

# MARITIME UPLAND FORESTS

## Contents

<b>MARITIME UPLAND FORESTS</b> .....	1
MARITIME UPLAND FORESTS THEME .....	2
KEY TO MARITIME UPLAND FORESTS .....	8
MARITIME SHRUB (STUNTED TREE SUBTYPE) .....	10
MARITIME SHRUB (WAX-MYRTLE SUBTYPE) .....	13
MARITIME SHRUB (BAYBERRY SUBTYPE).....	16
MARITIME EVERGREEN FOREST (MID-ATLANTIC SUBTYPE) .....	18
MARITIME EVERGREEN FOREST (SOUTH-ATLANTIC SUBTYPE) .....	24
MARITIME DECIDUOUS FOREST .....	27
COASTAL FRINGE EVERGREEN FOREST (TYPIC SUBTYPE).....	30
COASTAL FRINGE EVERGREEN FOREST (SAND SPIT WOODLAND SUBTYPE).....	33
CALCAREOUS COASTAL FRINGE FOREST (NORTHERN SUBTYPE).....	36
CALCAREOUS COASTAL FRINGE FOREST (SOUTHERN SUBTYPE).....	38
COASTAL FRINGE SHELL WOODLAND.....	40
MARSH HAMMOCK.....	42

## MARITIME UPLAND FORESTS THEME

**Concept:** Maritime Upland Forests are dry to mesic forest and shrubland communities of sandy soils within a few miles of the coast, dominated by a characteristic set of species that includes *Quercus virginiana*, *Juniperus silicicola*, *Ilex vomitoria*, and others that are relatively tolerant of salt and are rarely found inland. Many of the communities occur on barrier islands and coastal spits, where salt spray is an important ecological influence on plant composition and structure. There, canopies often are streamlined and visibly pruned by salt aerosol deposition, though salt spray is less extreme than in many Maritime Grassland communities. Other communities occur on small marsh islands or broader upland flats a short way inland from the marshes, lacking obvious evidence of salt spray but having similar species composition. A few communities are also influenced by calcareous soil conditions created by concentrations of shells.

**Distinguishing Features:** Maritime Upland Forests are distinguished from other upland woody communities by occurring on barrier island or coastal spits, or by having vegetation dominated or codominated by species confined to near the coast in North Carolina. These species include *Quercus virginiana*, *Juniperus silicicola*, *Quercus hemispherica*, *Sabal palmetto*, *Cartrema americana*, *Prunus caroliniana*, *Ilex vomitoria*, and *Morella cerifera*.

Within the theme, a barrier island setting easily distinguishes Maritime Shrub, Maritime Evergreen Forest, and Maritime Deciduous Forest from other communities, while Coastal Fringe Evergreen Forest and Calcareous Coastal Fringe Forest are distinguished by mainland locations inland of the sounds or marshes. Marsh Hammocks are distinguished by location on small islands embedded in marshes. A few examples of Maritime Shrub or Maritime Evergreen Forest may occur on back-barrier islands in locations where spray of salt or brackish water in the sounds produces similar conditions.

**Sites:** Most Maritime Upland Forests occur on sand deposits, including stable dunes, former overwash flats that have become sheltered, and low terraces or mounds. A few occur on prehistoric shell middens or in sandy soils with enough shells to produce calcareous conditions. They are always located within a few miles of the coast but are at least somewhat sheltered from wind and salt spray compared to many of the Maritime Grasslands. Sites tend to be sheltered from frequent natural fire, by occurring on small islands or by being surrounded by relatively nonflammable vegetation.

**Soils:** Soils are generally sandy Entisols or Inceptisols, occasional Spodosols. They have limited horizon development both because of young age and because of low clay content. Nutrient availability is less limited than in other sandy soils because of ongoing input by aerosols from sea water and because of shell fragments in the soil. Rare communities occur on concentrated shell deposits, either ancient human middens or natural accumulations; these soils are calcareous but are still sandy and well drained.

**Hydrology:** Soils are well drained to excessively drained. Topographic settings suggest a broad range of moisture levels, from xeric to mesic, accompanied with little visible change in vegetation. Sites are above normal flood levels and seasonal high water tables but may occasionally be

disturbed by storm flooding. Water comes primarily from rainfall. Saltwater aerosol deposition is both an ongoing stress and a source of nutrients (Boyce 1954).

**Vegetation:** Vegetation is dominated by woody plants, ranging from shrubland to dense forest. The dominant trees most often include evergreen species, particularly *Quercus virginiana*, *Juniperus silicicola*, *Quercus hemispherica*, and *Pinus taeda*, but may also include deciduous species such as *Quercus falcata*, *Carya glabra*, and *Fagus grandifolia*, or calciphilic species such as *Celtis laevigata* and *Tilia americana* var. *caroliniana*. Understory and shrub species include evergreen species such as *Cartrema americana*, *Prunus caroliniana*, *Ilex vomitoria*, and *Morella cerifera*, as well as some more widespread species such as *Carpinus caroliniana* and *Cornus florida*. Shrublands tend to be dominated by the same shrub species, or by stunted individuals of the same tree species. Overall species richness tends to be low.

**Dynamics:** Maritime Upland Forests occur in the more stable and sheltered locations within the maritime environment, but the maritime environment is more dynamic than other parts of North Carolina. These communities are subject to extreme natural disturbance by wind, heavy salt spray, or saltwater intrusion during storms, and recovery may take several years. In addition to natural disturbance of vegetation, the environment itself may be drastically altered by natural processes of erosion and deposition. New examples of Maritime Evergreen Forest can develop from Maritime Shrub or various open grasslands by processes of primary succession if an area becomes more protected from salt spray and overwash. This can happen naturally if the coastline accretes seaward or if dunes grow and become stable, and it has happened in areas after dunes were artificially stabilized by planting and sand fencing. Forests potentially can be destroyed by migrating dunes or by erosion associated with migrating inlets, and this may have been more important in the past than at present. Examples can also be destroyed if sheltering dunes are eroded away or are artificially removed or their height reduced. Interior portions of forests may also be damaged or altered if the seaward side of the patch is cleared.

The recent history and prevailing dynamics on at least the northern Outer Banks are somewhat uncertain or controversial. Brown (1959) noted the disagreement and contradictory reports about the amount of maritime forest in earlier history on the Outer Banks. Some believed there had been extensive forest that was destroyed by human activities such as grazing, farming, and burning, to create shifting sand on formerly stable islands. Brown himself suggested that forests were more widespread in the past, noting that the locations of villages likely had been forested. At the same time, he and others (Godfrey and Godfrey 1976; Hosier 1972; Birkemeier et al. 1984) cited extensive efforts by the National Park Service to enhance and stabilize the dunes in the northern half of North Carolina by planting and sand fencing. Later authors attributed the development of woody communities to artificial dune stabilization and viewed the prevalence of instability and grassland vegetation as the natural state. Extensive urban development on the barrier islands has obscured the present natural patterns over large areas, but it is possible that both stability and instability prevailed in different places.

It is also possible that such conditions prevailed at different times, in response to climatic cycles, and that both have existed at different times despite, rather than because of, human activities. Hurricane paths appear to follow a decadal cycle, producing periods of 10-20 years of greater or lesser activity in North Carolina. Longer term cycles are also likely. It has been decades since the

concerted efforts at dune stabilization on most undeveloped islands, and it is unclear how long the effects would have lasted in such a dynamic environment, if there were not a natural tendency toward stability and dune development. At present, even the least altered barrier islands, such as Core Banks, show a tendency to develop fairly continuous dunes and enough sheltering for Maritime Shrub communities to develop. Though limited in woody vegetation, the recent history of the spit south of Fork Fisher is instructive. The author observed that a relatively continuous line of dunes, enhanced by human actions, was completely destroyed by a hurricane in the 1990s. However, a relatively continuous dune line had again formed, apparently without substantial human intervention, in just a few years. Nevertheless, extensive, well-developed examples of Maritime Upland Forests are largely confined to cape complexes, complex barrier islands with older portions, and a few south-facing islands with higher and more extensive dune fields — places that are more conducive to sheltering forests in the longer term.

The climate of the maritime environment is more moderate than in other parts of North Carolina. Winter low temperatures are less extreme, and summer high temperatures too are ameliorated by sea breeze and proximity to the thermal mass of the ocean. This is presumed to be the reason that many of the characteristic species are largely confined to the maritime environment in North Carolina but are more widespread farther south, and it may contribute to the high proportion of evergreen species. Floristically, the maritime forests of North Carolina may be argued to be a northern extension of the evergreen hardwood hammock vegetation that is more widespread farther south.

Salt spray has long been recognized as an important on-going stress in maritime communities (Boyce 1954; Wells 1939; Wells and Shunk 1937). This distinctive environmental factor has been recognized in maritime forests in many different parts of the world (Doutt 1941). Maritime forest canopies often become streamlined by the flow of salt-laden winds. Twigs that grow above the canopy receive much more salt spray and are quickly killed. It is widely recognized that salt spray stress is a filter that is responsible for the small number of species in Maritime Shrub and Maritime Evergreen Forest, and that those that are present are those most tolerant of salt spray. Given that thick cuticles and tough, thick leaves correlate with the evergreen habit, salt spray alone might be the cause of the evergreen character of the canopy.

Salt spray, despite causing stress, is also a source of nutrients for plants. In mainland locations, salt spray is less of a stress and canopies are not streamlined, but it likely still is an important source of nutrients. The coarse sandy soils are limited in nutrient-holding capacity. Bellis (1995) reviewed literature suggesting nutrient limitation is severe in the sandy soils, that most plant nutrients are contained in the biomass, and that nitrogen fixing and mycorrhizae are both particularly important, while also emphasizing the importance of aerosol inputs. He also noted that the warm, moist climate would enhance decomposition of litter and nutrient cycling, while the evergreen plants would spread litter input through the year. However, one may wonder if the sclerophyllous nature of the litter would offset any enhanced decomposition,

The role of fire in Maritime Upland Forests is subject to differing opinions. Studies farther south document frequent occurrence of fire (Huffman et al. 2004; Bratton and Davison 1987), but these were related to European settlement and land use. Human-caused fires likely occurred in places where settlers kept livestock, but habitation on North Carolina's barrier islands was sparse until

recently, both after and before European colonization. Bratton and Davison (1987) indicated evidence of at least some fires of unknown cause before settlement in Buxton Woods, though it is unclear that they were frequent. Bellis (1995) believed fire was important in shaping maritime forests for thousands of years, attributing it to human action, but did not offer compelling evidence. He did, however, note the much lower frequency of dry lightning on the coast of North Carolina compared to Florida and Georgia.

It appears inescapable that, except in areas in intense human land use, fire must necessarily have been rare and less influential on barrier islands than on most of the mainland. Flammable vegetation is patchy on barrier islands, with bare sand, sparse grassland, and tidal channels fragmenting the marshes and shrublands. The major cause of frequent fire in the Coastal Plain, large fire compartments that allow the spread of fires over a large area from a single ignition, would not occur there. Any natural fire in a maritime forest would need to be started by a lightning strike within its small area. Given the small size of maritime forest patches and their limited wildlife, some of the motivations for human ignition before the arrival of livestock would also have been absent.

Maritime forest vegetation itself is highly variable in flammability. *Quercus virginiana* and *Quercus hemispherica* litter is not very flammable. Pine needles are flammable and can drape shrubs and vines to create a thick fuel layer. Where dense shrub layers are dominated by species with waxy leaves, such as *Ilex vomitoria* or *Morella cerifera*, fires might carry readily and be intense. However, shrubs are often sparse under forest canopies. Because shrubs increase following storm disturbance, storms and fire might interact. Some of the characteristic species of maritime forests show adaptations useful in persisting with fire, such as the thick bark of *Quercus virginiana* and *Pinus taeda*, and the sprouting abilities of most of the hardwoods. However, they are mixed with species not well adapted to fire, such as thin-barked *Quercus hemispherica*, *Juniperus silicicola*, *Fagus grandifolia*, *Cornus florida*, and *Carpinus caroliniana*. The most fire-adapted species from the mainland, such as *Pinus palustris* and *Quercus laevis*, are scarce or absent in North Carolina's maritime forests.

Fire is a greater possibility in the Maritime Upland Forest communities on the mainland, where fires ignited anywhere over a large area could spread into a given site. Many mainland maritime communities are close to more flammable sandhill and flatwoods vegetation. However, many are interspersed with tidal creeks and swamps, which would inhibit fire spread. Like the barrier island communities, they are dominated by species with litter of limited flammability and contain many species not well adapted to fire. Natural limitations on fire spread may help determine the boundary between Maritime Upland Forests and neighboring longleaf pine communities.

**Comments:** The Maritime Upland Forest communities of barrier islands have intrigued ecologists from the early decades of the field. There is an extensive literature, only part of which is cited here. Wells and Shunk (1931), Wells (1939), Bordeau and Oosting (1959), Brown (1959), and Bellis (1980) made the vegetation and flora, as well as the distinctive structure, familiar to readers. Later synthetic works such as Bellis (1995) summarized the growing literature. However, some other communities within the Maritime Upland Forests theme, especially the coastal fringe communities and Marsh Hammock, have had only limited study. Maritime forests were the first target of CVS

sampling in 1988, and the first data to be analyzed (Wentworth et. al. 1990), while more recent analysis of CVS data (Medford 2018) has examined vegetation patterns in more detail.

