Table II-7. Spawning Criteria of Hickory Shad within the A/P Study Area

Location:

ROANOKE RIVER - mouth upstream to RM 105 above US HWY 258 bridge at Scotland Neck (Marshall 1977). During low water years, adult hickory shad are commonly caught below the rapids at Weldon by sport fishermen in late April and early May (Mullis, pers. comm.).

CHOWAN RIVER - Upper Chowan into the Nottoway and Meherrin Rivers above the Virginia border (Marshall 1977)

TAR RIVER - Between Greenville (RM 60) and Rocky Mount (RM 121) (Marshall 1977)

NEUSE RIVER - RM 80 to RM 97 and entire tributaries: Turkey Quarter Creek; Pitchkettle Creek; Taylor Creek; Halfmoon Creek; Contentnea Creek; Grindle Creek (Hawkins 1979)

Season:

ROANOKE RIVER - not documented

CHOWAN RIVER - not documented

TAR RIVER - late March to early April (Marshall 1976).

NEUSE RIVER - late March to early May (Pate 1972; Hawkins 1979).

Temperature:

ALBEMARLE AREA - 13°C to 21°C (Street et al. 1975)

TAR RIVER - 14°C to 19°C (Marshall 1976)

NEUSE RIVER - lowest at 9.5°C (Pate 1972); range between 13°C and 18.5°C (Hawkins 1979)

Habitat:

Not documented. Generally, river swamp areas, lakes and large tributaries may be used (Godwin and Adams 1969; Street 1970).

Nursery Area:

Postlarvae and Juveniles:

ALBEMARLE AREA - not documented

TAR RIVER - Juveniles spend short time in upstream areas before migrating downstream to high salinity tributaries of the Pamlico River (Pate 1975). Specific locations not documented.

NEUSE RIVER - Juveniles spend short time in upstream areas before migrating to high salinity tributaries of Neuse River during summer months (Pate 1972; Spitsbergen and Wolff 1973; Marshall 1977; Hawkins 1979).

Fertilization:

Hickory shad eggs are released in open water areas of rivers where they are fertilized; typically demersal and somewhat adhesive, but easily dislodged and transported by currents (Mansueti and Hardy 1967).

Hatching:

Incubation time ranges from 48 to 70 hours at 16°C to 31° C (Mansueti and Hardy 1967).

Feeding:

Not documented

Table II-7 (Hickory Shad continued)

Water Quality:

In the Neuse River, hickory shad eggs were collected in waters of pH 6.4 to 6.5 and dissolved oxygen between 5 and 10 mg/l (Hawkins 1979). Hardiness to other water quality factors has not been documented.

Swimming Ability:

Not documented

Chemical Tolerances:

Egg and larval tolerances not documented

Table II-8. Spawning Criteria of Blueback Herring within the A/P Study Area

Location:

Albemarle Area -

CHOWAN RIVER - Rocky Hock Creek; Salmon Creek; Warwick Creek; Dillard Creek; Bennetts Creek; Sarem Creek; Barnes Creek; Wiccacon River (Winslow et al. 1985)

ALLIGATOR RIVER - Northwest fork; Frying Pan; Cherry Ridge Landing; Gum Neck Landing (pumping station); East Lake (lower); South Lake (upper); Second Creek (Loesch et al. 1977)

ROANOKE RIVER - Gardners Creek (SR 1511); Conoho Creek mouth (RM 37.5); Conine Creek mouth (RM 102); Cow Creek (Johnson et al. 1978)

CASHIE RIVER - SR 1225; SR 1514 (Johnson et al. 1978)

SCUPPERNONG RIVER - no specific location (Winslow et al. 1985)

Pamlico Area -

TAR RIVER - from Bear Creek above Washington to Town Creek above Old Sparta and tributaries (Marshall 1976)

Neuse Area -

NEUSE RIVER - SR 1008 bridge downstream to New Bern

SWIFT CREEK - SR 1440 bridge to mouth

LITTLE SWIFT CREEK - SR 1627 bridge to mouth

BACHELOR CREEK - US HWY 70 bridge to mouth

CONTENTEA CREEK - NC HWY 13 bridge (Snow Hill) to mouth

LITTLE RIVER - NC HWY 581 bridge to mouth

TRENT RIVER - Pleasant Hill to SR 1121 (Marshall 1977)

Entire creeks: Pinetree Creek, Turkey Quarter Creek, Pitchkettle Creek, Taylor Creek, Halfmoon Creek, Kitten Creek, Village Creek (Hawkins 1979)

Season:

Albemarle area - mid-March to late May (Winslow et al. 1985)

TAR RIVER - March 25 - May 7 (Marshall 1976)

PAMLICO RIVER tributaries - April 7 - May 3 (Marshall 1976)

NEUSE RIVER - late March to late May (Hawkins 1979)

Temperature:

Albemarle Area - 13°C to 22°C for "river herring" (Winslow et al. 1985)

TAR RIVER - 12°C to 19°C (Marshall 1976)

PAMLICO RIVER tributaries - 13°C to 25°C (Marshall 1976)

NEUSE RIVER - 13°C to 26°C (Hawkins 1979)

Habitats:

No specific information available. In general, prefer spawning sites with fast current and associated hard substrates (Loesch and Lund 1977). Brackish water or standing water rarely used.

Nursery Areas:

Postlarvae and Juveniles:

ALBEMARLE SOUND - Pasquotank River, Little River, Perquimans River, Chowan River, lower Roanoke River, Scuppernong River, Alligator River, and periphery of Albemarle Sound (Loesch et al. 1977; Winslow et al. 1985)

Nursery Areas:

Postlarvae and Juveniles (continued):

CROATAN SOUND - used as secondary nursery area from October through March (Street et al. 1975)

TAR-PAMLICO - Hardee Creek area to Washington, and Goose, Broad, and Blounts Creeks (Hawkins 1979)

PAMLICO SOUND - western and northern ends as secondary nursery areas from October through March (Spitsbergen and Wolff 1974; Marshall 1976)

NEUSE RIVER - mouth of Cove Creek downstream to mouth of Bachelor Creek (21 km) (Marshall 1977)

TRENT RIVER - Pollocksville downstream to mouth of Island Creek (Marshall 1977)

Fertilization:

Blueback herring eggs are essentially pelagic, but are demersal in still water and are somewhat adhesive (Lippson and Moran 1974; Loesch and Lund 1977). Eggs are released in grasses or vegetation and are fertilized (Frankensteen 1976).

Hatching:

Incubation period is dependent on water temperature; hatching time ranges from 80 to 94 hours at 20°C to 21°C, and 36 to 38 hours at 22°C (Morgan and Prince 1976; Street and Adams 1969).

Feeding:

Larvae begin feeding on zooplankton immediately after mouth becomes functional, primarily small cladocerans and copepods (Norden 1968; Nigro and Ney 1982).

Water Quality:

Blueback herring eggs and larvae exhibit high mortality when exposed to pH waters below 6 and 0.20 mg/l total aluminum (Klauda and Palmer 1987). Suspended sediments 100 ppm or less did not significantly affect the hatchability of blueback herring eggs (Auld and Schubel 1978).

Swimming Ability:

Prolarvae are positively phototropic (Mansueti 1956) and swim in spasms to the surface, sink to the bottom to rest for several seconds, then repeat the process (Cianci 1969).

Chemical Tolerances:

Monomeric aluminum concentrations of 0.1 mg/l during episodic pH events is highly toxic to eggs and larvae (Klauda and Palmer 1987). The LC_50 of total residual chlorine for eggs ranges from 0.20-0.32 ppm; sublethal concentrations resulted in deformed larvae (Morgan and Prince 1977). (Note: LC = lethal concentration, the concentration at which 50% of the test organisms die).

Table II-9. Spawning Criteria of Alewife within the A/P Study Area

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Location:

CHOWAN RIVER - Dillard Creek at SSR 1226 bridge and below (Winslow et al. 1985)

ALLIGATOR RIVER - Gum Neck Landing; Alligator River, Southwest and Northwest forks; Alligator Creek; East Lake (lower); Second Creek; Frying Pan; South Lake (middle and upper); Kilkenny Landing; Swan Lake; Cherry Ridge Landing (Loesch et al. 1977)

CASHIE RIVER - Hoggard Mill Creek (SR 1301); Wading Place Creek (SR 1514) (Johnson et al. 1978)

NEUSE RIVER - Not known; probably use the river as far upstream as Contentnea Creek (Hawkins 1979)

Season:

CHOWAN RIVER - mid-March through late May (Winslow et al. 1985)

ALLIGATOR RIVER - no information available

CASHIE RIVER - no information available

NEUSE RIVER - mid-March to mid-April (Marshall 1977)

Temperature:

CHOWAN RIVER - 13°C to 22°C (Winslow et al. 1985)

ALLIGATOR RIVER - no information available

CASHIE RIVER - no information available

NEUSE RIVER - 15°C to 20.5°C (Marshall 1977)

Habitat:

General - eggs and milt are released over detritus-covered bottom of attached vegetation, sticks, or other organic matter and occasionally over a hard sand bottom (Cooper 1961) in ponds and sluggish stretches of rivers and streams (Bigelow and Schroeder 1953, Kissil 1974).

Nursery Area:

Postlarvae and Juveniles:

General - Alewife larvae generally remain in the vicinity of the spawning grounds (Hildebrand 1963). Juveniles remain in tidal creek nursery areas and move seaward in late summer and fall (Bigelow and Schroeder 1953).

