **Tidally Influenced Sections of Large Creeks**. This category of waters includes the lower reaches of large creeks such as Brice and Hunter Creeks. Directional streamflow, depth, and salinity are influenced by wind tides of their receiving rivers. These stream reaches usually contain some saltwater fish species in addition to freshwater species such as largemouth bass, chain pickerel, and bluegill. The saltwater fish species usually include striped mullet, American eels, and summer flounder.

4. **Non-tidal mid reaches of Large Streams**. Two examples of this aquatic ecological type are Brice Creek in the vicinity of the public boating access, and the White Oak River near Belgrade. These ecological types are important in that they contain the most diverse assemblages of freshwater fish on the Croatan National Forest. These stream reaches contain a more diverse and abundant array of habitats than smaller stream reaches and consequently meet the habitat requirements of more species. The size of these stream reaches also allows more recreational opportunities such as canoe or boat fishing as opposed to wading or bank fishing only.

5. **Acidic, Upper Reaches of Large Streams**. Brice Creek from its origin at Catfish Lake downstream to a point where pH is 5.5 or less typifies this ecological type. The fish community is dominated by a relatively small number of acid-tolerant species, such as redfin pickerel and brown bullhead. Fishing opportunities, therefore, are more restricted than in less acid, larger stream habitats.

6. **Non-acidic Upper Reaches of Large Streams**. At present our data are not adequate to identify stream segments that are characteristic of this ecological type. It can be anticipated that this ecological type will not be well represented on the Croatan. Where it does occur, fish species diversity should be considerably greater than in similar, but more acid streams.

7. **Large Acidic Natural Lakes**. In North Carolina this ecological type is unique to the coastal plain and is represented by Great and Catfish Lakes.

8. **Acidic Ponds**. A pond may be defined as a natural or man-made body of water typically less than 5 acres in size. Ponds in this ecological category have a pH less than 5.5.

9. **Non-acidic Ponds**. Ponds with a pH equal to or greater than 5.5. An example is Cedar Swamp Pond. Although rare on the Croatan, this type pond has the capacity to be intensively managed for several species of sport fish.

10. **Estuarine Branches**. These are short drainages into saline, lower reaches of rivers such as the White Oak, Newport, Neuse, and Trent, or into estuarine portions of ocean sounds.

11. **Estuarine Creeks.** These are small streams that are largely within salt marsh ecosystems. Salinity is typically high and the biota are dominated by marine species. These habitats are often important nursery areas for many species of saltwater fish and shellfish.

Table H-1. Aquatic classification summary.

AQUATIC ECOLOGICAL TYPES	HABITAT	QUANTITY ACRES
1. Salt Water Sound	40	
	35	
3. Tidally Influenced Reaches of Large Creeks	16	
	16	
5. Acidic, Upper Reaches of Large Streams	32.5	
6. Non-acidic Upper Reaches of Large Streams	35.5	
7. Large Pocosin Lakes		2,800
8. Acidic Ponds		4.0
9. Non-Acidic Ponds		
10. Estuarine Branches	17.2	
	1.8	
12. Acidic First or Second Order Tributaries of Sounds and Rivers	32.4	
of sounds and Rivers	30.2	
14. Tributaries to Large, Saline Creeks	5.7	

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APPENDIX I: Timber Land Suitability Classification

Table I-1. Timber Land Suitability Classifications.

Stage I Classification from NFMA Regulations at 36 CFR 219.14(a)	**Acres**
1. Non-forest land (includes water, developed sites and administrative sites).	5,914
2. Forest Land.	155,228
3. Forest land withdrawn from timber production (includes lands designated as wilderness, historic areas, scenic areas, and natural areas).	31,221
4. Forest lands not capable of producing crops of industrial wood.	0
5. Forest Land physically unsuitable a. Technology is not available to ensure timber production from the land without irreversible resource damage to soil productivity or watershed conditions. b. Lands that cannot be adequately restocked c. Lands withdrawn due to inadequate access	 0 0 0
6. Forest lands with inadequate information to manage for timber production	0
7. Forest lands tenatively suitable for timber production	124,007
Stage II Classification from NFMA Regulations at 36 CFR 219.14(b)	
Lands with positive present net value	118,724
Stage III Classification from NFMA Regulations at 36 CFR 219.14©	
8. Forest Land not appropriate for timber production. Based upon consideration of multiple-use objectives, lands proposed for resource uses that preclude timber production (36 CFR 219.14©(1), and includes the following management prescriptions: River Corridors eligible for WS River Status, Hardwood Cypress Wetlands, Wildland Urban Interface, Black Bear Habitat, Developed Areas, OHV Areas, Special Interest Areas, and Old Growth.	98,284
9. Unsuitable forest land (lands 3,4,5,6, and 8)	129,505
10. Total suitable forest land (item 2 minus item 9), and includes the following prescriptions: RCW Habitat Management Area	25,723
11. Total national forest land (items 1 and 2)	161,142

Table I-2. Land Classification

Classification	**Acres**
1. Non-forest land (includes water)	5,914
2. Forest Land.	155,228
3. Forest land withdrawn from timber production	31,221
4. Forest lands not capable of producing crops of industrial wood.	0
5. Forest Land physically unsuitable: irreversible damage likely to occur not restockable within 5 years	0
6. Forest land—inadequate information*	0
7. Tenatively suitable forest land	124,007
8. Forest Land not appropriate for timber production	98,284
9. Unsuitable forest land (items 3,4,5,6, and 8)	129,505
10. Total suitable forest land (item 2 minus item 9)	25,723
11. Total national forest land (items 1 and 2)	161,142

* *Lands for which current information is inadequate to project responses to timber management. Usually applies to low site lands.*

Table I-3. Present and Future Forest Conditions.