**References:**

- Bellis, V.J. 1980. The vegetative cover on the barrier islands of North Carolina. Veroeff. Geobot. Inst. ETH, Stiftung Rubel, Zurich. 69. Heft:14-39.
- Bellis, V.J. 1995. Ecology of Maritime Forests of the Southern Atlantic Coast: A Community Profile. National Biological Service Biological Report 30.
- Birkemeier, W., R. Dolan, and N. Fisher. 1984. The evolution of a barrier island: 1930-1980. Journal of the American Shore and Beach Preservation Association 52:2-12
- Bordeau, P.F., and H.J. Oosting. 1959. The maritime live oak forest in North Carolina. Ecology 40:148-152
- Boyce, S.G. 1954. The salt spray community. Ecological Monographs 24:29-67.
- Bratton, S.P., and K. Davison. 1987. Disturbance and succession in Buxton Woods, Cape Hatteras, North Carolina. Castanea 52:166-179.
- Brown, C.A. 1959. Vegetation of the Outer Banks of North Carolina. Louisiana State University Press, Baton Rouge, LA.
- Doutt, J.K. 1941. Wind pruning and salt spray as factors in ecology. Ecology 22:195-196.
- Godfrey P.J., and Godfrey M.M. 1976. Barrier island ecology of Cape Lookout National Seashore and vicinity, North Carolina. Scientific Monograph Series No. 9, National Park Service, Washington, DC.
- Hosier, P. E. 1972. Resource management plan for Cape Lookout National Seashore. National Park Service, Beaufort, North Carolina.
- Huffman, J.M., W.J. Platt, H. Grissino-Mayer, and C.J. Boyce. 2004. Fire history of a barrier island slash pine (*Pinus elliottii*) savanna. Natural Areas Journal 24: 258-268.
- Medford, H. 2018. A refined classification of maritime forest communities of the Carolinas. Research paper. University of North Carolina, Chapel Hill
- Wells, B.W. 1939. A new forest climax: the salt spray climax of Smith Island, North Carolina. Bulletin of the Torrey Botanical Club 66:629-634.
- Wells, B.W., and I.V. Shunk. 1931. The vegetation and habitat factors of the coarser sands of the North Carolina coast. Ecological Monographs 1:465-520.

Wentworth, T.R., M.P. Schafale, A.S. Weakley, R.K. Peet, P.S. White, and C.C. Frost. 1993. A preliminary classification of North Carolina barrier island forests. Pages 31-46 in: C. A. Cole and F. K. Turner, editors. Barrier island ecology of the mid-Atlantic coast: A symposium. USDI National Park Service. Technical Report NPS/SERCAHA/NRTR-93/04. Atlanta, GA.

## KEY TO MARITIME UPLAND FORESTS

1. Community a shrubland, with an upper canopy persistently less than five meters high; canopy may be dominated by shrub species such as *Morella cerifera* or *Ilex vomitoria*, or by stunted or individuals of tree species, or by young individuals in sites that have not recently supported forest.
  2. Shrubland canopy dominated by tree species that grow taller in other settings, generally *Ilex vomitoria* or *Juniperus silicicola*, less often *Pinus taeda* or *Quercus hemispherica*. .....  
..... **Maritime Shrub (Stunted Tree Subtype)**
  2. Shrubland canopy dominated by species that do not grow into trees, generally *Morella cerifera*, *Morella pensylvanica*, or *Ilex vomitoria*.
    3. Shrubland canopy naturally dominated by *Morella pensylvanica*, sometimes codominant with other species; occurring on the northern Currituck Banks, in the northernmost part of the North Carolina coast. .... **Maritime Shrub (Bayberry Subtype)**
    3. Shrubland canopy dominated by other species, generally *Morella cerifera* or, less often, *Ilex vomitoria*. ..... **Maritime Shrub (Wax Myrtle Subtype)**
1. Community a forest or, occasionally, a woodland, dominated by trees five meters or more tall (may be shorter if recently disturbed by storm but then with evidence of having been taller and of likelihood to again grow taller).
  4. Community occurring on a barrier island or coastal spit exposed to the open ocean, always within 3 miles of the ocean beach and usually within 1.5 miles; canopy stunted and streamlined due to pruning of emerging twigs by salt spray; only Maritime Shrub or communities of the Maritime Grasslands or Maritime Wetlands theme occurring between it and the beach (occasional fingers of Estuarine Communities may also intrude).
    5. Canopy dominated by some combination of *Quercus virginiana*, *Quercus hemispherica*, and *Juniperus virginiana*, along with *Pinus taeda*; generally almost no other tree species present (occasionally with a few *Prunus serotina*, *Diospyros virginiana*, or *Carya glabra* present).
      6. Canopy containing *Sabal palmetto* or occurring on islands where it is naturally present; rare community in North Carolina though more common southward, limited in North Carolina to the Smith Island complex, including Bald Head Island, and southward. ....  
..... **Maritime Evergreen Forest (South Atlantic Subtype)**
      6. *Sabal palmetto* not naturally present; community occurring elsewhere on the coast (including the south-facing Brunswick County coast)..... **Maritime Evergreen Forest (Mid Atlantic Subtype)**
    5. Canopy dominated by deciduous hardwoods, generally *Fagus grandifolia* and *Quercus falcata*, in combination with *Pinus taeda*..... **Maritime Deciduous Forest**
  4. Community occurring on a back-barrier island or on mainland sites within 10 miles of the coast, occasionally within two miles; canopy not pruned by salt spray; inland communities or large expanses of Estuarine Communities or Freshwater Tidal Wetlands occurring between it and the ocean beach.
    7. Community showing strong calcareous influence on the flora; soil containing abundant shell material, which may be from ancient anthropogenic shell middens or natural estuarine deposits; containing multiple calciphilic species and species unusual in maritime settings, potentially including *Sageretia minutiflora*, *Parietaria praetermissa*, *Parietaria floridana*, *Swida asperifolia*, *Celtis laevigata*, *Tilia americana* var. *caroliniana*, *Magnolia grandiflora*, *Ulmus rubra*, *Aesculus pavia*, and *Aquilegia canadensis*, though the dominant species are generally more typical of Maritime Upland Forests.
      8. Community persistently an open woodland, even in the absence of recent disturbance; substrate consisting primarily of shell, leading to excessively drained or unstable conditions;



- community extremely rare, with the only examples occurring on back-barrier islands embedded in Salt Marshes or lagoons. .... **Coastal Fringe Shell Woodland**
8. Community a forest, with a nearly closed canopy of tall trees when not recently disturbed; substrate with abundant shells but with a sandy matrix, less excessively drained and generally stable; community very rare, with the handful of examples occurring on the mainland or on back-barrier islands.
9. Forest in the southernmost part of North Carolina or in states to the south; containing *Magnolia grandiflora* and other species of more southern affinities. ....  
..... **Calcareous Coastal Fringe Forest (Southern Subtype)**
9. Forest farther north, with known examples from Onslow County to Currituck County; southern species such as *Magnolia grandiflora* absent. ....  
..... **Calcareous Coastal Fringe Forest (Northern Subtype)**
7. Community not showing strong calcareous influence; soil containing limited shell material; species listed above generally absent or only one or two species present in small numbers.
10. Very rare community occurring on relatively recently deposited sand spits along an estuarine river; canopy generally an open woodland; shrub and herbaceous flora a mix of maritime, estuarine, sandhill, and weedy species, including *Spartina patens*, *Panicum amarum* var. *amarum*, *Eustachys petraea*, *Carex arenaria*, *Elymus virginicus*, *Scleria flaccida*, and *Cyperus* spp. ....  
..... **Coastal Fringe Evergreen Forest (Sand Spit Woodland Subtype)**
10. Community not on a sand spit along and estuarine river, or if so, lacking the above combinations of species.
11. Community in small patches embedded within a patch of Salt Marsh, Brackish Marsh, or potentially Tidal Freshwater Marsh, or along its edge along a tidal channel; canopy open or closed, trees often stunted or small; canopy of limited diversity, generally dominated by *Quercus virginiana* or *Juniperus silicicola*, though occasionally containing *Pinus taeda*; lower strata containing species shared with the adjacent marsh, such as *Juncus roemerianus* or *Spartina patens*. (If rarely dominated by *Pinus taeda*, the community is distinctly elevated above the marsh, is higher and drier than Estuarine Fringe Pine Forest, with has sandy rather than mucky soil). .... **Marsh Hammock**
11. Community in large to small patches, occurring on the mainland, associated with communities other than tidal marshes, though tidal marshes may also be adjacent; canopy of tall trees, generally closed if not recently disturbed, canopy potentially of slightly higher diversity, containing *Quercus hemispherica*, *Pinus taeda*, *Quercus virginiana*, less often *Juniperus silicicola*, and potentially also *Carya glabra*, *Quercus nigra*, *Quercus falcata*, and other species. (Note that overgrown Pine/Scrub Oak Sandhill (Coastal Fringe Subtype) communities may come to resemble this community, but they will be drier and may show evidence of *Pinus palustris* have been present. Note also that Swamp Island Evergreen Forest has similar canopy composition but has less of a maritime species component; it lacks *Ilex vomitoria* and is less likely to have abundant *Quercus virginiana*, and it occurs farther inland on upland islands surrounded by riverine or nonriverine swamps). **Coastal Fringe Evergreen Forest (Typic Subtype)**

## MARITIME SHRUB (STUNTED TREE SUBTYPE)

**Concept:** Maritime Shrub communities are naturally short woody vegetation (less than 5 meters tall) of barrier island uplands and swales, where salt spray is a major influence on plant composition and stature. The Stunted Tree Subtype is dominated or codominated by *Quercus virginiana*, *Juniperus virginiana* var. *silicicola*, *Persea palustris*, or other trees kept short by salt spray.

**Distinguishing Features:** Maritime Shrub type is distinguished from Maritime Evergreen Forest and other forests by the stature of the canopy, which is persistently less than 5 meters tall. Usually the canopy is streamlined and visibly pruned by salt spray. It may grade smoothly into Maritime Evergreen Forest with increasing canopy height as salt spray diminishes with distance from the ocean or as the ground drops behind dunes. Maritime Shrub is distinguished from Salt Shrub by species composition, with *Morella cerifera*, *Ilex vomitoria*, or other upland species dominant and with wetland species such as *Baccharis halimifolia* and *Iva frutescens* only a minor component if present.

The flora of the Stunted Tree Subtype may be very similar to that of Maritime Evergreen Forest, with only the vegetation height distinguishing them, but often it is more depauperate and more likely to be dominated by *Juniperus silicicola* or *Quercus virginiana* rather than *Quercus hemispherica* or *Pinus taeda*. The Stunted Tree Subtype is distinguished from other subtypes by the dominance or codominance of species capable of becoming larger trees, rather than solely by *Morella cerifera*, *Ilex vomitoria*, or other shrubs.

**Synonyms:** *Quercus virginiana* - (*Ilex vomitoria*) Shrubland (CEGL003833).

Ecological Systems: Central Atlantic Coastal Plain Maritime Forest (CES203.261). Northern Atlantic Coastal Plain Dune and Swale (CES203.264). Southern Atlantic Coastal Plain Dune and Maritime Grassland (CES203.273).

**Sites:** Maritime Shrub occurs on barrier islands and coastal spits, in dune swales, on sand flats sheltered from overwash, and sometimes higher on the leeward slopes of dunes.

**Soils:** Most examples are mapped as Newhan (Typic Quartzipsamments) or Corolla (Aquic Quartzipsamment), a few as Duckston (Typic Psammaquent) or other sandy Entisols.

**Hydrology:** Hydrology is typical of the theme as a whole, ranging from apparently xeric to mesic. Salt spray is substantial, excluding most plant species and limiting the height of vegetation. Salt water intrusion rarely if ever occurs.

**Vegetation:** The vegetation is a thicket of shrubs and stunted trees less than 5 meters tall. In shorter examples, the tree crowns effectively extend to the ground. In taller examples, there may be open space beneath the canopy, but there are not distinguishable understory and shrub layers. The canopy typically is dense but may be open or have small breaks in some cases. *Quercus virginiana* or *Juniperus silicicola* generally dominate the canopy, alone, together, or in combination with *Ilex vomitoria*. Infrequently, *Persea palustris*, *Prunus caroliniana*, *Prunus serotina*, or some other tree species may be abundant or even dominant in the canopy. CVS plot

data also show high constancy and often high cover for *Morella cerifera*, *Smilax auriculata*, *Smilax bona-nox*, *Muscadinia rotundifolia*, *Parthenocissus quinquefolia*, and only slightly less for *Toxicodendron radicans*. Herbs have low cover beneath the canopy but may be locally more abundant in small openings. No herbaceous species are as constant as the woody dominants. The most frequent species are *Uniola paniculata*, *Solidago mexicana*, *Galium bermudense*, *Opuntia drummondii*, *Sporobolus pumilus*, *Heterotheca subaxillaris*, and *Oenothera humifusa*. A wide variety of species of various Maritime Grassland communities may be present occasionally.

**Range and Abundance:** Ranked G3. The related association ranges from Virginia to Georgia. This Stunted Tree Subtype is scattered along the entire coast of North Carolina, but more sparsely than the other subtypes. Most examples are on wider or more stable barrier islands, where they are associated with forests. However, new vegetation resembling this subtype is developing in places where the dunes were artificially stabilized. It is unclear how similar this vegetation is to the long-standing natural examples.

**Associations and Patterns:** Maritime Shrub (Stunted Tree Subtype) most often occurs at the seaward edge of patches of Maritime Evergreen Forest, where salt spray becomes more extreme. Seaward, it gives way abruptly to Dune Grass, Maritime Wet Grassland, or Maritime Dry Grassland. Occasional examples may grade to marsh communities or barrier island communities.