ALBEMARLE AREA - Pasquotank River; Little River; Perquimans River; Chowan River; lower Roanoke River; Scuppernong River; Alligator River, and periphery of Albemarle Sound (Winslow et al. 1985)

CURRITUCK SOUND - all (Winslow et al. 1985)

Fertilization:

Alewife eggs are broadcast at random, are demersal and adhesive initially; within several hours the adhesive property is lost and eggs enter the water column (Mansueti 1956; Cooper 1961).

Hatching:

Incubation period for alewife eggs ranges from 2.1 days at 28.9°C to 15 days at 7.2°C (Edsall 1970)

Feeding:

Larvae begin feeding on zooplankton immediately after mouth becomes functional, primarily on small cladocerans and copepods (Norden 1968; Nigro and Ney 1982).

Table II-9 (Alewife continued)

Water Quality:

Hatching success of alewife eggs is not affected by suspended sediments in concentrations of 100 mg/l or less (Auld and Schubel 1978).

Swimming Ability:

Prolarvae are positively phototrophic (Mansueti 1956) and swim in spasms toward the surface (Cianci 1969).

Chemical Tolerances:

No information available

E. BARRIER ISLANDS: BEACHES, DUNES, FLATS, THICKETS, WOODLANDS, MARSHES, IMPOUNDMENTS, INLETS, DREDGED ISLANDS, AND AQUIFERS

E. 1. Description

The North Carolina Outer Banks extend from the Virginia-North Carolina border to the southern end of Cape Lookout National Seashore -- a distance of almost 200 miles. The communities of Corolla, Duck, Southern Shores, Kitty Hawk, Kill Devil Hills, Nag's Head, Whalebone, and South Nag's Head are located on Currituck Banks; Rodanthe, Waves, Salvo, Avon, Buxton, Frisco, and Hatteras on Hatteras Island; and Ocracoke and Portsmouth on islands of the same names.

The Outer Banks are a chain of long, narrow, sandy barrier islands, from one-quarter mile to 3 miles wide (mostly less than 1 mile wide), forming the seaward boundary of Currituck, Albemarle, Roanoke, Pamlico, and Core Sounds. Oregon, Hatteras, Ocracoke, Swash, Drum, and Bardens inlets separate the islands. Between the Outer Banks and the mainland, waters of the Roanoke, Chowan, Tar-Pamlico, Neuse, and other rivers mix with the salt waters of the ocean to form the brackish waters of our estuarine sounds (Dunbar and Kniffen 1956; Stick 1958).

The Outer Banks are exposed to the effects of salt-spray laden wind (Boyce 1954). Prevailing summer winds are from the southwest, and the pruning effects of the salt spray produce the "wind-form" of the woody vegetation. Northeastern storms in winter make a lesser wind form. Winter "northeasters" are often severe and prolonged (the Ash Wednesday storm of 1962 opened up a wide inlet at Buxton and caused major beach erosion). Hurricanes sweep the Outer Banks at irregular intervals, overwashing the islands as floodwaters surging out of the sounds break through the barrier islands (Engels 1942).

Moving water also affects the Banks. The average rate of beach erosion varies from 2 to 6 ft per year (Benton 1981). These forces are more evident near the inlets, which can migrate at rates of up to 25 feet per year (Benton 1981). Thus the physical forces of nature--wind and wave, storm and erosion, tides and salt spray--are a profound, continuous, and varying component of the Outer Banks (Brower and Frankenberg 1976; Dolan et al. 1973; Godfrey and Godfrey 1975, 1976).

The vegetation and natural communities of the Outer Banks extend from beach to sound in narrow, sometimes inter-weaving, more or less parallel strips, with each community or habitat type composed of a few dominant and distinctive plant species (Oosting 1954; Brown 1959; Quay 1959; Milne and Quay 1966).

The herbaceous beaches, dunes, and flats, exposed to the greatest salt spray, are characterized by northern beach grass (Ammophila breviligulata), sea oats (Uniola paniculata), saltmeadow cordgrass (Spartina patens), sand rush (Fimbristylis castanea), broom-sedge (Andropogon scoparius var. littoralis), seaside goldenrod (Solidago sempervirens), wild bean (Strophostyles helvola), and other salt-tolerant species (Schafale and Weakley 1985).

Landward (soundward) herb-shrub habitats become increasingly dominated by wax myrtle (Myrica cerifera), yaupon (Ilex vomitoria), marsh elder (Iva frutescens), and young and/or stunted live oak (Quercus virginiana). Farther into the dune and flats system, herb-shrub communities are replaced by taller and denser shrub thickets, which in turn may grade into thicket woodlands. Progressing soundward, the thicket woodlands increasingly become dominated by red cedar (Juniperis virginiana),

red bay (Persea borbonia), Hercules club (Zanthoxylum clava-herculis), live oak, and loblolly pine (Pinus taeda), with much greenbriar (Smilax) and grape (Vitus).

The oldest, tallest, and most stable vegetation on the Outer Banks is maritime forest, with live oak, laurel oak (Quercus laurifolia), red cedar, American holly (Ilex opaca), and ironwood (Carpinus caroliniana) forming the canopy and a distinctive understory of red cedar, wild olive (Osmanthus americanus), red bay, flowering dogwood (Cornus florida), willow (Salix nigra), wax myrtle, yaupon, groundsel-tree (Baccharis halimifolia), French Mullberry (Callicarpa americana), grape, greenbriar, and other vines, small trees, and shrubs (Lopazanski et al. 1988).

Sloping toward the sounds are first the irregularly flooded high marsh and then the low inter-tidal marsh, each with its characteristic biota. (These habitats are discussed in Section C of this chapter.) Fresh marsh vegetation exists along roadsides, in the two fresh-water impoundments of Pea Island National Wildlife Refuge; in ponds and swales in Buxton Woods, Nag's Head Woods, Kitty Hawk Woods; and scattered along the sound side on Currituck Banks, in roadside borrow pits on Bodie Island, and in the Bodie Island Lighthouse Pond (Parnell and Quay 1962).

An adequate source of fresh water has always been a problem on the Outer Banks. Original settlers made do with shallow wells and cisterns. Increasing populations have rendered these systems inadequate. Visitation to the Cape Hatteras National Seashore in 1957, before the Oregon Inlet Bridge, was about one-third of a million per year; in 193 it was 1,707,000 (Quay 1980). In 1988, the annual visitation was 2.1 million for Cape Hatteras National Seashore alone, and nearly 3 million for Cape Hatteras National Seashore, Wright Memorial, and Fort Raleigh (Roanoke Island) combined (R. Wood, Cape Hatteras National Seashore, pers. comm. 1989).

Since 1969, the freshwater supply for the Hatteras Island region from Avon to Hatteras Village has been secured from a number of wells 40-feet deep located within Buxton Woods; this well field is now due to be expanded but will remain within the single freshwater aquifer of the Buxton Maritime Forest. The present set of 20-year-old wells at Buxton is now pumping at nearly full capacity. At Ocracoke, the freshwater supply is primarily from a reverse osmosis desalinization plant built in 1977, with wells at 600 feet deep. The freshwater supply from shallow wells for the three upper villages of Hatteras Island has become limiting and a desalinization plant at Rodanthe, from deep wells, is now being planned with the hope of becoming functional by 1990-91.

The freshwater supplies for the Roanoke Island, Nags Head, and upper Currituck Banks regions have been from wells of various depths in the different locations, but, more recently, are primarily from deep wells in the Skyco region of Roanoke Island. Beginning three years ago, Dare County, Nags Head, and Kill Devil Hills joined in a united effort to build the second desalinization plant for the Outer Banks and Roanoke Island. This new plant, another using the reverse osmosis method, which became functional in the summer of 1989, uses brackish water from deep wells and has a capacity of 3-million gallons-per-day. Consideration is already being given to expansion of this new source, located at Kill Devil Hills.

The freshwater available for all of Currituck County is relatively poor in both quantity and quality, with little prospect of water for the Currituck County Banks coming by pipeline from the mainland of either North Carolina or Virginia.

About two-thirds of the NC Outer Banks in the A/P Study area is in some kind of state, federal, or public land trust ownership. Such areas include Cape Hatteras National Seashore, Cape Lookout

National Seashore, Pea Island National Wildlife Refuge, Pine Island National Audubon Society Refuge, 720 acres of maritime woods owned by Nag's Head and the Nature Conservancy, Jockey's Ridge State Park, Wright Brothers National Memorial Monument, Currituck National Wildlife Refuge, the North Carolina National Estuarine Research Reserve, the NC Coastal Reserve, and the North Carolina Nature Conservancy in the Swan Island-Monkey Island region (US Fish and Wildlife Service 1980; Taggart and Henderson 1988). All of these lands are held and managed as natural areas and are protected from development. In Cape Hatteras National Seashore, the 8 villages (totaling about 6,000 acres) are separate enclaves, each functioning the same as any other town or community within the county government system.

The 6,000 acres of Pea Island National Wildlife Refuge are now enclosed within the Cape Hatteras National Seashore but are managed by the US Fish and Wildlife Service and have been since the refuge was established and the freshwater impoundments were constructed in brackish marshes during the late 1930s. Waterfowl and other wildlife are more abundant at Pea Island than in the rest of the Cape Hatteras National Seashore. Vegetation on Pea Island is managed intensively for waterfowl by cutting, burning, discing, plowing, the use of water-control structures on the sound side, and formerly herbiciding to keep the natural communities more open, wetter, and in the earlier stages of plant succession.