	Unit of Measure	**Suitable Land**
Present Forest:		
Growing Stock	MMCF	63,187
Live Cull	MMCF	Not Available
Annual Mortality	MMCF	380
Future Forest:		
Growing Stock	MMCF	Not Available
Annual Net Growth	MMCF	2,173
Rotation Age		
Loblolly and Pond Pine		80 years
Longleaf Pine		120 years

Table I-4. Allowable Sale Quantity and Timber Sale Program Quantity.

Harvest Method	**Allowable Sale Quantity**	
	Sawtimber	**Other Products**
	(M CF)	**(M CF)**
Clearcut	2683	69
Shelterwood and Seed Tree	--	--
Shelterwood with reserve trees (two-aged system)	3293	74
Commercial Thinning	1892	747
Totals	**7857**	**901**
	Additional Sales	
	Sawtimber	**Other Products**
	(M CF)	**(M CF)**
Total for all harvest methods	--	--
Allowable Sale Quantity: 8758 MCF		

Allowable sale quantity includes chargeable volumes from suitable lands.
Additional sales only includes nonchargeable volumes from suitable and/or unsuitable lands.

Table I-5. Timber Productivity Classification.

Productivity Class	**Potential Growth (cubic feet/acre/year)**	**Suitable Lands (acres)**	**Unsuitable Lands (acres)**
	less than 20		6413
6	20-49		93421
5	50-84	6906	32590
4	85-119	12782	1474
3	120-164	4308	470
2	165-224		
1	225+	1727	
Total		25723	

Table I-6. Vegetation Management Practices. Annual Average in First Decade for Suitable Lands.

Practice	**Acres**
Clearcut	100
Shelterwood and seed tree	0
Shelterwood with reserve trees (two-aged system)	150
Commercial Thinning	320
Total*	570

**Pine straw production is not included in this total.*

.

Table I-7. Long-Term Sustained Yield Capacity and Allowable Sale Quantity

	Alternative A	**Alternative B**	**Alternative C**	**Alternative D**	**Alternative E**
Acres suitable for timber production	24,985	10,890	26,774	21,546	25,723
Allowable Sale Quantity by planning period (MCF/Year)	1st 497	1st 260	1st 2,093	1st 1,484	1st 876
	2nd 1,625	2nd 319	2nd 1,355	2nd 1,486	2nd 1,427
	3rd 1,625	3rd 319	3rd 1,355	3rd 1,489	3rd 1,427
	4th 1,625	4th 353	4th 1,355	4th 1,489	4th 1,427
	5th 1,625	5th 363	5th 1,355	5th 1,489	5th 1,427
Long-Term Sustained Yield Capacity (MCF/Year)	1,625	442	1,247	1,573	1,303
Maximum Present-Net Value (MM $)**	$23.2	$4.4	$29.3	$26.2	$20.9

APPENDIX J: Wildland Urban Interface

Catfish Lake WUI

The total Catfish Lake WUI area is approximately 2535 acres in size and occurs in portions of MAs 1, 2, and 7; about 350 acres are in Catfish Lake Wilderness. High pocosin vegetation dominates the area and the soils are primarily organic (Croatan). While there is some recent history of fire on both the west and northeast sections of the area, the largest portion has not been burned. The unroaded portion of this pocosin was threatened during Fish Day Fire, but did not burn. A prescribed fire program adjacent to such a large, continuous block of pocosin is not currently feasible without prior fuel treatments.

Most of the private land adjacent to Forest Service is owned by Weyerhaeuser. There are several farm fields, primarily on the west and northeast sections of the Catfish Lake WUI area. An analysis by Weyerhaeuser shows several young plantations along the landownership line here that would be at risk from wildfire. There are several roads throughout the privately owned lands, but very few on Forest Service. In the event of a wildfire, the Weyerhaeuser plantations between the roads and Forest Service land would more than likely be lost or severely damaged.

Pocosin WUI

The total Pocosin WUI area is approximately 1960 acres in size and occurs in portions of MAs 2, 4, 5, and 6; about 800 acres are in Pocosin Wilderness and 100 acres in Sheep Ridge Wilderness. The western portion of the area is dominated by high pocosin vegetation with a small hardwood segment on the eastern rim of Great Lake. The eastern portion of the area is primarily southern rough vegetation with numerous hardwood drains interspersed throughout. The Sheep Ridge Wilderness area burned during the 1994 Fish Day Fire, and the southern boundary of the area also has some history of fire. Parts of the eastern boundary are regularly prescribed burned, but any additional prescribed burning adjacent to these large, continuous unburned blocks of pocosin would not currently be feasible without prior fuel treatments.

Ownership varies along the Pocosin WUI area boundary. Camp Bryan, a developed camp retreat, lies along the southeastern shore of Ellis Lake. Weyerhaeuser has delineated several young plantations that would be at risk in the event of a wildfire along the eastern and southeastern portions of the area. There are also several farmfields in the eastern portion. A small private inholding has homes along the landownership line on Lake Road. The Marine railroad track intersects with the western boundary of the area, and with the exception of Weyerhaeuser plantation roads and Lake Road, the area is virtually unroaded. In the event of a wildfire, the Weyerhaeuser plantations and some homes in the small inholding would be lost or severely damaged. Camp Bryan would also be at risk.

Havelock WUI

The total Havelock WUI area is approximately 920 acres in size and occurs in MAs 5 and 6. No Wilderness is included in this area. While there are about 100 acres of high pocosin and organic soils, southern rough vegetation dominates the area. Because there is no recent fire history, 30+ year fuel accumulations in this pond pine woodland are considered to be relatively heavy.