**Variation:** No variants are recognized at present, but they may be warranted. This community covers a broad geographic range, and biogeographic variation comparable to that in Maritime Evergreen Forest may exist. However, the more extreme environment and more depauperate flora may limit such variation. There also may be a worthwhile distinction between long-standing examples on the extremely streamlined leading edge of forest patches, and earlier primary successional examples in places where shelter from salt spray has increased. The latter occur naturally in places where the coast has accreted or where growing dunes have increased shelter. A similar situation occurs where dunes have been artificially stabilized on narrower barrier islands. It can be difficult to distinguish these situations.

**Dynamics:** The dynamics of Maritime Shrub and Maritime Evergreen Forest have been the subject of intense scientific interest, as discussed in the Maritime Upland Forests theme description. As with other barrier island communities, Maritime Shrub communities occur in a dynamic environment. They may be temporarily disturbed or permanently converted to other community types by sand dune migration, loss of protection from salt spray, or erosion in severe storms. However, some examples, especially of this subtype, are old and have long been stable.

Examples may develop by primary succession if protection from salt spray and overwash increases. This appears to be happening naturally in places where the coastline has accreted, such as in some areas near Cape Hatteras. An artificially caused analogue develops in places where sand dunes have been increased by fencing and planting. The shrublands in these places may come to resemble more natural examples over time but appear to remain depauperate and not well developed decades after the dunes were stabilized.

The boundary between Maritime Shrub and Maritime Evergreen Forest is very sensitive to changes in sheltering from salt spray, because the gradient in salt spray influence is steep. Where Maritime

Shrub has been cleared at the seaward edge of a forest patch, the forest canopy often dies back and is reduced in stature, developing a new shrub-height leading edge.

**Comments:** Though the Stunted Tree Subtype usually occurs in association with Maritime Evergreen Forest, it can also occur as small isolated patches that “crouch” behind high dunes in a matrix of Dune Grass.

Because this subtype can be so floristically similar to Maritime Evergreen Forest, Medford’s (2018) analysis did not distinguish it readily. Some CVS plots clustered together in a group that was recognized as such, but more plots were in forest clusters. Plot data cannot always be distinguished readily by cover data alone, and canopy height may be needed for accurate identification of this community. Maritime Evergreen Forest plots that have been recently disturbed and are dominated by understory and shrub species may conversely be difficult to recognize in plot data, but generally are apparent in the field by their location and the presence of dead trees.

**Rare species:**

**References:**

Medford, H. 2018. A refined classification of maritime forest communities of the Carolinas. Research paper. University of North Carolina, Chapel Hill.

## MARITIME SHRUB (WAX-MYRTLE SUBTYPE)

**Concept:** Maritime Shrub communities are naturally short woody vegetation (persistently less than 5 meters tall) of barrier island uplands and swales, where salt spray is a major influence on plant composition and stature. The Wax-Myrtle Subtype covers examples dominated by shrub species, generally *Morella cerifera* alone or with *Ilex vomitoria*, without appreciable numbers of species capable of becoming large trees.

**Distinguishing Features:** The Maritime Shrub type is distinguished from Maritime Evergreen Forest and other forests by the stature of the canopy, which is persistently less than 5 meters tall. The Wax Myrtle Subtype is distinguished from other subtypes by the absence or low cover of *Quercus virginiana*, *Pinus taeda*, and other species capable of becoming larger trees, along with the absence of *Morella pensylvanica*. The Wax Myrtle subtype is distinguished from Salt Shrub, which may also have substantial *Morella cerifera*, by having only limited amounts of *Iva frutescens*, *Baccharis halimifolia*, *Borrchia frutescens*, or other more salt-tolerant species. Open examples may be distinguished from Maritime Wet Grassland, Maritime Dry Grassland, Dune Grass, or other herbaceous communities by high shrub cover even when not recently disturbed. NVC places the boundary at 25% shrub cover.

**Synonyms:** *Morella cerifera* / *Spartina patens* Shrubland (CEGL003839)?

Ecological Systems: Central Atlantic Coastal Plain Maritime Forest (CES203.261). Northern Atlantic Coastal Plain Dune and Swale (CES203.264). Southern Atlantic Coastal Plain Dune and Maritime Grassland (CES203.273).

**Sites:** Maritime Shrub occurs on barrier islands and coastal spits, in dune swales, sand flats sheltered from overwash, sometimes higher on the leeward side of dunes. The Wax-Myrtle Subtype can occur in more exposed sites than the Stunted Tree Subtype, in places more prone to flooding by saltwater intrusion, and in wetter swales.

**Soils:** Examples are most often mapped as Duckston (Typic Psammaquent) and Corolla (Aquic Quartzipsamment) but may occur on other sandy Entisols.

**Hydrology:** Dry to mesic or moderately wet. Examples in swales may have periodic high water tables, but long-term wetness is difficult to distinguish given the sandy soil and sometimes depauperate flora. As conceived, this community may cross the boundary between upland and wetland. Salt spray is substantial, excluding most plant species and limiting the height of vegetation. Saltwater intrusion is rare but is more likely to occur than in the Stunted Tree Subtype.

**Vegetation:** The vegetation includes a dense or open canopy of shrubs, with *Morella cerifera* dominant, alone or codominant with *Ilex vomitoria*. *Baccharis halimifolia* or various tree species may be present in small numbers or low cover. Vines may be extensive or absent. *Toxicodendron radicans* is the most frequent species, but *Smilax bona-nox*, *Smilax auriculata*, *Nekemias arborea*, or other species may be present. Herbs may be nearly absent in dense examples, or may be diverse and have moderate, even high, cover in open examples. CVS plot data (Medford 2018) indicate extreme variability in species present and their cover, though details may be unreliable because plots may include edges with open vegetation and because of confusion of plots among this

community, Salt Shrub, and marsh ecotone areas. *Spartina patens*, *Hydrocotyle bonariensis*, *Uniola paniculata*, and *Solidago mexicana* have high constancy and all but the last sometimes have as much cover as the shrubs. Any species of Maritime Dry Grassland or Maritime Wet Grassland may be present in open examples in dune swales. *Juncus roemerianus* may occasionally be extensive, even in swales isolated from salt marshes.

**Range and Abundance:** Ranked G3G5. This subtype occurs throughout the coast of North Carolina except possibly in the northernmost part. Suitable environments are more abundant than for the Stunted Tree Subtype, and it probably is more abundant, but examples often are not well reported. The equivalent NVC association, as very broadly defined, ranges from Maryland and Delaware to Florida.

**Associations and Patterns:** This community occurs as small to large patches and tends to be present in all but the lowest and most frequently overwashed parts of barrier islands. It can occur in small sheltered microenvironments within Dune Grass communities. It can also occur in deeper dune swales, where it grades to Maritime Wet Grassland or Maritime Dry Grassland. It may occur as a “leading edge” to a forest patch, but less often than the Stunted Tree Subtype. Patches may also occur on the sound side of barrier islands, where they can be difficult to distinguish from Salt Shrub and other marsh communities.

**Variation:** Examples vary over a wide range of shrub density, herb density, and composition of the herb component, as well as a wide range of wetness and exposure to disturbance. Three variants are recognized:

1. Closed Variant encompasses examples with dense shrubs and few openings. They have little herb cover and few species.
2. Dry Open Variant includes examples with less dense shrub layers, occurring on dunes and elevated sand flats. They have a low to moderate density of herbs such as *Uniola paniculata*, *Hydrocotyle bonariensis*, *Oenothera humifusa*, *Conyza pusilla*, *Strophostyles helvola*, *Panicum amarum*, *Physalis walteri*, and other species shared with Dune Grass.
3. Wet Open Variant includes examples with less dense shrub layers, occurring in dune swales and on low flats. They have a low to high cover of herbs shared with Maritime Wet Grassland, especially *Spartina patens*, but including *Hydrocotyle bonariensis*, *Juncus megacephalus*, *Juncus scirpoides*, *Centella erecta*, *Setaria parviflora*, *Hydrocotyle verticillata*, and many others. This variant may be the most distinct; given that it appears to be a true wetland, it perhaps should be distinguished as a separate community type.

**Dynamics:** As with other barrier island communities, Maritime Shrub communities occur in a dynamic environment, and the Wax Myrtle Subtype may be especially dynamic. Some patches occur just behind the foredunes, in areas only marginally suitable for woody vegetation because of high salt spray. Others occur in dune swales that occasionally receive saltwater flooding during storms, so that the vegetation is killed and plants must establish anew. Other examples occur in stabilized sheltered swales, which may be subject to the stress of high water tables in wet years. Some examples are stable over long periods, maintained by salt spray, while others may be a stage in primary succession that will give way to a forest.

*Morella cerifera* supports symbiotic bacteria that fix atmospheric nitrogen. This may potentially make this community particularly fertile, but given the environmental stresses it endures, it is unclear if this potential is realized.

**Comments:** The NVC's boundary between this community and more open communities, 25% shrub cover, is used here for consistency. However, it may be better to use a higher shrub cover, allowing Maritime Wet Grassland and Maritime Dry Grassland to have more shrub cover. Vegetation with 25% shrub cover may have a dense and diverse herb layer indistinguishable from a shrubless grassland community.

This community was called the Shrub Subtype in earlier editions of the 4<sup>th</sup> approximation guide, and the Bayberry Subtype was called the Northern Subtype. After changes in the NVC, the association equivalent of the Wax Myrtle Subtype ranges well to the north of North Carolina, and the names were changed to reduce confusion.

**Rare species:**

Vertebrate animals: *Passerina ciris*.

**References:**

Medford, H. 2018. A refined classification of maritime forest communities of the Carolinas. Research paper. University of North Carolina, Chapel Hill

## MARITIME SHRUB (BAYBERRY SUBTYPE)

**Concept:** Maritime Shrub communities are naturally short woody vegetation (persistently less than 5 meters tall) of barrier island uplands and swales, where salt spray is a major influence on plant composition and stature. The Bayberry Subtype covers examples with *Morella pensylvanica* as the dominant shrub. Stunted trees may be present at low density.

**Distinguishing Features:** The Maritime Shrub type is distinguished from Maritime Evergreen Forest and other forests by the stature of the canopy, which is persistently less than 5 meters tall. The Bayberry Subtype is distinguished by the dominance or codominance of *Morella pensylvanica*.

**Synonyms:** *Morella pensylvanica* / *Diodia teres* Shrubland (CEGL003881).

Ecological Systems: Northern Atlantic Coastal Plain Dune and Swale (CES203.264).

**Sites:** Maritime Shrub occurs on barrier islands and coastal spits, in dune swales, sand flats sheltered from overwash, sometimes higher on the leeward side of dunes.

**Soils:** May occur on any of the sandy Entisols characteristic of the barrier islands.

**Hydrology:** Dry to mesic or moderately wet.

**Vegetation:** The vegetation includes a dense or open canopy of shrubs, with *Morella pensylvanica* dominant or codominant. Small trees as well as shrubs may be present in lesser amounts. Limited plot data from North Carolina and Virginia show additional frequent woody species as *Baccharis halimifolia*, *Prunus serotina*, *Diospyros virginiana*, *Toxicodendron radicans*, *Muscadinia rotundifolia*, and *Salix caroliniana*. *Spartina patens* is present in almost all examples and can have moderate cover. Other herbs vary widely, and include many species shared with Dune Grass, Maritime Dry Grassland, and Maritime Wet Grassland. A few include *Uniola paniculata*, *Panicum/Coleataenia* sp., *Andropogon virginicus*, *Cenchrus tribuloides*, *Conyza pusilla*, *Hexasepalum (Diodia) teres*, and *Eupatorium* sp.

**Range and Abundance:** Ranked G2. This subtype is present in North Carolina only on the Currituck Banks, the southernmost native range extent for *Morella pensylvanica*. Its abundance there is poorly known but it appears to be very rare even there. It was first defined in Virginia, and ranges northward to Delaware.

**Associations and Patterns:** The Bayberry Subtype occurs as small patches, at least in North Carolina. It may be associated with Dune Grass or Maritime Wet Grassland, potentially with Maritime Dry Grassland or Maritime Evergreen Forest.

**Variation:** Little is known about the variation in North Carolina. Examples appear to vary in ways similar to the Open Dry and Open Wet variants of the Wax Myrtle Subtype, ranging from wet to dry and sharing species with the grassland communities of those environments.



**Dynamics:** Little is known specifically about the dynamics of this community in North Carolina. All North Carolina examples occur on the northern Currituck Banks, where grass planting is believed to have artificially stabilized the dunes and eliminated once-frequent overwash. However, it is likely that examples occurred naturally in the area before dune stabilization.

**Comments:**

**Rare species:**

**References:**

## MARITIME EVERGREEN FOREST (MID-ATLANTIC SUBTYPE)

**Concept:** Maritime Evergreen Forests are evergreen hardwood-pine forests of barrier islands and coastal spits. Salt spray is a major environmental factor in these communities, and its influences generally is indicated by a distinctively streamlined canopy form. The vegetation is dominated by some combination of *Quercus virginiana*, *Quercus hemisphaerica*, *Pinus taeda*, and *Juniperus silicicola*. The Mid-Atlantic Subtype covers most of the maritime forests in North Carolina, where deciduous canopy trees are largely absent and where more southerly species, primarily *Sabal palmetto*, are absent.