The Park Service management, in contrast, practices the classical "protect and leave alone" system. Park Service lands have been protected from cutting, burning, plowing, and four-wheel vehicles, but have been subjected to road and dune building and other human-induced perturbations. They have not experienced a devastating hurricane for the past 35 years. As a result, these areas have become much more heavily vegetated, moving into the later stages of succession, with major loss of openness, edge habitat, and standing fresh and brackish waters. Between 1958 and 1978, the 6,000 acres of Bodie Island moved into later stages of succession; the vegetation became taller, denser, and more woody -- 43% of the area underwent a change in habitat types. The comparative change at Pea Island was 14% (Quay 1980). The changes in stages of succession were from fresh pond and/or marsh, tidal marsh, or herbaceous beach or dune to herb-shrub thicket, or thicket woodland. These changes were measured by aerial photography and verified by ground studies.

Dredge spoil islands created and maintained by the US Army Corps of Engineers (Corps) have been an ecological feature of the Outer Banks region and A/P estuaries since the 1930s. They are common and widespread and are increasing in size and number along the inner lips of inlets, within the sounds, and bordering the Atlantic Intracoastal Waterway. Management of these islands has become a cooperative venture of the Corps, the National Park Service, the US Fish and Wildlife Service, the National Audubon Society, scientists from the University of North Carolina at Wilmington, the NC Nature Conservancy, the NC Wildlife Resources Commission, and the NC Division of Marine Fisheries. Personnel from these agencies combine to form management teams for the islands, brought together by their interests in channel maintenance, fisheries resources, wildlife management, and ecological ornithology. Twenty-three species of colonial-nesting waterbirds nest almost exclusively in dredge island habitats -from freshly-dumped bare sand and muck to thicket woodlands (Parnell and Soots 1979). 18 of the 23 are on "threatened" or "of special concerns" lists (Cooper et al. 1977; Parnell 1985).

Plant succession on dredge material islands progresses from bare sand to shrub thicket and on to thicket woodland in about 20 to 30 years and is thus very much amenable to regional management in conformation with dredging cycles (Parnell and Soots 1975).

E. 2. Status of Information

There is a vast and pertinent literature on all aspects of interest, concern, and needs of the A/P Study on the Outer Banks. The 1987 Cape Hatteras National Seashore Bibliography alone has 1080 references (National Park Service 1987). While some additional research might be desirable in specific areas, more than enough knowledge exists upon which to base definitive management plans and decisions (Owens 1985; US Fish and Wildlife Service 1980).

E. 3. Trends

In summary: human populations and intensity of land use are increasing. Urbanization is proceeding rapidly on privately owned lands. Waste disposal and fresh-water supply problems and needs are increasing rapidly and are near the critical point. Maritime forests continue to be degraded (Lopazanski et al. 1988). The engineering and management of sand is increasingly pressing and controversial; engineers, elected government officials, business people, and residents find themselves in basic and operational difference with ecologists, geologists, and other scientists (Pilkey 1989; Pilkey et al. 1978).

When the towns and villages of the Outer Banks were being developed in the 18th and 19th centuries, the barrier islands were wooded, with unique, salt-spray resistant maritime forests. All the villages were built on the sound side, under the protection of the canopy of live oaks. When Oregon and Hatteras inlets were torn out by the same hurricane in 1846, eye-witness accounts attest that the maritime woods was solid at least from Avon to Ocracoke and presumably in the Oregon Inlet region also (Engels 1942). Over the past 300 years, residents of the North Carolina Outer Banks have reduced the original extensive cover of woods, shrubbery, herbaceous dunes, and sound-side marshes to remnants in the earlier stages of succession. This reduction has been accomplished by cutting, logging, burning, and fragmenting the protective vegetation and thus exposing openings and edges to the necrotic effects of the salt spray. De-vegetation was intensified by grazing of pigs, goats, sheep, horses, and cattle (until the late 1930s); by roads, increasing urbanization, and their accompanying dredging and filling; by off-road vehicles in recent years; by the construction of hardened structures on beaches and at inlets; and (until recently) by the construction of dwellings atop and in front of the frontal dunes (Pilkey et al. 1978).

Urbanization is going on rapidly on all of Currituck Banks, from Nag's Head to Corolla, and in all 8 villages of the Cape Hatteras National Seashore -- from Rodanthe to Ocracoke, except for the refuges and land-trust areas. In the process, virtually all maritime forest and herb-shrub communities and some high marsh areas are being converted to developed land. NC State Highway 12 generally lies just behind (soundward of) the frontal dunes, extending into the herb-shrub and shrub-thicket communities. It frequently overwashes, and reconstruction of washed out and threatened sections will increasingly be into herb-shrub, woods, and high marsh areas.

With denser human populations and more intense urbanization, the ground water resources of the Outer Banks are being sorely taxed. The well field in Buxton Woods is now being expanded. This aquifer is maintained by the presence and function of the 3,000-acre Buxton Maritime Woods; any destruction of the woods will also endanger this finite lens of fresh water (Lopazanski et al. 1989; Heath 1988).

The acreage in public trust ownership and jurisdiction on the Outer Banks is increasing, with the US Fish and Wildlife Service, National Park Service, NC Wildlife Resources Commission, NC Division of Coastal Management, NC Division of Parks and Recreation, NC Nature Conservancy, NC National Estuarine Research Reserve, and NC Division of Marine Fisheries all involved. Urbanization is increasing rapidly in cities and villages and on the remaining private lands.

The condition of the ocean beach will continue to degrade as development continues, bringing increasing pressure for remedial measures. Beach replenishment, stabilization, and management are and will increasingly become questionable, expensive, and controversial subjects (Pilkey et al. 1978).

If, as predicted, sea level rises 5 feet by the year 2100, the ocean shoreline would be far inland of its present location and much of Currituck (over half), Dare (87%), and Hyde (more than 66%) counties would be under ocean water (Wilms 1988). With sea level rising 3-7 feet by 2030 (Benton 1981; Wilms 1988) the impending changes in the coastal zone are sobering.

E. 4. Management/Regulatory Status and Trends

A welter of laws, regulations, and standards administered by state, federal, and local agencies affect activities on the Outer Banks. The final Environmental Impact Statement for the proposed Currituck National Wildlife Refuge (US Fish and Wildlife Service 1980) lists, identifies, and explains 21 sets of North Carolina state environmental laws and regulations (legislation), and 17 sets of federal legislation which apply to the Outer Banks (US Fish and Wildlife Service 1980). While many of these management efforts may need to be more strict, and some may need to be added, better monitoring and enforcement of existing controls could be effected immediately.

F. RARE SPECIES AND NATURAL COMMUNITIES

F.1. Introduction

This section of the chapter: 1) provides basic information on both Federally-listed and State-listed endangered and threatened species in the A/P Study Area; 2) provides a listing of natural communities in the study area; and 3) discusses completed, ongoing, and planned work to inventory natural areas in the study area, including both North Carolina and Virginia.

F.2. Federally-listed Endangered, Threatened, and Candidate Species

The "U.S. List of Endangered and Threatened Wildlife and Plants" lists species that are Federally endangered or threatened. An "endangered" species is one that is in danger of extinction throughout all or a significant portion of its range. A "threatened" species is one that is likely to become endangered in the foreseeable future. A species is listed when a determination is made that its existence is threatened by at least one of five factors: the existing or threatened loss of the species' habitat; overuse of the species for commercial, sporting, scientific, or educational purposes; disease or predation; the nonexistence of regulatory means to prevent the decline of a species or the degradation

of its habitat; and other natural or manmade factors affecting the species' continued existence. Areas essential to a species' survival or conservation, known as "critical habitat," can also be protected.

In addition to being listed as endangered or threatened, plant and animal species may be categorized as "candidates". Candidate 1 (C1) species are those species for which the U.S. Fish and Wildlife Service has enough substantial information to list the species as endangered or threatened. Listing is "warranted but precluded by other pending proposals of higher priority." The U.S. Fish and Wildlife Service, however, can use emergency listing procedures "if the wellbeing of any such species is at significant risk." A candidate 2 (C2) species is one for which there is some evidence of vulnerability, but for which there are not enough data to support listing as endangered or threatened at that time. Again, listing is "warranted but precluded by other pending proposals of higher priority". Candidate species are not legally protected under the Endangered Species Act, and are not subject to any of its provisions until they are formally proposed or listed as endangered or threatened.

The Endangered Species Act of 1973, as amended, is carried out primarily by the U.S. Fish and Wildlife Service, in cooperation with States and other Federal agencies. The Fish and Wildlife Service and the National Marine Fisheries Service, for marine species, are responsible for administering the Act; regulations governing the import and export of endangered and threatened plants are enforced by the Animal and Plant Health Inspection Service of the U.S. Department of Agriculture. The U.S. Fish and Wildlife Service's involvement, beyond listing of a species, includes development of a recovery plan, Section 7 consultation responsibilities, law enforcement activities, research, and land management, with the purpose of increasing the species' chances for recovery and survival. The ultimate goal of the U.S. Fish and Wildlife Service's Endangered Species Program is to restore animal and plant populations to a level that would allow their delisting.