This area probably has the most severe Wildland Urban Interface problem on the Croatan. On the western boundary, there is a very large Mini-Storage operation (greater than 500 units), with only a 5-foot canal and Forest Service road separating the business from forested land.

Developments in the area include Cameron Village (approximately 50 homes), Laurel Hill Apartments, and Pine Ridge Apartments. Cameron Village has a paved road system with wide turnarounds and numbered houses, but few road signs. There are above ground powerlines, but only one fire hydrant in the area. While structural engines could enter and maneuver through the area, it is very doubtful that many (if any) structures could be saved with wildfire in the immediate vicinity.

Weyerhaeuser also has several plantations that would be at risk in the event of a wildfire on the northeast boundary of the area. There are no roads near Forest Service land on the southern portion. There is little development adjacent to Forest Service ownership on the southern boundary, but a powerline parallels this portion of the area.

APPENDIX K: Projected Financial Resource Needs

Budget:
The budget for the Croatan National Forest has averaged approximately $1,250,000 since FY 1996. Full implementation of the Plan would require a budget of $1,466,200 or an increase of 17.7 percent (Table K-1).

Outputs:
Also shown in Table K-1 are the projected outputs associated with each budget line item under the current alternative and proposed plan.

Table K-1. Average Budget (FY 1996 – FY 1999), Plan Budget, and Full Implementation Budget (in 1997 Dollars). Outputs Associated with each Functional Activity.

	Current		Fully Implemented Plan	
Functional Activity	Budget	Outputs	Budget	Outputs
	$	No.	$	No.
Forest Fire Protection	465,000		490,000	
Prescribed Burning (Acres)		15,000		25,000
Recreation, Trails, and Wilderness	119,000		128,340	
Developed Recreation (PAOTS)		1,675		2,240
Trail Use (Miles)				
OHV		36		8-10
Mountain Bike		0		20–40
Horseback		0		10–20
Hiking		31		31
Fishing		0		5
Canoe		0		16
Wildlife Viewing		0		4
Wilderness Management (Acres)		31,221		31,942
Wild and Scenic Rivers				
Designation (Miles/10 Years)		0		67.4
Timber Sales (Appr. And Salv.)	136,000		182,000	
Allowable Sale Quantity				
First Decade (MCF)		1,100		876
Long-Term Sustained				
Yield Capacity (MCF/Year)		1,625		1,303
General Administration	99,000		99,000	
Road Construction and Maintenance	108,000		124,400	
Forest Service Roads (Miles)		222		222
Roads Closed (Miles)		14		30
Seasonal Access (Miles)		9		17
Threatened and Endangered Species	38,500		64,560	
Growing Season Burn in HMA				
(Acres/Year)		200		2,000
Size of HMA (Acres)		37,845		69,000

New Recruitment Stands in 10 years		15–20		20-26
RCW Clusters in 10 Years (Number)		68–75		83–89
Long-Term Population Objective (Number)		126–139		137–169
SCSEP	121,000		121,000	
Cooperative Work – KV	27,500		55,000	
Reforestation	50,000		148,000	
Regeneration Methods (Acres)				
Clearcut		0		100
Seed-Tree/Shelterwood		60		0
Two Age		0		150
Landlines and Acquisition	20,000		20,000	
Acquisitions/Year (Acres)		300		900
Wildlife Habitat Management	8,000		8,000	
Wildlife Openings				
Constructed		0		25
Maintained		255		280
Fisheries Habitat Management	11,100		14,000	
Stocking (Acres)		8		158
Fertilization (Acres/Year)		0		20
Liming (Acres/Year)		0		20
Habitat Improvement (Miles)		0		5
Law Enforcement	16,500		16,500	
Planning, Inventory and Monitoring	14,800		5,000	
Cooperative Work – Other	5,500		5,500	
Soil, Water, and Air Operations	2,500		3,800	
Minerals Management	1,100		1,100	
Leases Administered (Number)		1.5		1.5
Cultural Resources	2,200		7,500	
Sites Interpreted (Number)		5		17
Budget Totals	1,245,700		1,493,700	

APPENDIX L: Monitoring Task Sheets

1. Resource Being Monitored:	**Monitoring Populations**
2. Monitoring Question:	1a) What are the population trends of the management indicator species? How do they compare with planned goals? 1b) Of the goals and objectives that likely contribute toward or affect the population trends, what are the rates of implementation?
3. Driver (s):	Endangered Species Act; National Forest Management Act; Forest Plan goals and objectives (Table L-1)
4. Priority:	High
5. Cooperators:	North Carolina Wildlife Resources Commission; USDI Fish and Wildlife Service; US Department of Defense, Marine Corps; USDA Forest Service Research;
6. Monitoring Item:	To answer the question, data on the overall trend in numbers of individuals and reproductive success is needed for RCW, wild turkey and black bear. For longleaf pine and wiregrass an assessment of occurrence across suitable habitat is needed.
7. Metadata of Data Collection: • Scale • Unit of Measure • Methods • QA/QC • Precision & Reliability • Frequency of Measurement • Who collects? When?	1a) **RCW** – color-banding, nest checks, adult/fledge checks for number and sex of all active clusters on a yearly basis. Assessment of habitat and location of future cavity trees is done on an annual basis. District and forest personnel do the data collection. Precision and reliability – Level A **Longleaf/wiregrass** – Longleaf data will be generated through CISC updates during field inventories, wiregrass was measured from a random sampling of plots; future plots will be established on a yearly basis, including areas of pine straw harvest. Remeasurement will occur on a portion of the total number of plots established. District and forest personnel collect the data. The CISC database needs updating to ensure reliability of data. Precision and reliability – Level A and B **Wild turkey** – harvest data, summer brood counts and observational data done on a yearly basis. The data is predominantly collected and synthesized by the NCWRC. District personnel contribute information. Precision and reliability – Level A **Black bear** - harvest data, mortality data, supplemented with nuisance complaints done on a yearly basis. Nusiance complaints are not considered useful indicators of bear population trends but are collected to gauge "cultural carrying capacity." The data is predominantly collected by NCWRC, and supplemented by USFS and other cooperators. Precision and reliability – Level A 1b) refer to table 5.3.1 for these measures and reporting systems. Precision and reliability is level B and C.
8. Reporting Period	Annually
9. Information Management	**RCW** – District Biologist maintains data - hard copy and GIS layers. **Longleaf and wiregrass** – Forest and District Silvculturists maintain CISC database. Forest Ecologist maintains wiregrass plot data. **Wild turkey and Black bear** - NCWRC controls raw data; USFS receives summary reports which are given to the Forest Wildlife Biologist and distributed.
10. Responsibility	District and Forest Silviculturists, Forest Ecologist, District and Forest Wildlife Biologists
11. Cost	RCW – Contract and force account Longleaf/Wiregrass – force account Black bear and wild turkey – force account
12. Evaluation Process	
13. How Will Information be Used?	To amend the Forest Plan and modify management practices based on population trends and habitat conditions.