**Distinguishing Features:** The Maritime Evergreen Forest type is distinguished from all other communities by the combination of evergreen forest vegetation with a canopy greater than 5 meters tall and location on a barrier island or comparable coastal spit. Examples usually have a compact, streamlined, salt-pruned canopy, though those dominated by *Juniperus* may not. Deciduous trees are largely absent, and the characteristic evergreen trees listed above make up most of the canopy in varying abundance. Maritime Evergreen Forest is distinguished from Marsh Hammock by having a broader set of the characteristic species, by generally having a streamlined canopy, and by the general absence of marsh and shade-intolerant herbs. It also occurs in a different setting, on barrier island interiors rather than on small raised patches within salt marshes.

These communities are periodically subject to heavy disturbance by hurricanes. Hard-hit examples may take some years to recover a closed canopy, but should be classified as Maritime Evergreen Forest unless major erosion has changed the environment so that forest cannot recover.

The South-Atlantic Subtype is distinguished from the Mid-Atlantic Subtype in North Carolina by the presence of *Sabal palmetto*, though that species may have limited cover. In North Carolina the subtypes can be distinguished geographically, with the southern range limit of the Mid-Atlantic Subtype north of the Smith Island complex, where the northern range limit of *Sabal palmetto* occurs. However, both subtypes apparently occur in South Carolina.

**Synonyms:** *Quercus virginiana* - *Quercus hemisphaerica* - *Pinus taeda* / *Persea palustris* - *Ilex vomitoria* Forest (CEGL007027).

Ecological Systems: Central Atlantic Coastal Plain Maritime Forest (CES203.261).

**Sites:** Maritime Evergreen Forests occur on barrier islands and coastal spits, on stabilized dunes and flats protected from salt water flooding and from the most extreme salt spray. Most examples are limited to wider barrier islands with substantial dune development.

**Soils:** Most examples are mapped as Newhan or Fripp series (Typic Quartzipsamments), some as Corolla (Aquic Quartzipsamment) or Duckston (Typic Psammaquent), or a few as other sandy Entisols.

**Hydrology:** Hydrology is typical of the theme as a whole, ranging from apparently xeric to mesic. Salt spray is significant enough to shape the canopy and to exclude many plant species, but is less extreme than that in Maritime Shrub.

**Vegetation:** Vegetation is generally a closed forest with a dense canopy, though the canopy may be open in recently disturbed examples and in newly developed examples. The canopy is composed of varying combinations of *Quercus virginiana*, *Quercus hemisphaerica*, *Pinus taeda*, and *Juniperus silicicola*. All have fairly high constancy, and any may dominate. Usually no other canopy trees are present, but occasional *Diospyros virginiana*, *Prunus serotina*, *Carya glabra*, *Xanthoxylum clava-herculis*, or species of the understory may occur. Frequent understory species in CVS plot data and site descriptions include *Persea palustris*, *Cartrema americana*, and possibly *Persea borbonia*, *Prunus caroliniana*, *Ilex opaca*, *Carpinus caroliniana*, and *Cornus florida*, as well as species also in the canopy. The shrub layer ranges from sparse under dense canopy to very dense where the canopy is open. *Ilex vomitoria* is almost always present and usually dominant. Saplings of oaks and of understory species may also be dense, and *Morella cerifera*, *Baccharis halimifolia*, or *Rhus copallinum* may be abundant in more open or recently developed examples. *Callicarpa americana* and *Hypericum hypericoides* are often present in small numbers. Vines are usually abundant, covering the ground in dense forest but sometimes draping the trees where the canopy has been disturbed. *Muscadinia rotundifolia* var. *rotundifolia*, *Toxicodendron radicans*, *Smilax bona-nox*, *Smilax auriculata*, *Smilax rotundifolia*, and *Parthenocissus quinquefolius* are the most frequent and abundant. *Berchemia scandens* also is frequent in plot data, and *Bignonia capreolata*, *Gelsemium sempervirens*, and *Nekemias arborea* are frequently observed. The herb layer is sparse to moderate in density. Plot data shows few herbs, with *Galium bermudense*, *Dichanthelium commutatum*, and various other *Dichanthelium* most frequent. Other species observed to be abundant in some examples or present in many include *Mitchella repens*, *Piptochaetium avenaceum*, *Asplenium platyneuron*, *Chasmanthium laxum*, *Chasmanthium sessifolium*, *Scleria flaccida*, and *Oplismenus setarius*. *Tillandsia usneoides* is sometimes abundant as an epiphyte. In open examples or examples transitional to wetter communities, additional species such as *Sporobolus pumilus* (*Spartina patens*), *Hydrocotyle bonariensis*, *Uniola paniculata*, or even *Juncus roemerianus* may be present.

**Range and Abundance:** Ranked G2. North Carolina examples are scattered along the coast from the Virginia line southward to the Carolina Beach area, with a few examples on exposed islands in brackish or salt water sounds. This subtype ranges into southern Virginia. It is replaced by the South Atlantic Subtype from Bald Head Island southwestward in North Carolina. See the discussion below about areas farther south.

**Associations and Patterns:** Maritime Evergreen Forest usually grades into Maritime Shrub at more exposed seaward edges. However, it may abruptly border Dune Grass or Maritime Grassland on the seaward edge, and often borders them on other edges. It may grade to Salt Shrub and various marsh communities on the landward side of islands. Maritime Evergreen Forest may also grade to Maritime Swamp Forest, Maritime Shrub Swamp, or Interdune Pond in wet swales.

**Variation:** Wentworth, et al. (1990), analyzing woody stem data in the early CVS plots, found the most fundamental division to be between forests dominated by *Quercus virginiana* and *Quercus hemisphaerica* and those dominated by *Pinus taeda*. Medford's (2018) analysis of cover

data in CVS plots recognized a different configuration of three major divisions within the range of Maritime Evergreen Forest vegetation, though not all were called by that name. One consists of plots dominated by *Quercus virginiana* or *Juniperus silicicola*, another by *Quercus hemisphaerica* or *Pinus taeda*. The third major group consisted of plots dominated by *Quercus virginiana* and *Pinus taeda* with more limited species richness, all from the Currituck Banks. Subdivisions within the first two groups also show a strong geographic signal, with most of the plots from one location (Bogue Banks, Buxton Woods) clustering together. Other subdivisions reflected plots transitional to Maritime Shrub or Maritime Wet Grassland.

Because the distribution of maritime forests is discontinuous, and because natural and human disturbance history is confounded with geographic location, it is unclear how many of these differences are useful for classification. Dominance by pines is problematic for differentiating subtypes because, though relatively less tolerant of salt spray, their abundance can change drastically and persistently in response to single disturbances. Nevertheless, a division based on apparent primary successional age may be useful, and recognition of the most striking geographic break seems warranted. Based on this three variants are recognized:

1. Northern Variant includes the examples on Currituck Banks. They have more *Diospyros virginiana* and *Prunus serotina*, in common with maritime forests farther north, while lacking some of the southern species such as *Prunus caroliniana*.
2. Live Oak--Red Cedar Variant includes forests south of the Currituck Banks heavily dominated by *Quercus virginiana* or *Juniperus silicicola*, generally lacking pines and *Quercus hemisphaerica*, which tend to occur in more exposed or successional younger areas.
3. Laurel Oak—Pine Variant includes forests south of Currituck Banks with substantial *Quercus hemisphaerica* or *Pinus taeda*. *Quercus virginiana* may also be abundant, but only rarely is *Juniperus silicicola* important. This variant occurs in areas that are more sheltered or farther from the ocean, and are generally later in primary succession.

**Dynamics:** The dynamics of this subtype are similar to the theme as a whole, especially the barrier island portion of it. Salt spray is an important factor in excluding many species, as well as in shaping the canopy.

Storm disturbance can create long-lasting changes in composition, as can historical land use. This is exemplified by Buxton Woods. Brown (1959) described it as being dominated by *Quercus virginiana* and *Pinus taeda*, but selective logging of *Quercus virginiana* as early as the 1700s (Bratton and Davison 1987) had reduced the abundance of that species and increased the pine. Brown (1959) noted that the forest was being logged. When sampled by CVS in 1988, the forest was strongly dominated by *Pinus taeda*, with an understory dominated by *Quercus hemisphaerica*. A hurricane later killed most of the pines through breakage and salt spray, leaving a shorter canopy dominated by *Quercus hemisphaerica*. Despite its greater tolerance to the salt spray that apparently killed most of the pines, *Quercus virginiana* remained a small component. Accretion of the island and concomitant increasing shelter from chronic salt spray may have changed the environment enough that it is now more favorable to *Quercus hemisphaerica*. The dramatic changes documented at Bull Island in South Carolina (Helm, et al. 1991, Conner et al. 2005), with a shift from pine dominance to oak in response to a hurricane but perhaps also in response to ongoing beach erosion, also illustrate the potential dynamics of maritime forests, though that site

is the South Atlantic Subtype rather than the Mid-Atlantic Subtype. More general observations suggest that effects of storm disturbance can vary, sometimes increasing pines, sometimes decreasing them. Storms can also leave forests with broken canopies and dominance by understory species for many years. Human disturbance such as logging or clearing usually leads to pine dominance, often initially with little understory and with dense tangles of vines.

Maritime Evergreen Forests can potentially develop quickly from Maritime Shrub if an area becomes more sheltered, with stunted trees growing to forest stature. More often, it seems to occur gradually through a process of scattered trees coalescing into more continuous canopy. It may be that common processes of primary succession, such as accumulation of nutrients and soil organic matter, amelioration of the environment by vegetation, are needed to facilitate forest development. It may also be that in environments that are only marginally suitable for this community, tree establishment is a rare event, leaving the closure of the canopy to occur through vegetative spread rather than extensive establishment from seed. The first trees to establish seem to be *Juniperus silicicola* or *Quercus virginiana*, the most salt-tolerant trees, with *Pinus taeda* and *Quercus hemispherica* appearing later.

Maritime Evergreen Forests are very susceptible to alterations in wind flow patterns, because of the effect on salt spray deposition. Breaks in the canopy can potentially create eddies that concentrate salt spray deposition and lead to death of trees around the opening. Loss of the Maritime Shrub community on the seaward edge of the forest can lead to canopy death or severe salt-pruning, effectively turning part of the forest into a new Maritime Shrub edge. This was documented by Lopazanski (1987) on Bogue Banks, and can be observed in other developed areas.

**Comments:** This subtype is what most people think of as the typical maritime forest in North Carolina. It was the primary focus of the early ecological studies such as Wells and Shunk (1931), Wells (1939), Bordeau and Oosting (1959), and Brown (1959), as well as the primary focus of most later studies.

With their restriction to the most stable, sheltered parts of barrier islands, these communities have always been very limited in extent. This sheltered environment has long been the focus of habitation and other human activities on the islands, and the destruction of maritime forests by development accelerated in the late 1900s. While some developments were created with efforts to minimize clearing and to retain the forest canopy, the creation of numerous small clearings for houses will probably have far-reaching effects on the dynamics of the forests.

The range and ecology of this subtype south of North Carolina is somewhat unclear. In North Carolina, it is distinguished by the absence of more southern species such as *Sabal palmetto* and represents a latitudinal shift in communities. However, the corresponding NVC association is attributed to South Carolina and questionably to Georgia, within the range of these southern species. Some South Carolina plots were clustered with the North Carolina plots for this subtype in the Medford (2018) analysis. The low cover of the indicator species may make recognition in plot data difficult; however, some barrier islands in South Carolina apparently have maritime forests resembling this subtype, lacking *Sabal palmetto*, *Pinus elliottii*, and other southern species. The distinction between subtypes may thus be ecological as well as biogeographic.

*Pinus taeda* / *Hudsonia tomentosa* Woodland (CEGL006052) is an open maritime forest described from southeasternmost Virginia. Comparable vegetation may occur on the Currituck Banks, but none is known. Maritime Forests on the Currituck Banks tend to be more open than farther south, and have openings containing *Hudsonia tomentosa*, but have more *Quercus virginiana*. They are considered part of this Maritime Evergreen Forest community. However, interpretation is confused by the tendency of pines to increase in examples that have been artificially cleared in the past.

*Pinus taeda* - *Quercus (falcata, nigra)* / *Morella cerifera* / *Vitis rotundifolia* Forest (CEGL006040) is another pine-dominated open forest that occurs in maritime areas of Virginia. No natural vegetation of this kind is believed to exist in North Carolina, though it appears more closely related to Maritime Deciduous Forest than Maritime Evergreen Forest.

**Rare species:** Vascular plants: -- *Asplenium platyneuron* var. *bacculum-rubrum*, *Cyperus tetragonus*, *Erythrina herbacea*, *Hudsonia tomentosa*, *Iresine rhizomatosa*, *Listera australis*, *Parietaria floridana*, *Parietaria praetermissa*, *Sabal palmetto*, *Sageretia minutiflora*, *Sideroxylon lycioides*, *Sideroxylon tenax*; nonvascular -- *Cheilolejeunea rigidula*, *Lejeunea dimorphophylla*, *Syrrophodon incompletus*, *Teloschistes flavicans*.