In the entire study area of North Carolina and Virginia, there are 14 Federally-listed endangered species, 5 Federally-listed threatened species, 2 species proposed-endangered, and 1 species proposed-threatened. In the North Carolina portion of the study area, there are 13 endangered species and 5 threatened species. In the Virginia portion of the study area, there are 4 endangered species and 1 threatened species. Two species, the Roanoke log perch (endangered) and American chaffseed (proposed endangered), are known to occur in the study area in Virginia but not in North Carolina. Table II-10 on the following page lists these Federally-endangered and -threatened species, as well as the counties in which they are documented to occur. Details on each species are beyond the scope of this report and will not be given; for more specific information on a given species, consult the appropriate Recovery Plan developed by the U.S. Fish and Wildlife Service. Recovery Plans exist for the following species: West Indian manatee, Dismal Swamp southeastern shrew, red wolf, roseate tern, bald eagle, red-cockaded woodpecker, piping plover, peregrine falcon, green sea turtle, Kemp's ridley sea turtle, loggerhead sea turtle, leatherback sea turtle, American alligator, and Tar River spiny mussel.

As previously mentioned, candidate species are those that are not now listed or officially proposed for listing as endangered or threatened but are under status review by the U.S. Fish and Wildlife Service. At the time of this writing, there were 30 candidate species in the North Carolina portion of the study area (listing dated 10-1-91, from U.S. Fish and Wildlife Service), and 20 candidate species in the Virginia portion of the study area (listing dated 1-24-92, from Virginia Department of Conservation and Recreation, Division of Natural Heritage). The U.S. Fish and Wildlife Service reviews and updates its lists of species on a regular basis. As more information becomes available on given species, the lists are subject to change.

Table II-10. Federally-listed endangered and threatened species in the Albemarle-Pamlico Study Area.

SPECIES	FEDERAL STATUS	NORTH CAROLINA COUNTIES IN WHICH SPECIES IS KNOWN TO OCCUR*	VIRGINIA COUNTIES IN WHICH SPECIES IN KNOWN TO OCCUR**
MAMMALS			
West Indian (Florida) manatee	E	Hyde	
Dismal Swamp southeastern shrew	T	Camden, Currituck, Gates, Pasquotank, Perquimans	Chesapeake, Suffolk, Virginia Beach
Red wolf	E	Dare, Tyrrell	
BIRDS			
Roseate tern	E	Offshore Migrant; Carteret, Dare	
Bald eagle	E	Beaufort, Carteret, Chowan, Craven, Dare, Durham, Hyde, Vance, Wake, Washington	Isle of Wight, Prince George, Suffolk, Surry
Red-cockaded woodpecker	E	Beaufort, Bertie, Camden, Carteret, Craven, Dare, Gates, Halifax, Hertford, Hyde, Johnston, Jones, Lenoir, Nash, Northhampton, Orange, Pamlico, Perquimans, Pitt, Tyrrell, Wake, Wayne, Wilson	Sussex
Piping plover	T	Carteret, Currituck, Dare, Hyde	
Arctic peregrine falcon	E	Carteret, Dare, Hyde	
REPTILES			
Green sea turtle	T	Beaufort, Bertie, Camden, Carteret, Chowan, Craven, Currituck, Dare, Hyde, Pamlico, Pasquotank, Perquimans	
Kemp's ridley sea turtle	E	Beaufort, Bertie, Camden, Carteret, Chowan, Craven, Currituck, Dare, Hyde, Pamlico, Perquimans, Tyrrell, Washington	
Leatherback sea turtle	E	Carteret, Currituck, Hyde	
Loggerhead sea turtle	T	Beaufort, Bertie, Camden, Carteret, Chowan, Craven, Currituck, Dare, Hyde, Pamlico, Pasquotank, Perquimans, Tyrrell, Washington	
American alligator	T S/A	Camden, Darteret, Craven, Dare, Hyde, Jones, Pamlico, Tyrrell	
FISH			
Roanoke log perch	E		Dinwiddie, Franklin City, Sussex, Sussex/Greensville

Table II-10. (continued)

SPECIES	FEDERAL STATUS	NORTH CAROLINA COUNTIES IN WHICH SPECIES IS KNOWN TO OCCUR	VIRGINIA COUNTIES IN WHICH SPECIES IS KNOWN TO OCCUR
MUSSELS			
Tar River spiny mussel	E	Edgecombe, Franklin, Nash, Pitt	
Dwarf wedge mussel	E	Edgecombe, Franklin, Granville, Johnston, Nash, Wake	Nottoway/Lunenburg
PLANTS			
Rough-leaved loosestrife	E	Beaufort, Carteret, Pamlico	
Harperella	E	Granville	
Michaux's sumac	E	Durham, Franklin, Johnston, Orange, Wake, Wilson	
Sensitive joint-vetch	T	Beaufort, Craven, Hyde	Prince George
Smooth coneflower	PE	Granville, Durham, Orange	Franklin, Nottoway
American chaffseed	PE		Greensville
Seabeach amaranth	PT		

* information provided by U.S. Fish and Wildlife Service
** information provided by Virginia Division of Natural Heritage

F.3. State-listed Endangered, Threatened, and Special Concern Species

In North Carolina, species are designated by two different State agencies. The N.C. Wildlife Resources Commission designates animal species and the North Carolina Plant Conservation Program lists and protects plants. The State defines an endangered animal species as any native or once-native species of wild animal whose continued existence as a viable component of the State's fauna is determined to be in jeopardy, or any species of animal listed as endangered pursuant to the Endangered Species Act (North Carolina Natural Heritage Program 1990a). A threatened animal species is defined as a native or once-native species 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 according to the Endangered Species Act. A special concern animal species is a species that is native or once-native to North Carolina which is determined to require population monitoring; individuals of the species may be taken in accordance with regulations (Article 25 of Chapter 113 of the North Carolina General Statutes) (North Carolina Natural Heritage Program 1990a).

The North Carolina Department of Agriculture's Plant Conservation Program lists State-endangered, -threatened, and -special concern plants. A State-listed endangered plant is defined as any plant species whose continued existence as a viable component of the State's flora is determined to be in jeopardy (North Carolina Natural Heritage Program 1990b). Endangered species cannot be removed

from the wild unless a permit is obtained for purposes of research, propagation, or rescue which will enhance the survival of the species. Wild-collected endangered species may not be sold or distributed (North Carolina Natural Heritage Program 1990b). A threatened plant species is defined by the State as any plant species likely to become an endangered species within the foreseeable future (North Carolina Natural Heritage Program 1990b). The State's regulations for threatened plants are identical to those for endangered plants. A special concern plant is defined by the State as any plant species which requires population monitoring, but which may be collected and sold under specific regulations (North Carolina Natural Heritage Program 1990b). Special concern plants which are not also listed as endangered or threatened can be wild-collected and sold under specified regulations. If a special concern plant is also listed as endangered or threatened, only propagated material may be sold or traded under specific regulations.

The definitions and regulations concerning State-listed endangered, threatened, and special concern species may differ slightly between North Carolina and Virginia; however, the Virginia definitions and any differences will not be discussed. As is the case in North Carolina, two Virginia agencies list endangered and threatened species in that state. Animals, except for insects, are listed by the Department of Game and Inland Fisheries, and plants and insects are listed by the Department of Agriculture and Consumer Services, Plant Protection Bureau.

In the North Carolina portion of the A/P Study Area, there are 28 State-listed endangered species (11 animals and 17 plants), 25 threatened species (14 animals and 11 plants), and 20 special concern animals. In the Virginia portion of the study area, there are 9 endangered species (8 animals and 1 plant), 10 threatened species (all animals), and 1 candidate species (there are no species designated as special concern). In addition to the agencies that are responsible for listing and protecting species, the Natural Heritage Program for each state maintains species lists. Updates occur on a regular basis, at least once a year (North Carolina Natural Heritage Program 1990a).

In addition to designating species as endangered, threatened, or special concern, plants, animals, and natural communities can be designated according to their Global status and their State status. However, no legal protection exists for these latter categories. The Nature Conservancy, scientific experts, and the various natural heritage programs together assign species a Global rank (North Carolina Natural Heritage Program 1990 a,b). Global rank 1 (G1) species are defined as being critically imperiled globally because of extreme rarity, meaning that they occur in 5 or fewer places worldwide, or because of some factor(s) making the species especially vulnerable to extinction. Global rank 2 (G2) species are imperiled globally because of rarity, 6 to 20 occurrences or few remaining individuals, or because of some factor(s) making it very vulnerable to extinction throughout its range. In the North Carolina portion of the study area, 13 animals are designated as G1 or G2 species and 31 plants are designated G1 or G2. In the Virginia portion of the study area, 9 animals are designated as G1 or G2 and 16 plants are so designated. In both states, most of these Globally-ranked species are also Federally-listed, State-listed, or State-ranked as S1 or S2.

State ranks are based on The Nature Conservancy's system of measuring rarity and threat status (North Carolina Natural Heritage Program 1990 a,b). In North Carolina, for instance, S1 species are defined as critically imperiled in the state because of extreme rarity, 5 or fewer occurrences or very few remaining individuals, or because of some factor(s) that make the species especially vulnerable to extirpation from the state. S2 species are imperiled in the state because of rarity, 6 to 20 occurrences or few remaining individuals, or because of some factor(s) that make the species very vulnerable to extirpation from the state. In the North Carolina portion of the study area, there are 155 S1 species. In the Virginia portion of the study area, there are 127 S1 species.