1. Resources Being Monitored:	**Monitoring Habitats**
2. Monitoring Question:	2a) On landtypes where planned management actions are relatively infrequent and low impact, what are the habitat conditions? Are plan objectives being met? 2b) Of goals and objectives likely to contribute toward affecting these habitat conditions, what are the rates of implementation?
3. Driver (s):	Forest Plan goals and objectives (Table L-1)
4. Priority:	Moderate to low priority
5. Cooperators:	**Aquatic habitats** – North Carolina Division of Marine Fisheries, North Carolina Wildlife Resources Commission, NC State University **Terrestrial habitats** – US Fish and Wildlife Service, North Carolina Wildlife Resources Commission (non-game), North Carolina Natural Heritage Program
6. Monitoring Item:	To answer the monitoring question, an assessment of change in water quality measurements will provide an assessment of aquatic habitats; within terrestrial habitats, old growth conditions in hardwood cypress wetlands need to be inventoried and mapped, sampling needs to take place in maritime ridge and dune forests (especially in areas to be restored), breeding bird surveys need to continue, and element occurrences need to be checked for condition and presence/absence.
7. Metadata of Data Collection: Scale Unit of Measure Methods QA/QC Precision & Reliability Frequency of Measurement Who collects? When?	2a) **Aquatic habitats** – Collected annually by District, Forest and State agency personnel during late summer; data collected includes water quality parameters (e.g. salinity, pH, dissolved oxygen, conductivity); fish data on species collected; analysis of the utilization of Forest waters by anadromous species. Precision and reliability – Level A **Terrestrial habitats** – Old growth will be mapped using GIS, aerial photography, and field verification within the first 3 years of Plan implementation; old growth stand conditions will be measured by random sampling each year 10% of the areas mapped; data collected will be tree species, age, DBH, crown cover, height, % snags, % woody debris, % cover of understory, evidence of human disturbance. District and Forest personnel will collect the data. Vegetation sampling data will be collected in the Maritime forest landtype by Forest and District personnel, at 5 year intervals beginning immediately prior to restoration activity. Breeding bird surveys record the occurrence of birds by sound along two driving routes on the CNF and are conducted annually by a variety of personnel and skilled volunteers in May and June. 10% of all recorded EOs will be assessed each year through site visits at appropriate times for occurrence and condition of plants and habitat by either contract or Forest/District personnel Precision and reliability – Level B and C 2b) Refer to table 5.3.1 for these measures and reporting systems. Precision and reliability is level B and C.
8. Reporting Period	Aquatic data is reported annually. Old Growth Condition and Inventory will be evaluated and assessed every 3 years Maritime Forest vegetation sampling results will be evaluated at 5 year intervals Results from breeding bird surveys are reported and synthesized every 2-years. Results of Element Occurrence assessments completed in each year will be evaluated annually.
9. Information Management	GIS layers of aquatic ecoclasses, fish survey points, bird survey routes, old growth stands, maritime forest vegetation plots, and Element Occurrences; Raw data for old growth and EO conditions and maritime forest vegetation plots will be linked to the layers, and stored hard copy in unit files.
10. Responsibility	Forest and District Wildlife/T&E Biologist, Forest Fisheries Biologist, Forest Ecologist
11. Cost	
12. Evaluation Process	
13. How Will Information be Used?	The information generated will be used to gauge the overall health of the habitat on the Croatan, how it fits into the larger regional habitat required for these species, and the level of human disturbance that may impact the habitats.