#### References:

- Bordeau, P.F., and H.J. Oosting. 1959. The maritime live oak forest in North Carolina. *Ecology* 40: 148-152
- Bratton, S.P., and K. Davison. 1987. Disturbance and succession in Buxton Woods, Cape Hatteras, North Carolina. *Castanea* 52: 166-179.
- Brown, C.A. 1959. Vegetation of the Outer Banks of North Carolina. Louisiana State University Press, Baton Rouge, LA.
- Conner, W.H., W.D. Mixon II, G.W. Wood. 2005. Maritime forest habitat dynamics on Bulls Island, Cape Romain National Wildlife Refuge, SC, following Hurricane Hugo. *Forest Ecology and Management* 212: 127-134.
- Helm, A.C., N.S. Nicholas, S.M. Zedaker, and S.T. Young. 1991. Maritime forests of Bull Island, Cape Romain, South Carolina. *Bulletin of the Torrey Botanical Club* 118: 170-175.
- Medford, H. 2018. A refined classification of maritime forest communities of the Carolinas. Research paper. UNC-Chapel Hill
- Wells, B.W. 1939. A new forest climax: the salt spray climax of Smith Island, North Carolina. *Bulletin of the Torrey Botanical Club* 66: 629-634.
- Wells, B.W., and I.V. Shunk. 1931. The vegetation and habitat factors of the coarser sands of the North Carolina coast. *Ecological Monographs* 1: 465-520.

Wentworth, T.R., M.P. Schafale, A.S. Weakley, R.K. Peet, P.S. White, & C.C. Frost. 1993. A Preliminary classification of North Carolina barrier island forests. Pages 31-46 in: C.A. Cole and F.K. Turner, editors. Barrier island ecology of the mid-Atlantic coast: A symposium. USDI National Park Service. Technical Report NPS/SERCAHA/NRTR-93/04. Atlanta, GA.

## MARITIME EVERGREEN FOREST (SOUTH-ATLANTIC SUBTYPE)

**Concept:** Maritime Evergreen Forests are evergreen hardwood-pine forests of barrier islands and coastal spits. Salt spray is a major environmental influence on these communities, and its influence generally is indicated by a distinctively streamlined canopy form. The South-Atlantic Subtype encompasses the forests from southeastern North Carolina southward, where *Sabal palmetto* mixes with the dominant combinations of *Quercus virginiana*, *Quercus hemisphaerica*, *Pinus taeda*, and *Juniperus silicicola*.

**Distinguishing Features:** The Maritime Evergreen Forest type is distinguished from all other communities by the combination of evergreen forest vegetation with a canopy greater than 5 meters tall when not recently disturbed, along with location on a barrier island or comparable coastal spit. The South Atlantic Subtype is distinguished by the native presence of *Sabal palmetto* in the stand. *Sabal palmetto* may be a small component or may codominate; it generally is well distributed in the community but may be absent from individual plots. South of North Carolina, *Pinus elliotii* also distinguishes this subtype.

**Synonyms:** *Quercus virginiana* - (*Pinus elliotii* var. *elliotii*, *Sabal palmetto*) / *Persea borbonia* - *Callicarpa americana* Forest (CEGL007032).

Ecological Systems: Central Atlantic Coastal Plain Maritime Forest (CES203.261).

**Sites:** The South Atlantic Subtype occurs on barrier islands, on stable dunes, swales, and flats protected from salt water flooding and from the most extreme salt spray.

**Soils:** Examples are mapped as Newhan or Fripp (Typic Quartzipsamments), but could potentially occur on other sandy Entisols.

**Hydrology:** Hydrology is typical of the theme as a whole, ranging from apparently xeric to mesic. Salt spray is significant enough to shape the canopy and to exclude many plant species, but is less extreme than that in Maritime Shrub.

**Vegetation:** Vegetation is generally a closed forest with a dense canopy, though the canopy may be open or may be dominated by understory species in recently disturbed areas. The canopy is composed of varying combinations of *Quercus virginiana*, *Quercus hemisphaerica*, *Pinus taeda*, and *Juniperus silicicola*, with small to large numbers of *Sabal palmetto*. In CVS plot data for Bald Head Island, the hardwoods dominate and are constant while *Pinus* and *Sabal* have somewhat lower constancy and cover, but both are widely distributed in the community as a whole. Understory species with high constancy and cover are *Prunus caroliniana*, *Cartrema americana*, and *Persea borbonia*, and *Cornus florida*, *Ilex opaca*, and *Carpinus caroliniana* are also frequent and abundant. The shrub layer ranges from sparse under dense canopy to dense where the canopy is broken. *Ilex vomitoria* dominates the shrub layer in our examples. *Callicarpa americana* and *Sabal minor* are frequent. Vines are abundant, with *Toxicodendron radicans*, *Muscadinia rotundifolia*, and *Smilax bona-nox* always present with high cover in plot data, and *Gelsemium sempervirens*, *Smilax auriculata*, and *Berchemia scandens* also frequent and abundant. The herb layer is generally moderate to sparse. *Mitchella repens* is constant and most extensive in this layer. Other frequent species include *Asplenium platyneuron*, *Galium bermudense*, *Carex* sp.,



*Dichantherium commutatum*, *Sanicula canadensis* var. *canadensis*, *Chasmanthium laxum*, and *Oplismenus setarius* are frequent. *Pleopeltis michauxiana* and *Tillandsia usneoides* are frequent as epiphytes.

**Range and Abundance:** Ranked G2. In North Carolina, the South Atlantic Subtype occurs only in the Smith Island (Bald Head Island) complex and along the southern Brunswick County coast. The association extends southward to Florida and westward to Alabama and possibly Mississippi.

**Associations and Patterns:** Maritime Evergreen Forest may grade into Maritime Shrub on the seaward side in places, but more often is bordered by steep encroaching dunes with adjacent Dune Grass communities. On the inland side, it grades to Salt Marsh or other marsh edge communities.

**Variation:** Because of its limited range in the state, this community has little recognized variation. As with the Mid Atlantic Subtype, within its few occurrences, it ranges across microsites that appear xeric to mesic or intermittently wet without visible change in vegetation. Some plots from Bald Head Island consistently are distinguished in analysis because they are dominated by understory species left after storm-caused canopy mortality. Farther south, within its range, *Pinus elliotii* replaces *Pinus taeda* as the predominant pine, and *Sabal palmetto* becomes more abundant.

**Dynamics:** The dynamics of this community are generally similar to those of the Mid Atlantic Subtype. Because all example in North Carolina are on islands that have long been stable, there are no known areas in early primary succession and no areas with composition known to be altered by past logging. Some areas have been heavily disturbed by storms, leading to shrubby open forest that can persist for years. The changes documented at Bull Island in South Carolina, an example of this subtype, illustrate the kind of dramatic changes that are possible. Bull Island initially had a large area dominated by *Pinus taeda*, noted for its age (Helm, et al. 1991). Hurricane Hugo killed almost all the pines, while *Sabal palmetto* doubled in density and basal area in the aftermath. Pines regenerated in subsequent years. *Quercus virginiana* was moderately reduced by the storm. At the same time, oak regeneration failed in some areas, apparently due to rising water tables in wetter areas and to increased salt spray where the island was eroding (Conner, et al. 2005).

These forests are very susceptible to alterations in wind flow patterns, because of the effect on salt spray deposition. Breaks in the canopy can potentially create eddies that concentrate salt spray deposition and lead to death of trees around the opening.

**Comments:**

The analysis of CVS data by Medford (2018) did not recognize the clear distinctness of this community. The 8 plots represent this subtype were lumped with plots of Coastal Fringe Evergreen Forest, perhaps because a coincidental high cover of deciduous understory species influenced the clustering algorithm more than the smaller cover of the more distinctive *Sabal palmetto*.

*Sabal palmetto* - *Quercus virginiana* Saturated Forest (CEGL007040), a hydric hammock community of central and southern Florida has been attributed to North Carolina, reportedly from the Bald Head Island complex. While the South Atlantic Subtype occurrence contains a few marginally wet swales dominated by these species, patches are very small and not distinct from the surrounding forest. It does not seem constructive to equate these small patches with this distant, non-maritime association, which contains many additional southern species.

**Rare species:** *Oplismenus setarius*, *Sabal palmetto*, *Cyperus tetragonus*, *Teloschistes flavicans*, others.

**References:**

Conner, W.H., W.D. Mixon II, G.W. Wood. 2005. Maritime forest habitat dynamics on Bulls Island, Cape Romain National Wildlife Refuge, SC, following Hurricane Hugo. *Forest Ecology and Management* 212: 127-134.

Helm, A.C., N.S. Nicholas, S.M. Zedaker, and S.T. Young. 1991. Maritime forests of Bull Island, Cape Romain, South Carolina. *Bulletin of the Torrey Botanical Club* 118: 170-175

Medford, H. 2018. A refined classification of maritime forest communities of the Carolinas. Research paper. UNC-Chapel Hill

## MARITIME DECIDUOUS FOREST

**Concept:** Maritime Deciduous Forests are barrier island upland forests dominated or codominated by deciduous hardwood trees, especially *Quercus falcata*, *Fagus grandifolia*, and *Quercus nigra* along with *Pinus taeda*. This community needs more shelter from salt spray than Maritime Evergreen Forest. It has distinctive species combinations not found in mainland forests.

**Distinguishing Features:** Maritime Deciduous Forest is readily distinguished from all other barrier island upland forests by the dominance or codominance of deciduous hardwoods. Maritime Swamp Forest differs its dominance by wetland tree species. In the few cases of forests dominated by species that could belong to either, such as *Acer rubrum* or *Liquidambar styraciflua*, the lower strata should distinguish upland and wetland communities. Maritime Deciduous Forests may resemble some Mesic Mixed Hardwood Forest (Coastal Plain Subtype) communities of the mainland, but the former have lower species richness while at the same time, having species suggestive of a greater range of moisture tolerance. In addition, maritime species such as *Quercus hemisphaerica* and *Quercus virginiana* are often present in Maritime Deciduous Forest.

**Related Concepts:** *Quercus falcata* - *Pinus taeda* - (*Fagus grandifolia*, *Quercus nigra*) / *Persea palustris* Maritime Forest (CEGL007540).

Ecological Systems: Northern Atlantic Coastal Plain Maritime Forest (CES203.302).

**Sites:** Maritime Deciduous Forests occur only on the more sheltered parts of unusually wide stable barrier islands. They are farther from the ocean and have more shelter from salt spray than even most Maritime Evergreen Forest occurrences.

**Soils:** Most areas are mapped as Fripp (Typic Quartzipsamment). A few parts are mapped as Ousley (Aquic Quartzipsamment) and Duckston (Typic Psammaquent).

**Hydrology:** Hydrology is typical of the theme as a whole, ranging from apparently xeric to mesic. Salt spray is significant enough to exclude many plant species, but is less extreme than in other maritime communities.

**Vegetation:** Vegetation is a closed canopy forest where not disturbed, with a well-developed understory. In Medford's (2018) analysis of CVS data, this community was one of the most distinct clusters among maritime forests. The canopy is dominated by a varying mixture, with *Pinus taeda*, *Quercus falcata*, and *Carya glabra* most frequently codominant. *Fagus grandifolia* and *Quercus virginiana* are fairly frequent (43%) and often codominant when present. *Liquidambar styraciflua*, *Quercus hemisphaerica*, *Quercus phellos*, *Juniperus silicicola*, and *Quercus alba* are at least fairly frequent but seldom as abundant. A few other species, including *Carya pallida*, *Quercus nigra*, and *Quercus michauxii* may codominate in one or two plots. Brown (1959) also noted the presence of old *Pinus echinata*, and surprising species such as *Quercus alba* or *Pinus palustris* are found in some site-specific descriptions and in a few CVS plots. The understory usually is dominated by *Cornus florida*, *Ostrya virginiana*, *Carpinus caroliniana*, or *Persea palustris*. *Ilex opaca*, *Sassafras albidum*, and *Nyssa sylvatica* have high constancy but are seldom dominant. Other species include *Acer rubrum* *Diospyros virginiana*,

and occasionally *Oxydendrum arboreum*. The shrub layer varies in density. *Arundinaria tecta*, *Gaylussacia frondosa*, or *Vaccinium pallidum* may dominate patches. *Callicarpa americana*, *Amelanchier canadensis*, *Morella cerifera*, and *Vaccinium arboreum* are frequent, while *Castanea pumila* and *Euonymus americanus* are fairly frequent. Vines can be extensive in the canopy or ground cover. Frequent species are *Muscadinia rotundifolia* var. *rotundifolia*, *Toxicodendron radicans*, *Smilax rotundifolia*, *Smilax bona-nox*, *Vitis aestivalis*, *Gelsemium sempervirens*, *Parthenocissus quinquefolia*, and *Bignonia capreolata*. The herb layer generally is sparse to moderately dense. *Mitchella repens*, *Pteridium aquilinum*, *Piptochaetium avenaceum*, or *Pteridium latiusculum* may dominate patches. *Hieracium gronovii*, *Nabalus autumnalis*, and *Asplenium platyneuron* are frequent (>50%), and *Cnidocolus stimulosus* and *Danthonia sericea* are almost as frequent (43%). *Tillandsia usneoides* and *Pleopeltis michauxiana* are often present as epiphytes. A few wetland herbs are present, especially *Osmunda spectabilis* and *Lorinseria areolata*.

**Range and Abundance:** Ranked G1?, but probably justifiably G1. The only examples in North Carolina are in northern Dare County, primarily at Nags Head Woods and Kitty Hawk Woods. One or a few examples occur in southern Virginia.

**Associations and Patterns:** Maritime Deciduous Forest occurs in large patches, with embedded Maritime Swamp Forest, Maritime Shrub Swamp, and Interdune Ponds in wet swales. It may grade to Maritime Evergreen Forest or open dune and grassland communities seaward, but the context has been lost in the known examples.

**Variation:** Some differentiation along a moisture gradient may be recognized, with more xerophytic species increasing on the higher hills and mesophytic species in swales. The driest plots contain a few species of sandhills and dry inland forests, including *Cnidocolus stimulosus*, *Vaccinium pallidum*, and even some *Pinus palustris*. These examples may warrant recognition as a xeric variant in the future. However, it is a notable characteristic of this community type that species with typically very different moisture tolerances are mixed together.