F.4. Natural Communities

A natural community is defined as "a distinct and reoccurring assemblage of populations of plants, animals, bacteria, and fungi naturally associated with each other and their physical environment" (Schafale and Weakley 1990). The North Carolina Natural Heritage Program has identified over 100 natural communities in the state; these are described in Schafale and Weakley (1990). As with plant and animal species, natural communities are ranked on Global and State scales; the definitions of G1, G2, S1, and S2 are found in the two previous paragraphs. Of the more than 100 North Carolina natural communities, 65 have been identified in the A/P Study Area. Of these 65 natural communities, 27 are ranked as G1, G2, S1, or S2. Table II-11 lists the natural communities, and their ranks, occurring in the North Carolina portion of the study area. The state of Virginia is currently in the process of classifying and ranking its natural communities.

F.5. Natural Area Inventories

The North Carolina Natural Heritage Program is responsible for maintaining a statewide inventory of important natural areas and rare species habitats, in accordance with the North Carolina Nature Preserves Act (Frost et al. 1990). The Albemarle-Pamlico Estuarine Study is funding the Natural Heritage Program to conduct an inventory to identify, describe, map, prioritize and make protection recommendations for special natural areas and endangered and rare species habitats in the North Carolina portion of the study area (Frost et al. 1990). Typically, the identified natural areas contain one to several natural communities, including those discussed in the previous section (Harry LeGrand, North Carolina Natural Heritage, personal communication 1992). The inventory data are being recorded in the Natural Heritage Program's inventory management system, as well as reproduced in reports.

The North Carolina inventories are being conducted in three phases. The first phase has been completed and the report is available. The field work for the second phase has been completed, but the report has not yet been produced, and the field work for the third phase is currently underway. The counties surveyed for the first report are: Currituck, Camden, Pasquotank, Perquimans, Chowan, Gates, Hertford, Bertie, Martin, and Washington. Those surveyed for the second report are: Hyde, Beaufort, Pitt, Pamlico, Craven, Jones, and Carteret. The third phase of the inventory covers the following counties: Lenoir, Greene, Wayne, Johnston, Wilson, Edgecombe, Northampton, Halifax, Nash, Wake, Franklin, Warren, Vance, Granville, Person, Orange, and Durham. Barrier islands, estuarine islands, and Dare and Tyrrell Counties were not inventoried (Harry LeGrand, North Carolina Natural Heritage, personal communication 1992). The mainlands of Dare and Tyrrell Counties were inventoried for CEIP reports (Coastal Energy Impact Program) in 1982 and 1981, respectively.

Phase 1 of the North Carolina natural areas inventory also identified especially significant wetland ecosystems, or "wetland complexes," in the ten study area counties covered by the survey (Frost et al. 1990). The Natural Heritage Program listed the following as significant wetland complexes: Roanoke River floodplain forests; Northwest River/North Landing River marshes, forests, and pocosins; Great Dismal Swamp forests and pocosins; Chowan River floodplain forests and marshes; North River/Great Swamp floodplain forests and marshes; Lake Phelps and Pungo Lake shoreline forests, marshes, and pocosins; Perquimans/Pasquotank hardwood forests on terrace flats; Merchants Millpond aquatic communities and forests; Maple Swamp and Church Island forests and marshes; Chowan County

Carolina bays; Cashie River floodplain forests; and East Dismal Swamp and Van Swamp forests. Information on individual sites can be found in Frost et al. (1990).

A natural areas inventory is also being conducted for the A/P Study Area in Virginia. The Virginia Department of Conservation and Recreation's Division of Natural Heritage is inventorying natural areas, exemplary wetlands, and endangered species in 16 of the 19 municipalities in the Virginia portion of the study area. The project is being conducted in two phases. The first phase inventoried 6 municipalities: Prince George County; Surry County; Isle of Wight County; Chesapeake City; Suffolk City; and Virginia Beach City (Tom Rawinski, Virginia Division of Natural Heritage, personal communication 1992). The inventory report includes information on 24 natural areas of special significance. The second phase of the Virginia inventory will focus on 10 of the remaining municipalities in the study area. The Division of Natural Heritage plans to have the second phase report completed in the Fall of 1992.

Table II.11. Natural communities in the Albemarle-Pamlico Study Area listed as G1, G2, S1, or S2. North Carolina listing from the N.C. Natural Heritage Program (listing dated 10-91)

COMMUNITY NAME	STATE RANK	GLOBAL RANK
Basic Mesic Forest (Coastal Plain subtype)	S1	G5 T3
Basic Mesic Forest (Piedmont subtype)	S2	G5 T3
Basic Oak-Hickory Forest	S2 S3 ?	G3 G4?
Coastal Fringe Evergreen Forest	S1	G3?
Coastal Fringe Sandhill	S1	G3
Coastal Plain Marl Outcrop	S1	G2
Diabase Glade	S1	G1
Floodplain Pool	S1?	G?
Granitic Flatrock	S2	G3
Interdune Pond	S1	G3
Maritime Deciduous Forest	S1	G1
Maritime Dry Grassland	S2	G3
Maritime Evergreen Forest	S1	G2
Maritime Shrub Swamp	S1	G1
Maritime Swamp Forest	S1	G1
Maritime Wet Grassland	S2?	G3?
Nonriverine Swamp Forest	S2	G2
Nonriverine Wet Hardwood Forest	S1	G1
Peatland Atlantic White Cedar Forest	S2	G2
Piedmont/Mountain Swamp Forest	S1	G2 G3
Pine Savanna	S2	G3
Small Depression Pocosin	S1	G2?
Small Depression Pond	S2	G3
Tidal Cypress-Gum Swamp	S2?	G3
Tidal Freshwater Marsh	S2?	G4
Ultramafic Outcrop Barren	S1	G1
Upland Depression Swamp Forest	S2	G3

"?" indicates community rank uncertain or unranked
"T" indicates the rank of a community subtype

G. SUMMARY

G. 1. Introduction

Critical areas are composed of those biophysical systems which have the greatest impact upon estuarine waters or are otherwise unique or noteworthy. In this study, they have been grouped for convenience under five major headings: submerged aquatic vegetation, emergent vegetation under sea level influence, riparian/alluvial forested wetlands, special fisheries habitats, and other critical areas.

G. 2. Description

Beds of submerged aquatic vegetation (SAV) occupy the shallow water habitat immediately behind the barrier islands and some of the tributaries along the mainland side. SAV distribution varies greatly in space and through time. Near the inlets, in higher salinity water, SAV is composed largely of eelgrass and Cuban shoalgrass. In waters of somewhat lower salinity, widgeongrass may predominate; and in slightly brackish to fresh areas, wild celery, Eurasian watermilfoil, or a mixture of pondweeds and other species may occur. Currituck Sound once contained dense growths of native SAV which were largely replaced by Eurasian watermilfoil during the 1960s and 1970s. The milfoil decreased dramatically during the latter 1970s and was replaced in turn by the native widgeongrass. Similarly, SAV was common in the Pamlico River until the mid-1970s, decreased to about 1% of its former volume by 1985, and has since recovered to some degree.

Emergent wetlands under the influence of sea level (progressing generally from the ocean or inlet landward or upstream) include tidal salt marshes, nontidal brackish marshes, fringe swamps, and nontidal freshwater marsh. Tidal salt marshes, under the direct effect of periodic lunar tides and high salinity water, constitute a rich but severe environment. Few vertebrate species and only one higher plant, salt marsh cordgrass, occur along the lower border of these systems. In terms of fixing solar energy and supporting biomass, however, tidal salt marshes rank among the most productive biotic communities. At slightly higher elevations, where inundation is more irregular, other species of grasses, sedges, and rushes occur and more terrestrial animals may be found. Along major freshwater estuarine tributaries, a fringe of cypress-tupelo swamp separates the aquatic environment from the upland, and pockets of freshwater marsh may be found. In contrast to the few species of plants in salt marshes, this last community contains a rich assemblage of flowering plants. These wetland systems represent the transition area (ecotone) between upland communities and estuarine waters.

Farther up estuarine tributaries, where riverine conditions predominate, ecotones consist of swamps and bottomland hardwood communities. Bald cypress and water tupelo characterize the former, whereas the latter contain many flood-tolerant species. In these systems, riverine flooding replaces the lunar and wind-driven components characteristic of emergent wetlands.

A number of special fisheries habitats overlap with some of the other critical areas. Bay scallops make their homes in beds of eelgrass. Hard clams and oysters are found in relatively stable sediments on vegetated or un-vegetated bottoms. Estuarine nursery areas may include areas of SAV and marsh streams. Anadromous species may spawn in the waters of fringe and riverine swamps.

While their specific functions differ, all the preceding ecosystems are essential to the continued production of estuarine systems and organisms. These wetlands filter sediment and excess nutrients

from overland runoff, provide detritus and other nutriment to the estuaries, serve as water retention areas during floods, and shelter juvenile estuarine and marine organisms within their internal streams and drainageways. Without their continued services, the Albemarle/Pamlico region would cease to be what we cherish today.

Several types of critical areas with less direct ties to the estuaries occur in the region. The beaches, flats, and maritime forests of the barrier islands are essential features of the coastal landscape. The poorly drained peat soils of many of the inter-stream areas support broad-leaved evergreen shrub vegetation. These pocosins are a unique and valuable natural resource, as are the small isolated swamps found in depressions without obvious connections to other surface waters.

G. 3. Status and Trends of Information

While scientists always desire additional and more precise information, a critical area information base sufficient to support an effective management program probably already exists. Critical areas' biotic and abiotic components have been described, their distributions defined, and their relationships to the larger estuarine and marine ecosystems generally ascertained. Most of the descriptive work has been done, and it makes a strong case for preservation of these areas.