1. Resource Being Monitored:	**Monitoring Public Use and Customer Satisfaction**
2. Monitoring Question:	3a) What amount and kinds of public use activities are occurring on the CNF and how satisfied are people with their experiences? 3b) Of goals and objectives that would contribute toward the trends of public use and satisfaction, what is the rate of implementation?
3. Driver (s):	Forest Plan Goals and objectives (Table L-1); Validation of assumptions made for recreation planning; Validation of the NVUM data collected specific for CNF
4. Priority:	Moderate to High
5. Cooperators:	Southern Research Station
6. Monitoring Items:	To answer the monitoring question, information needs to be collected that is specific to recreational opportunities offered on the CNF and user's specific desires for recreational activities. Assessing the satisfaction of users is also needed.
7. Metadata of Data Collection: • Scale • Unit of Measure • Methods • QA/QC • Precision & Reliability • Frequency of Measurement • Who collects? When?	3a) Using the NVUM project protocol, questions specific to the Croatan NF will be developed. Sampling on the Croatan will take place between 2002 and 2006. Sampling will be done force account using the same methods established for the national project. The specific questions will attempt to capture user input on desired facilities, and satisfaction of what is provided, especially the OHV system, biking and horseback trails and rustic, water-based and developed facilities. Precision and reliability – Level A 3b) Refer to table 5.3.1 for these measures and reporting systems. Precision and reliability is level B and C.
8. Reporting Period	The data collected will be evaluated and interpreted within 2 years of collection.
9. Information Management	Data collected is analyzed by the Southern Research Station and archived nationally. The Forest has access to the data, but does not manage or store it.
10. Responsibility	Forest and District personnel
11. Cost	$40,000.00
12. Evaluation Process	
13. How Will Information be Used?	The information generated will be used to adapt forest Plan objectives to specific needs and desires of the public. The information will also be used to validate the assumptions made during the planning process of what the public wanted for recreational opportunities, and to measure the accuracy of the sources used for these assumptions.

1. Resource Being Monitored:	**Monitoring Local Community Needs and Community Actions**
2. Monitoring Question:	4a) Are local communities attaching special significance to the natural and cultural attributes of the CNF as contributing to their well-being, and if so, how is this attachment exhibited through community actions? 4b) Of goals and objectives that would contribute toward creating a sense of place for local communities, what are the rates of implementation?
3. Driver (s):	Forest Plan Goals and objectives (Table L-1)
4. Priority:	Moderate to High
5. Cooperators:	Local Governments of Carteret, Craven, and Jones Counties, other state and federal agencies, local businesses
6. Monitoring Items:	Collaborative efforts measured in terms of special events co-sponsored by various cooperators. The change in special uses, land adjustments, and WUIs treated would also be reported.
7. Metadata of Data Collection: • Scale • Unit of Measure • Methods • QA/QC • Precision & Reliability • Frequency of Measurement • Who collects? When?	Scale is the 3-county area. Number of special events would be reported by the District Ranger. Precision and reliability is Level C. Data collected Annually.
8. Reporting Period	The data collected will be evaluated and interpreted within 1 year of collection.
9. Information Management	Documented in the Annual Monitoring Report
10. Responsibility	Forest and District personnel
11. Cost	$1,000.00
12. Evaluation Process	
13. How Will Information be Used?	Collaborative efforts to develop a sense of place in the 3-county area should result in more protection of CNFs special attributes. For example, fewer incidents of illegal trash disposal should occur because people would want to keep the forest in a natural condition.

1. Resource Being Monitored:	**Implementation Monitoring**
2. Monitoring Question:	5a) Are projects being designed to achieve desired conditions of the management prescriptions? 5b) Are projects being implemented according to decisions made through the NEPA process, including plan standards?
3. Driver (s):	Forest Plan Goals and Objectives (Tables 5.14 and L-1)
4. Priority:	High
5. Cooperators:	US Fish and Wildlife Service, NC Wildlife Resources Commission, NC Natural Heritage Program, NC Division of Forest Resources, North Carolina Division of Marine Fisheries, NC Parks and Recreation, variety of user groups
6. Monitoring Item:	To answer the monitoring question, data needs to be collected for how and what is accomplished each year, using existing tracking systems.
7. Metadata of Data Collection: Scale Unit of Measure Methods QA/QC Precision & Reliability Frequency of Measurement Who collects? When?	Forestwide scale. Check on NEPA process and project implementation. Forest Assistance Visits. Level B. Every two years. Planning staff
8. Reporting Period	Annually, and possibly more or less frequently as projects are accomplished
9. Information Management	Report of Findings
10. Responsibility	Planning Staff
11. Cost	Approximately $8,000 per ID team visit
12. Evaluation Process	
13. How Will Information be Used?	The information will be used to modify expectations of accomplishment in the Forest Plan, and amend the Plan, if necessary, to better regulate implementation.

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APPENDIX M: Longleaf Old Growth

Allocate longleaf old growth in the following areas:

Management Area 1:

- 78 acres in Comp. 4 within stands 20 and 44 centered at RCW cluster 21.
- 21 acres in RCW nest areas of clusters 22, 28, and 908.

Management Area 2:

- 18 acres in Comp. 49, within stands 22 and 23 and Comp. 48 within stand 10. Center at RCW cluster 905.

Management Area 3:

- 140 acres in Comp. 55 within stands 8, 18, 19, 20, 21 centered at RCW cluster 112.
- 95 acres in Comp. 34 within stands 3, 4, 13 and Comp. 56 within stand 21. Center at RCW clusters 67 and 70.
- 5 acres in Comp. 31 within stands 9, 13, 23, and Comp. 34 within stand 26. Center at RCW clusters 27 and 152.
- 55 acres in Comp. 43 within stands 20, 21, and Comp. 47 within stand 7. Center at RCW cluster 115.
- 49 acres in Comp. 42 within stand 29 centered at RCW cluster 43.
- 36 acres in Comp. 34 within stands 18 and 38 centered at RCW cluster 13.
- 33 acres in nest areas of RCW clusters 62, 68, 69, 904, 906.