**Dynamics:** These communities are the most sheltered of any barrier island community from the stresses of the maritime environment. The high dune ridges and distance from the beach protect them from most salt spray and storm waves. They are, however, still subject to high winds and salt spray during storms, and are more frequently disturbed than inland communities. Such disturbance may kill parts, but generally not all, of the canopy, producing a multi-aged population of trees.

As in other maritime forests, it is unlikely that natural fire was frequent in this community. It is notable that *Pinus palustris* and some other species associated with sandhill communities are present occasionally, but the more frequent species include *Fagus grandifolia*, *Carpinus caroliniana*, *Ostrya virginiana*, and others that are not tolerant of fire. The large patches might occasionally be hit by lightning and ignited, but the surrounding areas are not flammable and fires would not spread from ignitions elsewhere. The rugged topography and interspersed forest with wetlands also would inhibit fire spread.

**Comments:** This community more resembles common inland mesic communities than other maritime forests do. It is more diverse and contains species less tolerant of salt. However, the unusual combinations of species, along with a distinctive environment, justifies its recognition as distinct. More frequent natural disturbance, the sandy soil containing shell fragments, the continuous input of nutrients by salt spray, or the more moderate temperatures may be the cause of the unusual combinations of species.

Medford (2018) found several plots from mainland bluff sites that resembled the Maritime Deciduous Forest plots. While not similar enough to be regarded as representing this community, these sites warrant further investigation. *Quercus hemisphaerica* is present in some, though other maritime species are not. They could prove to be a mainland analogue – a kind of coastal fringe maritime deciduous forest. Other than these bluff sites, the Maritime Deciduous Forest plots cluster very distinctly in Medford’s (2018) analysis. Wentworth, et al. (1990), analyzing only woody stem data from early CVS plots, found that pine-dominated Maritime Evergreen Forest plots clustered with pine-dominated Maritime Deciduous Forest plots, though they separated cleanly at a lower level of clustering.

While Maritime Deciduous Forest has not received the intensive research focus that Maritime Evergreen Forest has, the distinctive vegetation was described by Brown (1959) and in a number of site-specific descriptive reports.

**Rare species:** Vascular -- *Listera australis*

**References:**

- Brown, C.A. 1959. Vegetation of the Outer Banks of North Carolina. Louisiana State University Press, Baton Rouge, LA.
- Medford, H. 2018. A refined classification of maritime forest communities of the Carolinas. Research paper. UNC-Chapel Hill
- Wentworth, T.R., M.P. Schafale, A.S. Weakley, R.K. Peet, P.S. White, & C.C. Frost. 1993. A Preliminary classification of North Carolina barrier island forests. Pages 31-46 in: C.A. Cole and F.K. Turner, editors. Barrier island ecology of the mid-Atlantic coast: A symposium. USDI National Park Service. Technical Report NPS/SERCAHA/NRTR-93/04. Atlanta, GA.

## COASTAL FRINGE EVERGREEN FOREST (TYPIC SUBTYPE)

**Concept:** Coastal Fringe Evergreen Forests are communities that occur on the mainland within a few miles of the coast, not strongly influenced by salt spray, but which contain species such as *Quercus virginiana*, *Quercus hemispherica*, *Carthagenia americana*, and *Ilex vomitoria*, which are typical of maritime forests and not otherwise widespread on the mainland in North Carolina. The Typic Subtype covers most examples, which lack the distinctive characteristics of the Sand Spit Woodland Subtype. They are tall forests of mesophytic or broadly tolerant species.

**Distinguishing Features:** Coastal Fringe Evergreen Forests are distinguished from Maritime Evergreen Forests by occurring on the mainland and well inland of any communities of the coastline (Dune Grass, Maritime Dry Grassland, or Maritime Shrub). Ambiguous cases may occur on back-barrier islands within the sounds, though generally Maritime Evergreen Forest will occur on exposed islands surrounded by salty or brackish water. Coastal Fringe Evergreen Forests may be distinguished by lack of a streamlined canopy produced by salt spray and by difference in species composition. Examples generally contain more deciduous species in all strata, and include some species rarely found in Maritime Evergreen Forest, such as *Quercus nigra*, *Liquidambar styraciflua*, *Aesculus pavia*, *Vaccinium arboreum*, and *Nekemias arborea*.

Coastal Fringe Evergreen Forest is easily distinguished from Swamp Island Evergreen Forest by its setting on low upland flats near the coast rather than on inland ridges surrounded by swamps. Coastal Fringe Evergreen Forest has a greater diversity and abundance of maritime forest plants. *Ilex vomitoria* is not found in Swamp Island Evergreen Forest, and *Quercus virginiana* is rarer there.

The Typic Subtype is distinguished from the Sand Spit Woodland by having a tall canopy that is closed if not recently disturbed, rather than an open, shorter canopy. The Sand Spit Woodland Subtype contains a number of herbaceous species that are shared with sandhill communities and others that are typical of various open habitats. Such species include *Andropogon ternarius*, *Aristida condensata*, *Carex arenaria*, *Cyperus grayi*, *Opuntia humifusa* var. *humifusa*, *Panicum amarum* var. *amarum*, and *Scleria flaccida*.

**Synonyms:** *Quercus virginiana* - *Quercus hemisphaerica* - *Pinus taeda* - *Quercus falcata* / *Persea palustris* Forest (CEGL007026).

Ecological Systems: Central Atlantic Coastal Plain Maritime Forest (CES203.261).

**Sites:** Coastal Fringe Evergreen Forest (Typic Subtype) occurs in two kinds of settings: low flats and gentle rises just uphill of tidal marshes, and small patches farther inland along brackish estuaries.

**Soils:** The most frequently mapped soil for examples is Wando (Typic Quartzipsamment), with several mapped as Mandarin (Oxyaquic Alorthod). A wide variety of other sandy Entisols, Spodosols, and even Ultisols are mapped occasionally. It is unclear if this indicates a true diversity of potential soil conditions or if the community occurs on inclusions within a variety of units.

**Hydrology:** Sites are mesic to dry. The water table may be close enough to the surface that small wetland microsites occur within the community. Sites are not regularly subject to inundation, but some could be susceptible to intrusion by brackish water during rare storm surges.

**Vegetation:** Vegetation is a dense forest, where not recently disturbed. In site descriptions, *Pinus taeda* is most often dominant, and *Quercus hemispherica* is almost always present and often dominant. *Quercus virginiana*, *Quercus nigra*, and *Carya glabra* are frequent. Several other species not typical of maritime forests are moderately frequent, including *Quercus falcata*, *Quercus stellata*, and *Carya ovalis*. The understory almost always includes *Persea palustris* and *Ilex opaca*. *Cartrema americana*, *Cornus florida*, *Juniperus silicicola* are frequent, *Nyssa sylvatica* somewhat less so. A few southern examples have *Persea borbonia* and *Magnolia grandiflora* which appears to be native. Other species characteristic of maritime forests are present in small numbers, including *Carpinus caroliniana*, *Prunus serotina*, and *Prunus caroliniana*. The shrub layer is almost always dominated by *Ilex vomitoria*, and *Morella cerifera* is almost always present and often abundant. Other shrubs that are fairly frequent include *Vaccinium arboreum*, *Callicarpa americana*, and *Sassafras albidum*. Less frequent are *Arundinaria tecta*, *Vaccinium fuscatum*, and *Aesculus pavia*. Several other *Vaccinium* species, *Gaylussacia frondosa*, and a variety of other shrubs may occur. Woody vines are abundant and diverse. *Smilax bona-nox*, *Muscadinia rotundifolia*, and *Gelsemium sempervirens* are almost always present. *Smilax rotundifolia*, *Nekemias arborea*, *Toxicodendron radicans* and *Bignonia capreolata* are frequent. Herbs are scarce in most examples. *Mitchella repens*, the most frequent herb layer species, is still noted only in about half the examples. The other most frequent species are *Chimaphila maculata*, *Chasmanthium laxum*, *Dichantheium commutatum*, and less often, *Yucca filamentosa* and *Scleria flaccida*. A couple of examples have a diverse herb layer, often with unusual combinations of species.

**Range and Abundance:** Ranked G2. In North Carolina, this community is confined to within a few miles of the coast or shores of sounds. It appears to have formed a fairly continuous band from southern Carteret County southward, but to have occurred only in scattered small patches northward. The association is reported to range southward to Georgia.

**Associations and Patterns:** Coastal Fringe Evergreen Forest once formed large patches along the southern mainland coast, but only small, isolated patches remain. It occurs naturally as small patches in more northern and inland estuary sites and usually grades to Salt Marsh or Brackish Marsh, occasionally to Tidal Swamp. On the inland side, it may grade to the Coastal Fringe Subtype of Xeric Sandhill Scrub or Pine/Scrub Oak Sandhill. In Kure Beach, where the coastal strand is not on a barrier island, it apparently graded directly into Maritime Evergreen Forest.

**Variation:** No variants are recognized. The northern and more inland small patch occurrences tend to be lower in species richness.

**Dynamics:** Little is known about the dynamics of these communities. Their location in low areas near the coast makes them vulnerable to wind and saltwater flooding caused by hurricanes. Their elevation is often lower than the dune settings of maritime forests on barrier islands. The susceptibility to canopy disturbance may be responsible for the characteristic dominance or codominance by *Pinus taeda*.

The stress on the canopy by salt spray, so characteristic of barrier islands, is not obvious in Coastal Fringe Evergreen Forests, which tend to be tall and not obviously pruned. The dominance by tree species tolerant of salt may suggest it still is important, but this is not certain.

The mainland location of Coastal Fringe Evergreen Forests potentially makes them more susceptible to natural fire than barrier islands, as fires may spread from ignitions over a large area. Exposure to fire is reduced from typical mainland fire regimes though, by occurrence adjacent to estuaries and in areas dissected by tidal swamps. The flammability of the vegetation is not well known. Pine needles are abundant, and sometimes can drape vines and shrubs to produce a volatile fuel load. However, the litter of the evergreen oaks is not very flammable and may reduce fire spread and intensity.

**Comments:** Coastal Fringe Evergreen Forests are intermediate in character between Maritime Evergreen Forest and inland Mesic Mixed Hardwood Forest and Dry-Mesic Oak–Hickory Forest. Its dominant vegetation is more similar to the forests of barrier islands, but a substantially larger pool of species is present. Several characteristic evergreen canopy and understory tree species occur in North Carolina almost exclusively in maritime or coastal fringe communities, e.g., *Quercus virginiana*, *Quercus hemispherica*, *Cartrema americana*, and *Ilex vomitoria*. It is not clear why they are confined to near the coast. Their evergreen habit suggests that moderation of the climate by the ocean may be important. The occurrence of these species farther inland in states to the south, where some are widespread, supports this hypothesis. However, the occurrence of several of them farther inland in rare Swamp Island Evergreen Forest communities suggests an alternative hypothesis, such as natural sheltering from fire.

This community type is naturally limited in extent, though it probably was once more extensive than Maritime Evergreen Forest. With easy access and extensive coastal development, more of it has been lost than other maritime forests, leaving it one of the most endangered communities in the state.

**Rare species:**

Vascular plants: *Magnolia grandiflora*, *Sideroxylon lycioides*, and *Tilia americana* var. *caroliniana*.

**References:**



## COASTAL FRINGE EVERGREEN FOREST (SAND SPIT WOODLAND SUBTYPE)

**Concept:** Coastal Fringe Evergreen Forests are communities that occur on the mainland within a few miles of the coast, not strongly influenced by salt spray, but that contain species such as *Quercus virginiana*, *Quercus hemispherica*, *Cartrema americana*, and *Ilex vomitoria*, that are typical of maritime forests and not otherwise widespread on the mainland in North Carolina. The Sand Spit Woodland Subtype covers the rare open woodland communities that occur on relatively young sand deposits adjacent to estuarine rivers, that share species both with maritime forests and with other, more open communities. Though treated as a subtype of Coastal Fringe Evergreen Forest, these communities are conceptually intermediate between it, Pine/Scrub Oak Sandhill, Marsh Hammock, and Estuarine Beach, with characteristics of each.

**Distinguishing Features:** Coastal Fringe Evergreen Forest (Sand Spit Woodland Subtype) is distinguished from all other communities by a canopy that contains *Quercus virginiana* or other species characteristic of maritime forests, along with a rich herbaceous flora containing species of both sandhills and open coastal habitats. It should not be confused with areas of the Typic Subtype that are transitional to Pine/Scrub Oak Sandhill, or with examples of Pine/Scrub Oak Sandhill that have seen proliferation of oaks due to fire suppression. The Sand Spit Woodland has a more varied flora in the lower strata, and one that contains marsh and coastal elements such as *Spartina patens*, *Panicum amarum* var. *amarum*, and *Eustachys petraea*, in addition to other elements not typically in sandhills, such as *Carex arenaria*, *Elymus virginicus*, *Scleria flaccida*, and *Cyperus* spp. The setting, on high sand spits adjacent to tidal waters, is characteristic.

**Synonyms:** *Quercus virginiana* - *Quercus hemisphaerica* / *Ilex vomitoria* / *Aristida condensata* - *Panicum amarum* var. *amarum* Forest (CEGL004399).

Ecological Systems: Central Atlantic Coastal Plain Maritime Forest (CES203.261).