The work remaining is largely quantitative and explanatory. Important questions include: What causes the distribution of SAV to vary so widely? What can be done about it? Can the environmental factors limiting the distribution and functioning of these systems be characterized quantitatively? How are riparian and alluvial systems affected by off-site events such as the application of fertilizers and pesticides, flood-control and drainage programs, channelization, and other man-caused and natural phenomena? Perhaps the most important question is: how will all these systems be affected by the various sea-level rise scenarios that have been proposed?

G. 4. Management/Regulatory Status and Trends

As one passes from Navigable Waters of the United States upstream and inland, he encounters a continuum from strong federal involvement and generally effective overall regulation to almost exclusive local control and few restrictions. Construction on lands beneath Navigable Waters of the United States, extending inland to the mean high water line in tidal waters or the ordinary high water line in nontidal areas and including contiguous wetlands, is regulated by the US Army Corps of Engineers under the provisions of the River and Harbor Act of 1899 (33 U.S.C. 401, 403). Dredging in coastal waters also requires a state permit (NCGS 113-22). Upland and inland from this zone, deposition of dredged and fill material in other waters and wetlands without a Corps permit is prohibited by section 404 of the Clean Water Act (33 U.S.C. 1344). Much of the same area is included within Areas of Environmental Concern (AECs) identified by the NC Coastal Resources Commission under the provisions of North Carolina's Coastal Area Management Act (CAMA) (N.C.G.S. 113A-101 et seq.). Development in such areas requires a permit from the NC Division of Coastal Management. Discharge of pollutants into these areas is similarly regulated by a combination of federal and state laws, generally implemented through permits issued by the NC Division of Environmental Management.

However, a number of factors and activities which may have a profound effect on critical areas escape this regulatory matrix. Nutrients, pesticides, and other pollutants currently enter these systems

through diffuse overland flow or other nonpoint sources without regulation (note, however, that section 208 of the Clean Water Act [33 U.S.C. 1288] and section 319 of the Water Quality Act of 1987 address the subject of nonpoint source pollution). Increased runoff from development on upland areas outside of AECs may affect both quantity and quality of waters entering critical areas. Many interior wetlands are not protected against destruction other than direct filling, and neither the state nor the nation has enacted legislation directly addressing the issue of wetland protection.

Laws, regulations, and institutional organizations do not by themselves constitute effective resource management systems. They must have the support of knowledgeable and active citizens, the backing of concerned elected and appointed government officials, staffs of competent public servants, and adequate budgetary support. These may be the most important factors in determining the future of the Albemarle/Pamlico region.

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Appendix A
Definitions of Wetlands

The information in items 1,2, and 3 is found in USEPA et al, 1991:

Several definitions of wetlands have been formulated by the U.S. Environmental Protection Agency (USEPA), the U.S. Army Corps of Engineers (USACE), the Soil Conservation Service (SCS), and the U.S. Fish and Wildlife Service (USFWS) in order to carry out their statutory, regulatory, and non-regulatory responsibilities related to wetland protection. The USEPA, USACE, and SCS have adopted regulatory definitions of wetlands (see 40 CFR part 110, 40 CFR part 116, 40 CFR part 117, 40 CFR part 122, 40 CFR part 230, 40 CFR part 232, 40 CFR part 435, 33 CFR part 328, and 7 CFR part 12). USFWS defines wetlands for the purposes of conducting an inventory of the nation's wetland, but this definition is not regulatory.

1. Section 404 of the Clean Water Act - USEPA and USACE Definition

The term wetlands means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas (USEPA - 40 CFR 230.3; December 24, 1989; USACE - 33 CFR 328.3, November 13, 1986).

2. Food Security Act of 1985 - SCS Definition

Wetlands are defined as areas that have a predominance of hydric soils and that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions, except for lands in Alaska identified as having a high potential for agricultural development and a predominance of permafrost soils (7 CFR12.2 (a)(28)).

3. USFWS Definition - This definition was published in the USFWS publication, "Classification of Wetlands and Deepwater Habitats of the United States" (Cowardin, et al. 1979).

Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) At least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil, and (3) the substrate is nonsoil and is saturated with water at some time during the growing season of each year.

An important point to remember is that USEPA, USACE, and SCS definition of wetlands centers on the presence of all three parameters: hydrology, hydrophytic vegetation, and hydric soils, whereas USFWS requires the presence of only one of the three parameters.

4. Definition of Pocosin, as used by Richardson et al. (1981)

Pocosin covered "...a number of subclasses of wetlands found on the coastal plain of the southeastern United States. Specifically, the dominant subclasses from the 1954 classification of the United States Fish and Wildlife Service (USFWS) that were included under the term bog were pond pine wetlands, and scrub/shrub wetlands, along with Atlantic white cedar stands, savannas, and loblolly pine stands on hydric soils." (Richardson 1992)

From Richardson et al. (1981): "...the typical pocosin ecosystem in North Carolina is characterized by the vegetation..." ti-ti, sweetbay magnolia, red bay, ink-berry, greenbrier, and pond pine "...growing on waterlogged, acid, nutrient poor, sandy or peaty soils located on broad, flat topographic plateaus, usually removed from large streams and subject to periodic burning."

Appendix B

Scientific Names of Plants and Animals Referenced in the Wetlands Section and Rare Species and Natural Communities Section of the Status and Trends Report

PART 1. PLANTS

American beech	*Fagus grandifolia*
American chaffseed	*Schwalbea americana**
American elm	*Ulmus americana*
American hornbeam	*Carpinus caroliniana*
Arrowhead	*Sagittaria* spp.
Atlantic white cedar	*Chamaecyparis thyoides*
Bald cypress	*Taxodium distichum*
Bitter gallberry, ink-berry	*Ilex glabra*
Black gum	*Nyssa sylvatica*
Black needlerush	*Juncus roemerianus*
Broad-leaf cattail	*Typha latifolia*
Bulrush	*Scirpus* spp.
Catbrier	*Smilax* spp.
Cattail	*Typha* spp.
Chair-maker's rush	*Scirpus americanus*
Cherrybark oak	*Quercus falcata* var. *pagodaefolia*
Chinese privet	*Ligustrum sinense*
Common pawpaw	*Asimina triloba*
Fetter-bush	*Lyonia lucida*
Flowering dogwood	*Cornus florida*
Giant bulrush	*Scirpus robustus*
Giant cane	*Arundinaria gigantea*
Green ash	*Fraxinus pennsylvanica*
Ground ivy	*Glechoma hederacea*
Groundsel-tree	*Baccharis halimifolia*
Harperella	*Ptilimnium nodosom**
Hollies	*Ilex* spp.
Honeycup	*Zenobia pulverulenta*
Japanese honeysuckle	*Lonicera japonica*
Joint-head arthraxon	*Arthraxon hispidus*
Laurel oak	*Quercus laurifolia*
Loblolly bay	*Gordonia lasianthus*
Loblolly pine	*Pinus taeda*
Longleaf pine	*Pinus palustris*
Marsh elder	*Iva frutescens*
Michaux's sumac	*Rhus michauxii**
Nepal microstegium	*Eulalia viminea*
Olney's three square	*Scirpus olneyi*
Pennywort	*Hydrocotyle umbellata*
Pond pine	*Pinus serotina*
Red bay	*Persea borbonia*
Red maple	*Acer rubrum*
Riverbirch	*Betula nigra*
Rough-leaved loosestrife	*Lysimachia asperulaefolia**
Salt grass	*Distichlis spicata*
Salt meadowgrass	*Spartina patens*
Saw grass	*Cladium jamaicense*
Sea ox-eye	*Borrichia frutescens*

* Federally - listed endangered and threatened species

Seashore mallow	*Kosteletzkya virginica*
Sensitive joint-vetch	*Aeschynomene virginica**
Smooth coneflower	*Echinacea laevigata**
Shumard oak	*Quercus shumardii*
Smartweeds	*Polygonum* spp.
Smooth cordgrass	*Spartina alterniflora*
Soft-stem bulrush	*Scirpus validus*
Sourwood	*Oxydendron arboreum*
Southern cattail	*Typha domingensis*
Spikerush	*Eleocharis* spp.
Sugarcane plumegrass	*Erianthus giganteus*
Sugar-berry	*Celtis laevigata*
Swamp chestnut oak	*Quercus michauxii*
Swamp cottonwood	*Populus heterophylla*
Swamp tupelo	*Nyssa sylvatica* var. *biflora*
Sweet gallberry, ball-gall holly	*Ilex coriacea*
Sweetbay magnolia	*Magnolia virginiana*
Sweetgum	*Liquidambar styraciflua*
Switch grass	*Panicum virgatum*
Sycamore	*Platanus occidentalis*
Ti-ti, swamp cyrilla	*Cyrilla racemiflora*
Umbrella-sedge	*Cyperus* spp.
Water hickory	*Carya aquatica*
Water oak	*Quercus nigra*
Wax myrtle	*Myrica cerifera*
Wiregrass	*Aristida stricta*

PART 2. ANIMALS

MAMMALS

Beaver	*Castor canadensis*
Black bear	*Ursus americanus*
Bobcat	*Lynx rufus*
Dismal Swamp southeastern shrew	*Sorex longirostris fisheri**
Hispid cotton rat	*Sigmodon hispidus*
Marsh rice rat	*Oryzomys palustris*
Mink	*Mustela vison*
Muskrat	*Ondatra zibethicus*
Nutria	*Myocastor coypus*
Otter	*Lutra canadensis*
Raccoon	*Procyon lotor*
Red wolf	*Canis rufus**
West indian (Florida) manatee	*Trichechus manatus**
White-tailed deer	*Odocoileus virginianus*