Management Area 4:

- 155 acres in Comp. 25 within stands 20 ,21, 22 and Comp. 57 within stands 8, 9, 31. Center at RCW clusters 10, 11, 50.
- 130 acres in Comp. 26 within stands 12, 13, 26, 28, 29, 35. Center at RCW clusters 12, 33.
- 110 acres in Comp. 22 within stands 8, 10, 27, 29 and Comp. 23 within stand 1. Center at RCW clusters 4 and 18.
- 70 acres in Comp. 24 within stands 8,9,10 centered at RCW cluster 16.
- 70 acres in Comp. 24 within stands 22, 23, 39, 41. Center at RCW clusters 51, 60.
- 50 acres in Comp. 29 within stand 5 centered at RCW cluster 52.
- 30 acres in Comp. 30 within stand 4 centered at RCW cluster 73.
- 30 acres in Comp. 28 within stands 20, 32 centered at RCW cluster 19.
- 30 acres in Comp. 57 within stand 3 centered at RCW cluster 25.
- 20 acres in Comp. 26 within stand 19 centered at RCW cluster 71.
- 180 acres in 19 small areas within nesting areas of RCW clusters 4, 11, 17, 18, 25, 46, 48, 52, 53, 55, 56, 57, 65, 66, 71, 72, 73, 903, 909.

Additional opportunities for old-growth restoration outside the allocated old growth network exist in Comp. 22, stand 12; Comp. 26, stands 19, 22, 51; and Comp. 30, stand 19.

Management Area 5:

- 35 acres in 4 small areas within nest areas of RCW clusters 3, 8, 24, 31.

Management Area 6:

- 44 acres in Comp. 18 within stands 22, 35, 43 and Comp. 60 within stand 24.
  Center at RCW cluster 130.

Management Area 7:

- 120 acres in Comp. 6 within stand 22; Comp. 50 within stands 4, 7, 10.
  Center at RCW clusters 35 and 38.
- 100 acres in Comp. 5 within stands 7, 8; Comp. 50 within stand 26.
  Center at RCW clusters 1, 47, 177.
- 40 acres in Comp. 6 within stands 5 and 6 centered at RCW cluster 105.
- 100 acres in 6 small areas within nesting areas of RCW clusters 2, 29, 36, 58, 907.

APPENDIX N: Glossary

Age Class (Cohort) - A distinct aggregation of trees originating from a single natural event or regeneration activity, or a grouping of trees, e.g., 10-year age class, as used in inventory or management.

Anchor point - and advantageous location, usually varies to fire spread, from which to start constructing a fireline. The anchor point is used to minimize the change of being flanked by the fire while the line is being constructed.

Artificial Regeneration (Reproduction) - An age class created by direct seeding or by planting seedlings or cuttings.

Available fuel - that portion of the total fuel that would actually burn under various environmental conditions.

Bedding - Preparing a wet site for artificial regeneration using a bedding plow to till and mound soil above the water table. This allows planted seedlings to establish root systems in poorly drained soils.

Burning - prescribed - The application of fire, usually under existing stands and under specified conditions of weather and fuel moisture, in order to attain silvicultural or other management objectives.

Burning rotation - the planned number of years between prescribed fires on a specified areas.

Clearcutting - A method of regenerating an even-aged stand in which a new age class develops in a fully-exposed microclimate after removal, in a single cutting, of all trees in the previous stand. Regeneration is from natural seeding, direct seeding, planted seedlings, and/or advance reproduction. Harvesting may be done in groups or patches (Group or Patch Clearcutting), or in strips (Strip Clearcutting). In the Clearcutting System, the management unit or stand in which regeneration, growth, and yield are regulated consists of the individual clearcut stand (see Group Selection).

Clearcutting with Reserves - A clearcutting method in which varying numbers of reserve trees are not harvested to attain goals other than regeneration.

Codominant - Trees with crowns forming the general level of the main canopy in even-aged groups of trees, receiving full light from above and comparatively little from the sides.

Composition, Stand - The proportion of each tree species in a stand expressed as a percentage of either the total number, basal area, or volume of all tree species in the stand.

Continuous fuels - fuels that are arranged close enough in proximity to sustain a fire.

Control line - an inclusive term for all constructed or natural fire barriers and treated fire edges used to control a fire.

Convection column - the rising column of gases, smoke, fly ash, particulates, and other debris produced by a fire. The column has a strong vertical component indicating that buoyant forces override the ambient surface wind.

Coppice - A method of regenerating a stand in which all trees in the previous stand are harvested and the majority of regeneration is from sprouts or root suckers.

Coppice Methods - Methods of regenerating a stand in which the majority of regeneration is from stump sprouts or root suckers.

Coppice with Reserves - A coppice method in which reserve trees are retained to attain goals other than regeneration. The method normally creates a two-aged stand.

Crop Tree - Any tree that is selected to become a component of a future final harvest.

Crown - The part of a tree or woody plant bearing live branches and foliage.

Crown Class - A class of tree based on crown position relative to the crowns of adjacent trees.

Crown Cover - The ground area covered by the crowns of trees or woody vegetation as delimited by the vertical projection of crown perimeters and commonly expressed as a percent of total ground area (syn. Canopy Cover).

Crown closure - the spacing between tree crowns; usually expressed as the percent of area covered by tree crowns in the forest canopy region as viewed from above.

Crown Density - The amount, compactness, or depth of foliage of the crowns of trees and/or shrubs.

Cutting Cycle - The planned interval between partial harvests in an uneven-aged stand (see Thinning Interval).

Direct attack - a method of suppression that treats the fire as a whole, or all its burning edge, by wetting, cooling, smothering, or by chemically quenching it or mechanically separating it from unburned fuel.

Dominant - Trees with crowns extending above the general level of the main canopy of even-aged groups of trees, and receiving full light from above and partly from the sides.

Even-Aged Methods - Methods designed to maintain and regenerate a stand with a single age class.

Even-Aged Stand - A stand of trees containing a single age class in which the range of tree ages is usually less than 20 percent of rotation.