**Sites:** The Sand Spit Woodland Subtype occurs on sandy areas adjacent to open estuaries. The configuration of known examples is a narrow ridge of sand with lower marshes behind, suggesting a sand spit deposited across a bay by currents in the river, but one old enough to have allowed full development of marshes behind it. They front open water with a wave-washed sandy beach, and wave deposits may have raised the elevation of the spits.

**Soils:** The occurrences do not appear to be distinguished in soil mapping. Though mapped as Rimini (Entic Haplohumod), they are probably on younger sandy Entisols.

**Hydrology:** Sites are well drained but may be subject to incursion by waves during storms and to spray by brackish water.

**Vegetation:** The vegetation is a woodland or open forest of fairly short stature but potentially large tree diameter, but without substantial pruning by salt spray. The canopy is dominated by *Quercus virginiana* or *Quercus hemispherica*, with some *Juniperus silicicola*, *Pinus taeda*, and *Carya glabra*. The open understory includes *Cartrema americana* and *Persea palustris*. The shrub layer is dominated by *Ilex vomitoria*, but also includes abundant *Polygonella polygama* and some *Morella cerifera*, *Amorpha frutescens*, and *Yucca filamentosa*. Vines are prominent, especially *Smilax auriculata*, *Smilax bona-nox*, and *Muscadinia rotundifolia*, but also including *Smilax*

*smallii* and *Gelsemium sempervirens*. The herb layer is patchy and well developed compared to most maritime forest communities. *Spartina patens*, *Carex arenaria*, *Aristida condensata*, *Panicum amarum*, *Cladonia* sp., and *Cladina evansii* may dominate patches. Other species of note, out of a diversity of species, include *Panicum virgatum* var. *virgatum*, *Andropogon ternarius*, *Cyperus grayi*, *Opuntia humifusa*, *Opuntia pusilla*, *Scleria flaccida*, *Schizachyrium scoparium*, *Galactia regularis*, *Elymus virginicus*, *Bulbostylis ciliatifolia*, *Cirsium repandum*, *Eustachys petraea*, and *Erythrina herbacea*.

**Range and Abundance:** Ranked G1G3 because of uncertainty about the range and abundance. This community is newly recognized and its full status is not well known. It is currently known at only a handful of sites along the estuarine Cape Fear River in New Hanover County. If endemic to North Carolina, it should probably be ranked G1.

**Associations and Patterns:** The known examples are bordered by Brackish Marsh or Tidal Freshwater Marsh communities and open water. They may connect to various sandhill communities or Coastal Fringe Evergreen Forests.

**Variation:** Little is known about variation in the few examples. Newly found examples may differ from the description here.

**Dynamics:** Little is known about this community. It occurs on sand deposits that are subject to potential wave action and salt water during storms, as well as being exposed to wind, and may be younger than most coastal fringe soils. It may represent a middle stage of long-term primary succession, or it may last indefinitely in a cyclic succession driven by severe natural disturbance.

**Comments:** This community is rare and not well known. It was first recognized by Richard LeBlond during the New Hanover County natural areas inventory. It was found in several places along the Cape Fear River, but no plot data represent it. LeBlond called these communities Tidal Saltwater Levee Forest, because they occur along the estuarine river in a position analogous to the natural levees of inland rivers. However, these sand spits do not appear to the author to be remnants of flood-deposited natural levees, but rather to have been created by estuarine tidal currents, wave action, and wind.

The placement of this community in the Maritime Upland Forests theme is uncertain. The dominant species are shared mostly closely with the Typic Subtype of Coastal Fringe Evergreen Forest. However, it shares characteristics with several other communities in different themes. Its open structure and component of xerophytic herbs is shared with Pine/Scrub Oak Sandhill (Coastal Fringe Subtype). However, it is unlikely to burn and does not have *Aristida stricta* or *Pinus palustris*. The presence of salt-tolerant herbs that are shared with adjacent marsh edges resembles Marsh Hammock, but it contains numerous species never found in Marsh Hammocks. The location on an estuary shoreline, apparent periodic disturbance by waves, young substrate, and presence of weedy flora resembles Estuarine Beach Forest. However, the sites are drier, less open, and less weedy.

**Rare species:** *Erythrina herbacea*.

**References:**

LeBlond, R.E. 2004. Personal communication and correspondence about Tidal Saltwater Levee Forest.

## CALCAREOUS COASTAL FRINGE FOREST (NORTHERN SUBTYPE)

**Concept:** Calcareous Coastal Fringe Forests are rare deciduous hardwood forests of shell-rich sandy soils of the coastal fringe. Coarse-textured calcareous soil, influence of coastal storms, maritime climate, and possibly mild salt spray likely determine their character, with calcareous soils differentiating them from Coastal Fringe Evergreen Forest. The Northern Subtype covers the more northerly examples, from middle and northern North Carolina, lacking more southerly species such as *Magnolia grandiflora*.

**Distinguishing Features:** Calcareous Coastal Fringe Forests are distinguished from Coastal Fringe Shell Woodlands by denser vegetation, occurring in more sheltered environments, and having finer textured soils. They are distinguished from all other communities by the co-dominance of maritime forest species such as *Quercus virginiana* and *Ilex vomitoria* with substantial calciphilic flora and vegetation in a coastal fringe site. Lack of species restricted to more southern regions, especially *Magnolia grandiflora*, distinguishes the Northern Subtype from the Southern Subtype.

**Synonyms:** *Quercus virginiana*-*Celtis laevigata* - *Tilia americana* var. *caroliniana* / *Aesculus pavia*-*Ilex vomitoria* Forest (CEGL007282).

Ecological Systems: Central Atlantic Coastal Plain Maritime Forest (CES203.261).

**Sites:** Calcareous Coastal Fringe Forests occur on sand ridges, upland flats, or small sound islands with substantial amounts of shell material in the soil. The sites are believed to be ancient Native American shell middens.

**Soils:** No soils series is specific to these communities. They are mapped as Pactolus or Ousley (both Aquic Quartzipsamments) but might be mapped as other sandy Entisols. The soils are rich in calcium because of the high shell content but are well drained and may be low in other nutrients.

**Hydrology:** This community could potentially range from dry to mesic or marginally wet. The known examples appear to be mesic to marginally wet.

**Vegetation:** Calcareous Coastal Fringe Forest is generally a forest, with a closed to slightly open canopy when not recently disturbed. In the Northern Subtype, *Quercus virginiana* dominates, or codominates with *Carya glabra*, *Tilia americana* var. *caroliniana*, *Celtis laevigata*, *Pinus taeda*, or *Ulmus rubra*. Other canopy trees include *Quercus hemispherica*, *Fraxinus* sp., and *Liriodendron tulipifera*. The understory is dominated by *Persea palustris* or *Acer floridanum*, and other species may include *Ilex opaca*, *Carpinus caroliniana*, *Zanthoxylum clava-herculis*, and *Swida (Cornus) asperifolia*. The shrub layer is dominated by *Ilex vomitoria* and *Sabal minor*. *Aesculus pavia* is also sometimes also abundant. Vines are abundant, especially *Toxicodendron radicans*, *Parthenocissus quinquefolia*, *Berchemia scandens*, and *Smilax* spp. The herb layer is sparse to moderate density. Abundant species in at least one of the sites include *Chasmanthium laxum*, *Chasmanthium sessilifolium*, *Asplenium platyneuron* var. *baculum-rubrum*, *Juncus coriaceus*, and *Rhynchospora miliacea*. Other species include *Verbesina occidentalis*, *Dichantherium commutatum*, *Galium bermudense*, *Sanicula canadensis* var. *floridana*, *Ruellia*

*carolinensis*, *Elephantopus carolinianus*, *Phryma leptostachya*, *Piptochaetium avenaceum*, *Sideroxylon lycioides*, *Oplismenus setarius*, and *Mitchella repens*.

**Range and Abundance:** Ranked G1. Only two examples are known, in Onslow and Currituck counties. No examples are known in other states.

**Associations and Patterns:** The known examples are small patches that grade to various Tidal Freshwater Marsh and Brackish Marsh communities. No natural connection to upland communities remains, but examples might grade to Coastal Fringe Evergreen Forest or to longleaf pine communities.

**Variation:** The two known examples are somewhat different in ways that may reflect the combination of latitude and moisture status that separates them.

**Dynamics:** Dynamics are probably similar to Coastal Fringe Evergreen Forest, with fire of limited importance but with storm disturbance more important than in most communities. The Corn Landing occurrence was heavily disturbed by two hurricanes in 1996 and 20 years later remains with a broken canopy and dense shrub layer very different from its state when it was first observed.

**Comments:** There has been confusion in the application of the NVC associations corresponding to the two subtypes, regarding whether the crucial distinction is one of biogeography or one of environmental differences such as moisture. They are here interpreted to represent biogeographic subtypes, marked by the presence or absence of southern indicator species. Each potentially spans a range of moisture levels and varies somewhat in the amount of evergreen versus deciduous canopy trees, but examples are too rare to see the full range.

A different shell midden community, sharing some species but very different in overall flora, occurs farther north, and is better documented than this community (McAvoy and Harrison 2012). The history of shell middens they document, showing human use of estuarine shellfish as early as 3800 years ago, with most intense use 1000-2000 years ago, may apply to North Carolina as well. This is a rare situation, where use by humans and alteration of the environment occurred long enough ago that a natural community has developed in response to it. The more limited flora in North Carolina's shell midden communities may come from the greater distance to inland calcareous rock substrates of any great extent. However, it may be due solely to the lower density of such sites on the coast of North Carolina.

**Rare species:**

Vascular plants: *Arenaria lanuginosa* var. *lanuginosa*, *Clematis catesbyana*, *Oplismenus setarius*, and *Swida asperifolia*.

**References:**

McAvoy, W.A., and J.W. Harrison. 2012. Plant community classification and the flora of Native American shell-middens of the Delmarva Peninsula. *Maryland Naturalist* 52:1-34.

## CALCAREOUS COASTAL FRINGE FOREST (SOUTHERN SUBTYPE)

**Concept:** Calcareous Coastal Fringe Forests are rare deciduous hardwood forests of shell-rich sandy soils of the coastal fringe. Coarse-textured calcareous soil, influence of coastal storms, maritime climate, and possibly mild salt spray likely determine their character, with calcareous soils differentiating them from Coastal Fringe Evergreen Forest. The Southern Subtype covers more southerly examples, containing species more widespread south of North Carolina, such as *Magnolia grandiflora*.

**Distinguishing Features:** Calcareous Coastal Fringe Forests are distinguished from Coastal Fringe Shell Woodlands by denser vegetation, occurring in more sheltered environments, and having finer textured soils. They are distinguished from all other communities by the dominance of maritime forest species such as *Quercus virginiana* and *Ilex vomitoria* with substantial calciphilic flora and vegetation in a coastal fringe site. The southern subtype is distinguished by species of more southern affinities, especially *Magnolia grandiflora*. In South Carolina, *Sabal palmetto* is also a frequent component. *Quercus hemisphaerica* appears to be the predominant maritime oak in samples of this subtype, while it is absent and *Quercus virginiana* dominates in the Northern Subtype, but the significance of this difference is unclear.

**Synonyms:** *Quercus falcata* - *Tilia americana* var. *caroliniana* - *Magnolia grandiflora* / *Ilex vomitoria* Forest (CEGL007470).

Ecological Systems: Southern Atlantic Coastal Plain Maritime Forest (CES203.537).

**Sites:** The Southern Subtype occurs on low upland flats or gentle slopes on the mainland coast, with substantial amounts of shell material in the soil. The sites are believed to be ancient Native American shell middens.

**Soils:** No soils series is specific to these communities. Examples are mapped as Pactolus (Aquic Quartzipsamment) or Wando (Typic Quartzipsamment) but might be mapped as other sandy Entisols. The soils are rich in calcium because of the high shell content but are well drained and may be low in other nutrients. The few small remaining North Carolina examples have flora suggesting they are only marginally calcareous.

**Hydrology:** This community can range from dry to mesic or marginally wet. Local wetter inclusions may be present.

**Vegetation:** Calcareous Coastal Fringe Forest is a forest with a closed to slightly open canopy when not recently disturbed. The southern subtype is most often dominated by *Quercus hemisphaerica* and *Tilia americana* var. *caroliniana*, with *Quercus virginiana*, *Pinus taeda*, *Magnolia grandiflora*, *Carya glabra*, or *Ulmus americana/rubra* sometimes codominant. *Celtis laevigata*, *Quercus shumardii*, and *Carya cordiformis* may also be abundant. The understory generally is dominated by *Acer floridanum* or *Carpinus caroliniana*, and *Persea palustris* (or *borbonia*?) are constant. Other species include *Ilex opaca*, *Swida asperifolia*, *Juniperus silicicola*, *Cornus florida*, *Cartrema americana*, *Prunus caroliniana*, and *Prunus serotina*. The shrub layer is dominated by *Ilex vomitoria*, with *Morella cerifera*, *Aesculus pavia*, and *Sabal minor* frequent and locally codominant. A wide variety of vines may be present, including *Vitis labrusca*,

*Hydrangea (Decumaria) barbara*, and *Berchemia scandens*, as well as more widespread species such as *Muscadinia rotundifolia* and *Smilax* spp. The herb layer is variable and generally sparse. Species include *Mitchella repens*, *Polystichum acrostichoides*, *Arisaema triphyllum*, *Dichantheium commutatum*, *Dichantheium boscii*, *Sanicula canadensis*, *Galium bermudense*, other *Galium* spp., *Endodeca serpentaria*, *Asplenium platyneuron*, and many others in a single site. All of the few plots and species lists include some wetland species, such as *Anchistea virginica*, *Hypericum walteri*, or *Persicaria* spp.