BIRDS

Arctic peregrine falcon	*Falco peregrinus tundrius**
Bald eagle	*Haliaeetus leucocephalus**
Great crested flycatcher	*Myiarchus crinitus*
Hooded warbler	*Wilsonia citrina*
Piping plover	*Charadrius melodus**
Prothonotary warbler	*Protonotaria citrea*
Red-cockaded woodpecker	*Picoides borealis**
Roseate tern	*Sterna dougallii dougallii**

* Federally - listed endangered and threatened species

Swainson's warbler	*Limnothlypis swainsonii*
Worm-eating warbler	*Helmitheros vermivorus*
Wild turkey	*Meleagris gallopavo*

REPTILES

American Alligator	*Alligator mississippiensis**
Diamondback terrapin	*Malaclemys terrapin*
Green sea turtle	*Chelonia mydas**
Kemp's ridley sea turtle	*Lepidochelys kempii**
Leatherback sea turtle	*Dermochelys coriacea**
Loggerhead sea turtle	*Caretta caretta**

FISH

Mosquito fish	*Gambusia affinis*
Mummichog	*Fundulus heteroclitus*
Roanoke log perch	*Percina rex**
Sheepshead minnow	*Cyprinodon variegatus*
Striped killifish	*Fundulus luciae*

INVERTEBRATES

Dwarf wedge mussel	*Alasmidonta heterodon**
Fiddler crabs	*Uca* spp.
Periwinkle	*Littorina irrorata*
Tar River spiny mussel	*Elliptio (Canthyria) steinstansana**

* Federally - listed endangered and threatened species

Appendix C

Discussion On Land Use/Land Cover Data For the Entire Albemarle-Pamlico Estuary Study Area, Landsat Data (1988)

The following summary and conclusions were taken from Khorram et al, 1992:

Five Landsat Thematic Mapper (TM) scenes covering 97% of the Albemarle-Pamlico drainage basin were used to classify land use and land cover. Digital TM data were physiographically stratified, converted to a Lambert Conformal Conic projection and classified into 18 classes using a supervised approach and statistics from TM bands 3, 4, and 5 (red, near infrared and middle infrared). Classification accuracies were determined based on 1,931 verification sample sites. Leaf-off conditions and, near the coast, excessive soil moisture limited differentiation of certain vegetation types particularly within the Tidewater region. Mapping accuracies were relatively low for Urban and Built-up land (46%) and ranged from 73% to 97% for five other Level 1 categories (Water, Agriculture, Forestland, Wetlands and Barren Land).

Image data were processed and classified into land use and land cover classes at the Computer Graphics Center (CGC) at North Carolina State University and then transferred to the North Carolina Center for Geographic Information & Analysis (CGIA). At the CGIA, image data were filtered using a standard 5x5 mode filter, converted to the ARC/INFO data format and partitioned by USGS 1:100,000 scale map boundaries. Land use/land cover data and products can be obtained from CGIA by USGS 1:100,000 map windows or by county in a variety of formats. Prospective users need to be aware that these data require large amounts of disk storage. Data are georeferenced to the N.C. State Plan Coordinate System, but, because of their deviation, mapping discrepancies may exist between this data layer and data layers derived from different mapping methodologies.

Overall, Landsat TM data appeared to be a good source of information for large area inventories of land use/land cover patterns. The resultant map products provide the level of detail and accuracy required regional/basin-level analyses for management and research needs.

Recommendations

The following recommendations should be considered during use of the current (1988) land use/land cover inventory:

1. Data are applicable to inventory and research efforts designed to characterize large geographic areas such as the entire Albemarle-Pamlico estuarine system, groups of counties, or basins, but are not appropriate for site-specific evaluations such as characterization of urban infrastructures.

2. Because of the low classification accuracies for developed areas and underestimation of forested wetlands, the estimates of these areas should be considered with great caution. Data on road networks or municipal boundaries can be obtained from alternative sources (USGS DLG files, Bureau of Census TIGER files or CGIA databases can be overlaid with the inventory data to provide quality assurance for developed areas.

3. Users should be aware that data require large amounts of disk storage due to large file sizes. Identification of appropriate hardware needs is recommended before acquisition and manipulation of digital data files.

4. Efficient map production equipment, preferably an electrostatic plotter, is required to produce hard-copy output.

5. In order to adequately monitor land use/land cover activities within the A/P basin, an inventory from satellite data should be conducted every five years. The next database should be developed for 1993 conditions.

The following information was taken from Table 5, Classification Accuracy Estimates, found on page 33 of Khorram et al, 1992. Standard errors, which are indicated within the parentheses (+/-) were calculated for Level 1 categories using a 95% confidence level. The Level I Total column is the standard error for all the categories found in that particular class.

LEVEL I CLASS	CLASS NAME & NUMBER	LEVEL 1 TOTAL A*	LEVEL 1 TOTAL B**
Water	Water / 2	99 (+/- 1.24)	97 (+/- 2.11)
Urban or Built-up Land	Low Dev / 3 Med Dev / 4 High Dev / 5	76 (+/- 7.35	46 (+/- 7.90)
Agriculture	Agriculture / 6 Disturbed / 12	86 (+/- 3.01)	93 (+/- 2.30)
Shrub/Scrub	Low Vegetation / 7	84 (+/- 6.21)	90 (+/- 5.25)
Forest Land	Pine / 8 Hardwood / 10 Mixed / 11	89 (+/- 2.51)	93 (+/- 2.10)
Wetland	Bottom HDWD / 9 Riverine / 14 Evergreen / 15 White Cedar / 16 Low Pocosin / 17 Low Marsh / 18 High Marsh / 19	89 (+/- 3.15)	88 (+/- 3.25)
Barren Land	Sand / 20	100 (-)	73 (+/- 29.5)

A* - Percent probability that an area which is actually in class N has been classified as class N on the image; "Producers accuracy".

B** - Percent probability that an area which has been classified as class N on the image actually is class N; "User's accuracy".

Appendix D

Albemarle-Pamlico Study Area
Forest Land Information - Forest Inventory and Analysis Data

The following tables and data depicting the status and recent trends of the forested wetlands of the A/P Study Area were drawn from data taken in the 5th and 6th surveys conducted by the Forest Inventory and Analysis Research Unit (FIA). This Research Unit, based in Asheville, North Carolina is a part of the Southeastern Forest Experiment Station of the US Forest Service. The primary objective of the FIA survey is to periodically inventory and evaluate all forest and related resources for the Southeastern States (VA, NC, SC, GA, and FL). Similar units working out of other Experiment Stations are responsible for the rest of the country.

This activity began in 1933 and has been repeated roughly each decade until 1984 when the cycle was reduced to 6 years. Basically the data are drawn from 24,658 forest and 24,807 non-forest permanent ground cluster plots. Since the beginning each successive survey has increased in statistical sophistication, and in the quantity and kind of data taken. Today data are taken on not only the merchantable volume of timber species but upon total biomass of all vegetated strata by species and frequency, and wildlife habitat data. Many non-timber attributes are collected at each sample location.

The 1990 or Sixth Survey for North Carolina was based upon the classification of 128,322 sample clusters systemically spaced and superimposed upon the latest available aerial photographs. Each sample is a systematic grid of 16 points, and each point is used for photo interpretation. A subsample of 9612 of the 16 point clusters was ground checked, and a linear regression was fitted to the data to develop the relationship between the photo and ground classification of the subsample. The procedure provides a means for adjusting the initial estimates of areas for change in land use since date of photography and for photo misclassification. Measurements of timber volume, classification of vegetation, and forest type, and other area attributes were recorded at 5692 on-site sample locations. Ownership information was collected from correspondence, public records, and local contacts. In those counties where the sample missed a particular ownership class, temporary samples plots were added.

All Timberlands, APES Area

Timberland as used herein means "lands at least 16.7 percent stocked by forest trees of any size, or formerly having had such tree cover, not currently developed for non forest use, capable of producing 20 cubic feet or industrial wood per acre per year and not withdrawn from timber production by legislative action."

Survey sample data, drawn from such timberland were processed for the 2870 plots which were located in the 47 county area of North Carolina and Virginia which comprise the APES region. Estimates of total timberland area in the APES area has a sampling error of 0.34 percent in terms of one standard error of estimate. Sampling error of course increases for estimates of area of each smaller subset of conditions. The following tabular information titled "Timberland Area" is drawn from analysis of these data.

Possible Wet Timberlands, APES Area

All timberlands are assigned to one of thirteen physiographic classes based upon soil moisture and drainage, topography, aspect, and soil characteristics. Of these classes in the APES area eight have the potential to include wetlands. The definition of these eight physiographic classes follows:

Flatwoods - Flat or fairly level sites outside the floodplains of rivers and streams. Excludes deep sands as well as wet, swampy sites.

Narrow Floodplains - Floodplains less than 1/4 mile in width along rivers and streams. Consider the floodplain on both sides of the stream in determining the width. These sites are normally well drained but are subject to occasional flooding during periods of heavy or extended precipitation. Includes associated levees, benches, and terraces within a 1/4 mile limit. Excludes swamps and sloughs with year-round water within the 1/4 mile limit.