Even-Aged Silvicultural System - A planned sequence of treatments designed to maintain and regenerate a stand with one age class. The range of tree ages is usually less than 20 percent of the rotation. (see Clearcutting, Coppice, Seed-Tree, Shelterwood,).

Extreme fire behavior - implies a level of fire behavior characteristics that ordinarily precludes methods of direct control action. One or more of the following is usually involved: high rates of spread; prolific crowning and /or spotting; presence of firewhirls; a strong convection column. Predictability is difficult because such fires often exercise some degree of influence on their environment, behaving erratically and sometimes dangerously.

Fire behavior prediction model - a set of mathematical equations that can be used to predict certain aspects of fire behavior when provided with an assessment of fuel and environmental conditions.

Fire danger - a term used to express an assessment of fixed and variable factors such as fire risk, fuels, weather, and topography, which influence whether fires will start, spread, and do damage; also the degree of control difficulty to be expected.

Fire intensity - the rate of heat release for an entire fire at a specific point in time.

Flame length - the distance between the flame tip and the midpoint of the flame depth at the base of the flame (generally the ground surface). It is measured on a slant when the flames are tilted due to effects of wind and slope and is used as an indicator of fire intensity.

Fuel loading - the amount of fuel present expressed quantitatively in terms of weight of fuel per unit area. This may be available fuel (consumable fuel) or total fuel and is usually dry weight.

Fuel moisture content - the quantity of moisture in fuel expressed as a percentage of the weight when thoroughly dried at 212 degrees F. In dead fuels, fuel moisture contents of smaller fuels change more readily with changes in atmospheric moisture than larger fuels. Dead fuels respond to day-to-day and hourly changes in the microclimate surrounding the fuel particle. Live fuel moistures exhibit slower changes, generally based on seasonal changes, precipitation events, the temperature trend, and the species.

Group Selection - A method of regenerating uneven-aged stands in which trees are removed, and new age classes are established, in small groups. The maximum width of groups is approximately twice the height of the mature trees, with small opening providing micro-environments suitable for tolerant regeneration and the larger openings providing conditions suitable for more intolerant regeneration. In the Group Selection system, the management unit or stand in which regeneration, growth, and yield are regulated consists of a landscape containing an aggregation of groups (see Clearcutting).

Harvesting Method - A cutting method by which a stand is harvested. Emphasis is on meeting logging requirements rather than silvicultural objectives. (see Regeneration Methods).

Improvement Cutting - A cutting made in a stand past the sapling stage primarily to improve composition and quality by removing less desirable trees of any species.

Ingrowth - Trees that during a specified period have grown past an arbitrary lower limit of (usually) diameter or height. Ingrowth is usually measured as basal area or volume per unit area.

Intermediate - Trees with crowns extending into the lower portion of the main canopy of even-aged groups of trees, but shorter in height than the codominants. They receive little direct light from above and none from the sides.

Intermediate Treatments (Tending) - A collective term for any treatment designed to enhance growth, quality, vigor, and composition of the stand after establishment of regeneration and prior to final harvest (see Tending, Stand Improvement).

Liberation - A release treatment made in a stand not past the sapling stage in order to free the favored trees from competition of older, overtoppping trees.

Midflame windspeed - the speed of the wind measured at the midpoint of the flames, considered to be most representative of the speed of the wind that is affecting fire behavior. It is usually less than the standard 20 foot windspeed, i.e. windspeeds measured at 20 feet above the average top of the vegetation.

Natural Regeneration - An age class created from natural seeding, sprouting, suckering, or layering.

Nurse Tree (Nurse Crop) - A tree, group of crop of trees, shrubs, or other plants, either naturally occurring or introduced, used to nurture or improve the form of a more important tree or crop during youth by protecting it from frost, insolation, or wind.

Overstory Removal - The cutting of trees comprising an upper canopy layer in order to release trees or other vegetation in an understory.

Overtopped (Suppressed) - Trees of varying levels of vigor that have their crowns completely covered by the crowns of one or more neighboring trees.

Plantation - An artificially reforested area, established by planting or direct seeding.
Precommercial Thinning (PCT) - A thinning that does not yield trees of commercial value, usually designed to improve crop spacing.

Rate of spread - the relative activity of a fire in extending its horizontal dimensions. It is expressed as rate of increase of the total perimeter of the fire, as rate of forward spread of the fire front, or as rate of increase in area, depending on the intended use of the information. Usually it is expressed in chains or acres per hour for a specific period in the fire's history.

Regeneration (Reproduction) Method - A cutting method by which a new age class is created. The major methods are Clearcutting, Seed-Tree, Shelterwood, Selection, and Coppice (see Harvesting Method).

Regeneration (Reproduction) Period - The time between the initial regeneration cutting and the successful re-establishment of a new age class by natural means, planting, or direct seeding.

Regular Uneven-Aged (Balanced) Stand - A stand in which three or more distinct age classes occupy approximately equal areas and provide a balanced distribution of diameter classes.

Release (Release Operation) - A treatment designed to free young trees from undesirable, usually overtopping, competing vegetation. Treatments include, liberation, and weeding (see Stand Improvement).

Reserve Trees - Trees, pole-sized or larger, retained after the regeneration period under the Clearcutting, Seed-Tree, Shelterwood, or Coppice Methods. syn. Standards.

Relative humidity - the ratio of the amount of moisture in the air to the maximum amount of moisture that air would contain if it were saturated. The ratio of the actual vapor pressure to the saturated vapor pressure.

Salvage Cutting - The removal of dead trees or trees being damaged or killed by injurious agents other than competition, to recover value that would otherwise be lost.

Sanitation Cutting - The removal of trees to improve stand health and to reduce actual or anticipated spread of insects and disease (see Stand Improvement).