**Range and Abundance:** Ranked G2G3. Only two examples have been known in North Carolina, both in Brunswick County. This community is somewhat more widespread in South Carolina but still rare.

**Associations and Patterns:** This community occurs as small patches that grade to various salt marsh communities. No natural connection to upland communities remains, but examples might grade to Coastal Fringe Evergreen Forest or to longleaf pine communities.

**Variation:** Too few examples remain to characterize variation in North Carolina. In South Carolina it contains much diversity, and it may warrant splitting into several subtypes there. Examples there vary with the amount of shells making up the soil.

**Dynamics:** Dynamics are probably similar to Coastal Fringe Evergreen Forest, with fire of limited importance but with storm disturbance more important than in most communities.

**Comments:** Coastal shell middens appear to be more abundant in the Sea Islands region of South Carolina. At the same time, upland mesic forests containing *Magnolia grandiflora* are also more abundant, perhaps making the identity of this community more difficult there.

**References:**

## COASTAL FRINGE SHELL WOODLAND

**Concept:** Coastal Fringe Shell Woodlands are rare open communities of shell deposits that support shrubby or woodland vegetation rather than forest due to the coarse soil or exposure to chronic disturbance. This is a more extremely developed version of the Calcareous Coastal Fringe Forest (both subtypes). It is typically associated with prehistoric shell middens or other deposits of nearly pure shell with poorly developed soil, on small islands within estuaries or on the mainland coast. While a number of well-developed examples occur in South Carolina, only a few small examples are known in North Carolina.

**Distinguishing Features:** Coastal Fringe Shell Woodlands are distinguished from all other communities by the occurrence of persistent open woody vegetation on coastal fringe shell deposits. The flora has at least some calciphilic component. The distinction from Calcareous Coastal Fringe Forest may be difficult to determine in the immediate aftermath of hurricanes, but the small stature, sparseness, and growth form of trees should make the persistent vegetation structure clear even at times of heavy mortality.

**Synonyms:** *Juniperus virginiana* var. *silicicola* - *Zanthoxylum clava-herculis* - *Quercus virginiana* - (*Sabal palmetto*) / *Sageretia minutiflora* - (*Sideroxylon tenax*) Woodland (CEGL003525).

Ecological Systems: Southern Atlantic Coastal Plain Maritime Forest (CES203.537). Central Atlantic Coastal Plain Maritime Forest (CES203.261).

**Sites:** Coastal Fringe Shell Woodlands occur on back-barrier islands in the sounds or on the edge of the mainland coast, on deposits that consist largely of shells. Most sites probably originated as prehistoric shell middens, but some have been more recently worked by waves, making their origin unclear. At least one known example is a tombolo, a former island connected to the mainland by a recently deposited spit.

**Soils:** This community has limited soil development. The substrate is whole or fragmented shells mixed with sand. The coarse substrate is excessively drained and readily disturbed by wave action.

**Hydrology:** Sites are excessively drained, though occurring near sea level.

**Vegetation:** The two known North Carolina occurrences share a canopy dominated or codominated by *Quercus virginiana*, with *Juniperus silicicola* codominant in one. *Zanthoxylum clava-herculis*, *Ilex vomitoria*, and *Sageretia minutiflora* are present in both. Other shrubs include *Morella cerifera*, *Parietaria floridana*, *Parietaria praetermissa*, *Aesculus pavia*, and *Baccharis halimifolia*. Herbs include a mix of calciphilic, general maritime, and weedy species. Species reported in one of the examples include *Aquilegia canadensis*, *Arenaria lanuginosa*, *Arenaria serpyllifolia*, *Ageratina aromatica*, *Geranium carolinianum*, *Melica mutica*, *Piptochaetium avenaceum*, *Sphenopholis obtusata*, *Phytolacca americana*, and *Atriplex crispa*. Examples in states to the south also contain *Sideroxylon tenax*, *Celtis laevigata*, *Frangula caroliniana*, and *Cartrema americana*, which might be found in North Carolina examples in the future.



**Range and Abundance:** Ranked G2?. Only two examples are known in North Carolina. The community is somewhat more abundant in South Carolina and perhaps farther south.

**Associations and Patterns:** Coastal Fringe Shell Woodlands are small patch communities. They may occur in connection with Salt Marsh or Brackish Marsh, and possibly with Calcareous Coastal Fringe Forest.

**Variation:** The two known examples are substantially different, but this may partly be related to recent hurricane disturbance when one of them was surveyed.

**Dynamics:** Coastal Fringe Shell Woodlands appear to be dynamic communities subject to periodic severe natural disturbance. They are exposed to salt spray, storm winds, storm surge, and potential reworking of the underlying sediment. One of the known examples underwent severe disturbance in the hurricanes of 1996, resulting in nearly total canopy mortality. Nevertheless, the presence of specialized plant species that are not in the surrounding communities suggests they have persisted for a long time.

**Comments:** This community appears to be more abundant in states to the south. North Carolina's examples appear floristically depauperate. *Sabal palmetto* and *Celtis laevigata* are frequent components in other states.

**Rare species:**

Vascular plants: *Arenaria lanuginosa* var. *lanuginosa*, *Parietaria praetermissa*, and *Sageretia minutiflora*.

**References:**

## MARSH HAMMOCK

**Concept:** Marsh Hammocks are small evergreen forest or woodland patches that occur in a matrix of salt or brackish marshes, on either the sound side of barrier islands or on the mainland. They resemble depauperate Maritime Evergreen Forests but usually contain some marsh species, are more subject to edge effects and storm water intrusion, and are less influenced by salt spray. They may occur farther inland than the other maritime communities, though they also overlap their ranges. They may range in structure from forests to woodlands or savannas.

**Distinguishing Features:** Marsh Hammocks are most easily distinguished from Maritime Evergreen Forest and Coastal Fringe Evergreen Forest by occurring in small patches embedded in marshes or on their edges. The vegetational distinction of these communities can be subtle. Marsh Hammocks may be dominated by any of the same tree species, though *Quercus virginiana*, *Pinus taeda*, or *Juniperus silicicola* are much more likely than *Quercus hemisphaerica*. The understory and shrub layers of Marsh Hammocks generally have fewer species. Most of the species of the maritime forests may be present, but *Quercus hemisphaerica*, *Cornus florida*, *Carpinus caroliniana*, and *Prunus caroliniana* are unlikely. Also present are some marsh edge species such as *Baccharis halimifolia* and *Borrchia frutescens*, as well as *Morella cerifera*. Herbs may be sparse but usually include some species shared with the adjacent marsh or marsh edge, such as *Juncus roemerianus*, *Cladium jamaicense*, *Panicum virgatum*, or *Spartina patens*.

**Synonyms:** Maritime Evergreen Forest. *Juniperus virginiana* var. *silicicola* - (*Quercus virginiana*, *Sabal palmetto*) Forest (CEGL007813).

Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Salt and Brackish Marsh (CES203.260). Southern Atlantic Coastal Plain Salt and Brackish Tidal Marsh (CES203.270).

**Sites:** Marsh Hammocks occur on small elevated areas within or on the edges of tidal marshes. Most examples are associated with mainland marshes or islands in the sounds, but they could occur on larger barrier islands. Elevations are generally only a few feet above the marsh.

**Soils:** Soils often are sandy Entisols, but there is little consistency in how the soils in Marsh Hammocks are treated in soil mapping, when patches are large enough to be distinguished at all. Examples on barrier islands may be mapped as Duckston, Newhand, or Fripp (Typic Quartzipsamments), or Corolla (Aquic Quartzipsamment). Mainland examples are mapped a wide variety of soils, including Humaquepts and even Ultisols.

**Hydrology:** Sites appear to range from well drained to marginally wet. The small mounds and ridges on which these communities usually occur produce strong gradients in wetness from the edges to the center. The water table is seldom far below the surface, but the water may be brackish; the patches probably are too small to form a lens of fresh groundwater. Mass effects and clonal spread allow marsh plants to occur even in drier portions, making it difficult to tell how wet or salty an area is, though the presence of less salt-tolerant plants makes it clear that the environment is different from that of the adjacent marsh. Marsh Hammocks are subject to brief flooding by salt or brackish water during major storms but are not flooded or saturated by normal tides.

**Vegetation:** Marsh Hammocks can range in structure from closed forest canopy to open woodland or even savanna. The canopy may be tall but usually is short. As in all woody maritime communities, the structure may depend on recent history of natural disturbances. Both the limited CVS plot data and qualitative descriptions indicate substantial variation in vegetation. *Quercus virginiana* is constant, usually dominating or codominating the canopy, though occasionally occurring as an understory beneath *Pinus taeda*. *Juniperus silicicola* codominates some examples. *Quercus hemispherica* is only rarely present. CVS plot data included no other understory or canopy species, but other observations have noted a few more inland species, such as *Quercus nigra*, *Carya glabra*, or *Liquidambar styraciflua*, along with understory species such as *Persea palustris*, *Ilex opaca*, *Diospyros virginiana*, *Magnolia virginiana*, and some unexpected species such as *Quercus margaretiae* and *Quercus geminata*. All these species have low constancy. The shrub layer may be sparse or dense throughout, or it may be dense only near the edges. *Ilex vomitoria*, *Morella cerifera*, *Baccharis halimifolia*, *Iva frutescens*, and *Borrchia frutescens* all have high constancy. Vines may be sparse or dense, though species vary. *Toxicodendron radicans* and several species of *Smilax* are most constant, but a wide variety of species occur with low frequency. The herb layer may be dense or sparse. Species typical of marshes or marsh edges are almost always present in significant amounts. *Spartina patens* is most constant and sometimes dense. *Distichlis spicata*, *Juncus roemerianus*, and *Fimbristylis Castanea* are in at least 50% of both plots and other occurrences. Less frequent species include *Panicum virgatum*, *Ipomoea sagittata*, *Solidago sempervirens*, *Elymus glabriflorus*, and *Limonium carolinianum*.

**Range and Abundance:** Ranked G3? Marsh Hammocks range along the entire coast of North Carolina, but recorded examples are few and very widely scattered. A few examples are miles inland along the sounds, but most are within a few miles of the mainland coast. Examples often were not reported in earlier site surveys, and it is likely that this community is more abundant than recorded examples suggest. The equivalent association ranges southward to Georgia.

**Associations and Patterns:** Marsh Hammocks occur as small patches, from a few acres to less than one acre. Most are completely or largely surrounded by Salt Marsh or Brackish Marsh communities, though they may border open water. They may potentially border upland communities on one side.

**Variation:** Examples are extremely variable, but patterns are not well enough known to recognize variants. A potential distinction between northern and southern examples, or between more inland and more coastal examples, needs investigation.

**Dynamics:** Like other maritime communities, Marsh Hammocks are exposed to natural disturbances more than inland communities. The importance of the same evergreen salt-tolerant tree and shrub species suggests a similar environment of moderate climate but exposure to stresses related to salt. Compared to the similar Maritime Evergreen Forest, they are farther from the beach and from chronic salt spray, but they are subject to storm winds and potentially exposed to salt spray during storms. They also are susceptible to flooding by brackish or salt water during storm surges.

The potential role of fire in Marsh Hammocks is unknown. Marsh vegetation can carry fire, and many examples occur in marshes connected to the mainland, where fires might spread from

ignitions anywhere in a large area. However, vegetation includes few species known to be tolerant of fire, suggesting that the community is not shaped by it.

Cleary et al. (1979) described the origin of marsh island landforms in southeastern North Carolina as being connected to inlets in the barrier islands, with storm waves pushing sand from flood tidal deltas over marshes to produce higher land. They suggested that ongoing deposition is needed to maintain the island, and that islands will sink and disappear into the marsh if the inlet migrates away. Different dynamics may prevail in other parts of the coast. Marsh Hammocks along more inland estuaries presumably have a different origin.

**Comments:** This community needs much more study, as it is less well understood than most. In the 3<sup>rd</sup> approximation, examples were regarded as small and depauperate Maritime Evergreen Forest occurrences. A similar assumption may have led to them being overlooked in many site-specific descriptions. Differences in vegetation alone are relatively small, since ecotonal or successional Maritime Evergreen Forests can share some of the features otherwise distinguishing Marsh Hammocks. Present interpretation is that the distinctive dynamics and landscape relations indicate a community different enough to be of scientific and conservation interest.

The fit of North Carolina's Marsh Hammocks to the synonymized NVC association is imperfect. The association was described from farther south, and the more southerly examples often have *Sabal palmetto* and other species not shared in North Carolina. The NVC description emphasizes dominance by *Juniperus silicicola*, which is present but rarely dominant in North Carolina's examples. In addition, communities that are not marsh hammocks, such as vegetation along Florida spring run creeks, have also been attributed to the association. The dynamics of such a community would be quite different, and further study is likely to document floristic differences.

*Sabal palmetto* - (*Juniperus virginiana* var. *silicicola*) Woodland (CEGL003526) is another marsh hammock association defined for South Carolina to Florida; it has been suggested to occur in North Carolina but has not been found. It is classified as a woodland rather than a forest. However, given the natural variability and heterogeneity in vegetation structure in this frequently disturbed community, it does not appear that such a distinction based on narrow differences in structure is appropriate.

**Rare species:**

**References:**

Cleary, W.J., P. E. Hosier, and G.R. Wells. 1979. Genesis and significance of marsh islands within southeastern North Carolina lagoons. *Journal of Sedimentary Petrology* 49:703-710.