Broad Floodplains - Floodplains 1/4 mile or wider along rivers and streams. These sites are normally well drained but are subject to occasional flooding during periods of heavy or extended precipitation. Includes associated levees, benches, and terraces. Excludes swamps and sloughs with year-round water.

Other Mesic - All moderately moist physiographic sites not described.

Deep Swamps - Low, wet, flat forested areas, usually quite large in extent, which are flooded for long periods of time except during periods of extended drought. Soil and moisture conditions are generally quite favorable for forest growth of selected species. Excludes cypress ponds and small drains.

Small Drains - Narrow, streamlike, wet strands of forest land often without a well-defined stream channel. These areas are poorly drained or flooded throughout most of the year except during periods of extended drought, and drain the adjacent, higher ground.

Bays and Wet Pocosins - Low, wet, boggy sites characterized by peaty or organic soils. May be somewhat dry during periods of extended drought.

Other Hydric - All other hydric physiographic sites. Includes cypress ponds and other hydric conditions not described by other classes.

Of these eight physiographic forest types four, Deep Swamps, Small Drains, Bays/Wet Pocosins, and other Hydric are clearly, by any rational definition, wetlands. They may or may not be "jurisdictional wetlands", but they are forest habitats wherein a surplus of water, surface or subsurface, plays a dominant role in the formation and perpetuation of the various layers of vegetation. The remaining physiographic classes Flatwoods, Broad Flood Plains, Narrow Flood Plains, and other Mesic are less clear cut. This is particularly true of the Flatwoods.

To estimate the portion of these timberland types which are likely to be wetlands a process was developed by the FIA Unit in Asheville to screen the plot data drawn from such types in the APES area. The screening process to identify the "possible wet" acres within these timber types is as follows:

1. All plots with the physiographic class of deep swamp, small drain, bay and wet pocosin, or other hydric were identified as "possible wet".

2. All North Carolina plots drawn from the physiographic classes of broad flood plain or narrow flood plain which had a forest type classification of loblolly pine, pond pine, oak-pine, oak-gum-cypress, elm-ash-cottonwood, or maple-beech-birch were identified as "possible wet".

3. Any flatwood or other mesic plot where:
   (a) obligate wetland species exceed 50 percent of the stocking or,
   (b) both facultative wet and obligate wet species together exceed 50 percent of the stocking or,
   (c) facultative and wetter species accounted for more than 50 percent of the stocking and there was the presence of surface water or the site was judged to exhibit conditions which limited forest operations due to soil moisture; during sometime of the year, not necessarily the growing season, was identified as "possible wet".

Samples with a humus depth of greater than 9 in. were classified as hydric. Other soils data collected in FIA samples usually are inadequate to determine the presence of hydric soils and were disregarded in the screening process.

The estimates are conservative since small stand conditions less than 1 acre, narrow strands of trees less than 91 feet wide, and some forest such as National parks are not sampled.

While there is clearly opportunity for error in this approach the results are a reliable broad brush estimate of the status of forest land which may be functioning in a wetland role and their very recent trends in the APES area.

The tabular data entitled "Possible Wet" represent the results of this screening process. Complete print out of the FIA data for the APES area for all timberlands and "possible wet" for the 1984 and 1991 surveys, each consisting of 81 tables, are available at the APES Office, 225 North McDowell Street, Raleigh, North Carolina 27603. The telephone number is 919-733-0314.

Additional information on the FIA program may be obtained from Noel Cost of the FIA staff in Asheville at the Southeastern Forest Experiment Station, Forest Inventory and Analysis, 200 Weaver Boulevard, Asheville, NC 28804. The telephone number is 704-257-4350.

POSSIBLE WET TIMBERLANDS
ALBEMARLE - PAMLICO STUDY AREA
PHYSIOGRAPHIC CLASS BY OWNERSHIP

PHYSGRAPH CLASS	PUBLIC		FOREST IND.		OTHER PRIVATE		ALL OWNSHP	
	1984	1990	1984	1990	1984	1990	1984	1990
Deep Swamps	27,198	20,903	33,119	29,964	165,807	142,379	226,124	193,246
Broad Flood Plains	5,568	24,064	44,984	52,728	134,305	135,218	184,857	212,010
Narrow Flood Plains	6,963	9,119	51,825	44,722	577,965	496,260	636,753	550,101
Flatwood and Dry Pocosins	24,464	28,981	314,063	365,971	691,591	818,594	1,030,118	1,213,546
Bays and Wet Pocosins	138,137	211,973	90,038	56,971	329,113	243,723	557,288	512,667
Other Misc. Classes	9,129	17,623	17,690	32,343	68,429	99,274	95,248	149,240
TOTAL	**211,459**	**312,663**	**551,719**	**582,699**	**1,967,210**	**1,935,448**	**2,730,388**	**2,830,810**

Note:
(1)Although only 10.9 percent of the total is in public ownership over 41 percent of the bays and wet pocosins which support timberland are in public ownership.
(2)The extremely large shifts of acreage both within and between classifications is probably due to sampling error and to changes in identification more than to actual increase or decrease in timberlands.
(3)Descriptions of physiographic classes may be found on page ___ of this appendix.

POSSIBLE WET TIMBERLANDS
BROAD MANAGEMENT CLASS BY OWNERSHIP
ALBEMARLE - PAMLICO ESTUARINE STUDY AREA

Acres By Class By Survey Year

OWNERSHIP	PINE PLANTATION	NATURAL PINE	OAK-PINE	UPLAND HRDWOOD	LOWLAND HRDWOOD	ALL MNGMENT CLASSES
PUBLIC						
1984	5,369	80,318	33,937	4,520	87,315	211,459
1990	1,567	32,260	33,129	1,729	143,978	312,663
FOR. INDUSTRY						
1984	146,058	117,615	33,677	31,144	223,225	551,719
1990	197,677	83,864	47,833	35,398	217,927	582,699
OTHER PRIVATE						
1984	42,637	372,262	206,677	193,207	1,152,427	1,967,210
1990	96,399	287,796	238,140	214,662	1,098,451	1,935,448
ALL OWNERSHIP						
1984	194,064	570,195	274,291	228,871	1,462,967	2,730,388
1990	295,643	403,920	319,102	251,789	1,460,356	2,830,810

POSSIBLE WET TIMBERLANDS
ALBEMARLE - PAMLICO ESTUARINE STUDY AREA
OPERABILITY CLASS

OPERABILITY CLASS	TIMBERLAND AREA (acres) 1984	TIMBERLAND AREA (acres) 1990
Seasonal Water [1]	1,065,178	1,118,410
Mixed Wet & Dry [2]	52,174	48,229
Year Round Water [3]	312,736	315,704
Total	1,430,088	1,482,343

1. Limited to seasonal use due to water conditions in wet weather.
2. Mixed wet and dry areas within forest condition typical of multi-channeled streams with intermixed dry areas or islands.
3. Adverse operating conditions caused by year round water problems.

POSSIBLE WET TIMBERLANDS
ALBEMARLE-PAMLICO SOUND STUDY AREA

Acres* Treated or Disturbed Annually

Treatment or Disturbance	1984 Acres	1990 Acres
Final Harvest	56,393	81,839
Partial Harvest **	13,020	6,158
Commercial Thinning	2,755	4,811
Other Stand Improvement	3,170	1,524
Site Preparation	28,750	37,227
Artificial *** Regeneration	22,594	29,669
Natural *** Regeneration	21,677	43,488
Other Treatment	5,533	7,952
Natural Disturbance	37,899	33,235

* Many acres experience more than one treatment or disturbance during a remeasurement period, E.G., final harvest, site preparation, artificial regeneration, hence the individual treatments or disturbances are not totaled.

** Includes high grading and some selective cutting.

*** Includes establishment of trees for timber production on forest and nonforest land.

POSSIBLE WET FIA DATA
ALBEMARLE-PAMLICO STUDY AREA
PERCENT SAMPLING ERROR

CATEGORY	1984	1990
Deep Swamps	1.99	2.15
Broad Flood Plains	2.20	2.05
Narrow Flood Plains	1.19	1.27
Flatwoods and Dry Pocosins	0.87	0.86
Bays and Wet Pocosins	1.27	1.32
Other Mesic and Hydric	3.04	2.44
Softwood Plantations	2.15	1.73
Natural Pine	1.25	1.33
Oak Pine	1.81	1.67
Upland Hardwood	1.98	1.88
Lowland Hardwood	0.78	0.78
Seasonal Water	0.91	0.89
Mixed Wet and Dry	4.14	4.29
Year Round Water	1.69	1.68
All of Above	0.79	0.77

ALBEMARLE-PAMLICO ESTUARINE STUDY AREA
SUMMARY STATISTICS

CATEGORY	1984	1990	% CHANGE 1984-1990
All Timberlands	7,739,628	7,697,488	-0.5
All Possible Wet Timberlands	2,730,388	2,830,810	+3.6
All Pine Plantations	1,072,442	1,422,340	+32.6
All Possible Wet Pine Plantations	194,064	295,643	+52.3
All Natural Pine	1,889,188	1,668,983	-11.6
All Possible Wet Natural Pine	570,195	503,920	-11.6
All Oak-Pine	1,045,537	1,086,923	+3.9
All Possible Wet Oak-Pine	274,291	319,102	+16.3
All Upland Hardwood	2,036,741	1,870,657	-8.1
All Possible Wet Upland Hardwood	228,871	251,789	+10.0
All Lowland Hardwood	1,695,720	1,648,585	-2.8
All Possible Wet Lowland Hardwood	1,462,967	1,460,356	-0.2