Sapling - A tree, usually young, that is larger than a seedling but smaller than a pole. Size varies by region.

Seed-Tree - An even-aged regeneration method in which a new age class develops from seedlings that germinate in fully-exposed micro-environments after removal of all the previous stand except a small number of trees left to provide seed. Seed trees are removed after regeneration is established.

Seed-Tree with Reserves - A seed-tree method in which some or all of the seed trees are retained after regeneration has become established to attain goals other than regeneration.

Shearing- A method of preparing a site for artificial regeneration by shearing stumps and residual trees at ground line using a serrated, V shaped blade mounted to a large bulldozer.

Shelterwood - A method of regenerating an even-aged stand in which a new ageclass develops beneath the partially shaped micro-environment provided by the residual trees. The sequence of treatments can include three distinct types of cuttings: 1) an optional preparatory harvest to enhance conditions for seed production; 2) an establishment harvest to prepare the seed bed and to create a new age class; and 3) a removal harvest to release established regeneration from competition with the overwood. Harvesting may be done uniformly throughout the stand (Uniform Shelterwood), in groups or patches (Group Shelterwood), or in strips (Strip Shelterwood).

Shelterwood with Reserves - A variant of the Shelterwood Method in which some or all of the shelter trees are retained, well beyond the normal period of retention, to attain goals other than regeneration. The resulting stand may be two-aged or tend towards an uneven-aged condition as a consequence of both an extended period of regeneration establishment and the retention of reserve trees that may represent one or more age classes.

Single-Tree Selection - A method of creating new age classes in uneven-aged stands in which individual trees of all size classes are removed more-or-less uniformly throughout the stand to achieve desired stand structural characteristics.

Silviculture - The art and science of controlling the establishment, growth, composition, health, and quality of forests and woodlands. Silviculture entails the manipulation of forest and woodland vegetation in stands and on landscapes to meet the diverse needs and values of landowners and society on a sustainable basis.

Silvicultural System - A planned process whereby a stand is tended, harvested, and re-established. The system name is based on the number of age classes (see Even-Aged, Two-Aged, Uneven-Aged), and/or the regeneration method used (see Clearcutting, Seed-Tree, Shelterwood, Selection, Coppice, Shelterwood with Reserves).

Site Class - A classification of site quality, usually expressed in terms of ranges of dominant tree height at a given age or potential mean annual increment at culmination.

Site Quality (Productivity) - The productive capacity of a site, usually expressed as volume production of a given species.

Size Classes - Tree sizes recognized by distinct ranges, usually of diameter or height.
Spotting - behavior of a fire producing sparks or embers that are carried by convection columns and/or wind and which start new fires beyond the zone of direct ignition by the main fire.

Stand - A contiguous group of trees sufficiently uniform in age class distribution, composition, and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit (see Mixed, Pure, Even-Aged, and Uneven-Aged Stands).

Stand Density - A quantitative, absolute measure of tree occupancy per unit of land area in such terms as numbers of trees, basal area, or volume.

Stand Improvement - A term comprising all intermediate cuttings made to improve the composition, structure, condition, health, and growth of even-aged, two-aged, or uneven-aged stands.

Stocking - An indication of growing-space occupancy relative to a pre-established standard. Common indices of stocking are based on percent occupancy, basal area, relative density, and crown competition factor.

Stratum (Canopy Layer) - A distinct layer of vegetation within a forest community.

Surface fire - a fire that burns surface litter, debris, and small vegetation.

Suppress a fire - the most aggressive wildfire suppression strategy leading to the total extinguishment of a wildfire.

Two-Aged Methods - Methods designed to maintain and regenerate a stand with two age classes. (See Shelterwood with Reserves and Coppice with Reserves).

Thinning - A cutting made to reduce stand density of trees primarily to improve growth, enhance forest health, or to recover potential mortality.

- **Crown Thinning (Thinning From Above, High Thinning)** - The removal of trees from the dominant and codominant crown classes in even-aged stands, or in even-aged groups within uneven-aged stands, in order to favor the best trees of those same crown classes.
- **Free Thinning** - The removal of trees in even-aged, two-aged, or uneven-aged stands to control stand spacing and favor desired trees using a combination of thinning criteria without regard to crown position.
- **Low Thinning -** The removal of trees from the lower crown classes to favor those in the upper crown classes.
- **Mechanical Thinning (Geometric Thinning)** - The thinning of trees in either even-aged or two-aged stands, or in even-aged groups within uneven-aged stands, in the dominant crown class in order to favor the lower crown classes.

Thinning Interval - The period of time between successive thinning entries, usually used in connection with even-aged stands (see Cutting Cycle).
Two-Aged Stand - A stand composed of two distinct age classes that are separated in age by more than 20 percent of rotation.

Two-Aged Silvicultural System - A planned sequence of treatments designed to maintain and regenerate a stand with two age classes (see Shelterwood with Reserves, Coppice with Reserves).

Uneven-Aged (Selection) Methods - Methods of regenerating a forest stand, and maintaining an uneven-aged structure, by removing some trees in all size classes either singly, in small groups, or in strips.

Mixed Stand - A stand in which there is a mixture of tree species.

Pure Stand - A stand composed of essentially a single tree species.

Stratified Mixture - A stand in which different tree species occupy different strata of the total crown canopy.

Uneven-Aged Stand - A stand of trees of three or more distinct age classes, either intimately mixed or in small groups.

Uneven-Aged Silvicultural System - A planned sequence of treatments designed to maintain and regenerate a stand with three or more age classes (see Single-Tree Selection, Group Selection).

Weeding - A release treatment in stands not past the sapling stage that eliminates or suppresses undesirable vegetation regardless of crown position.