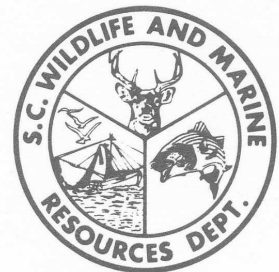
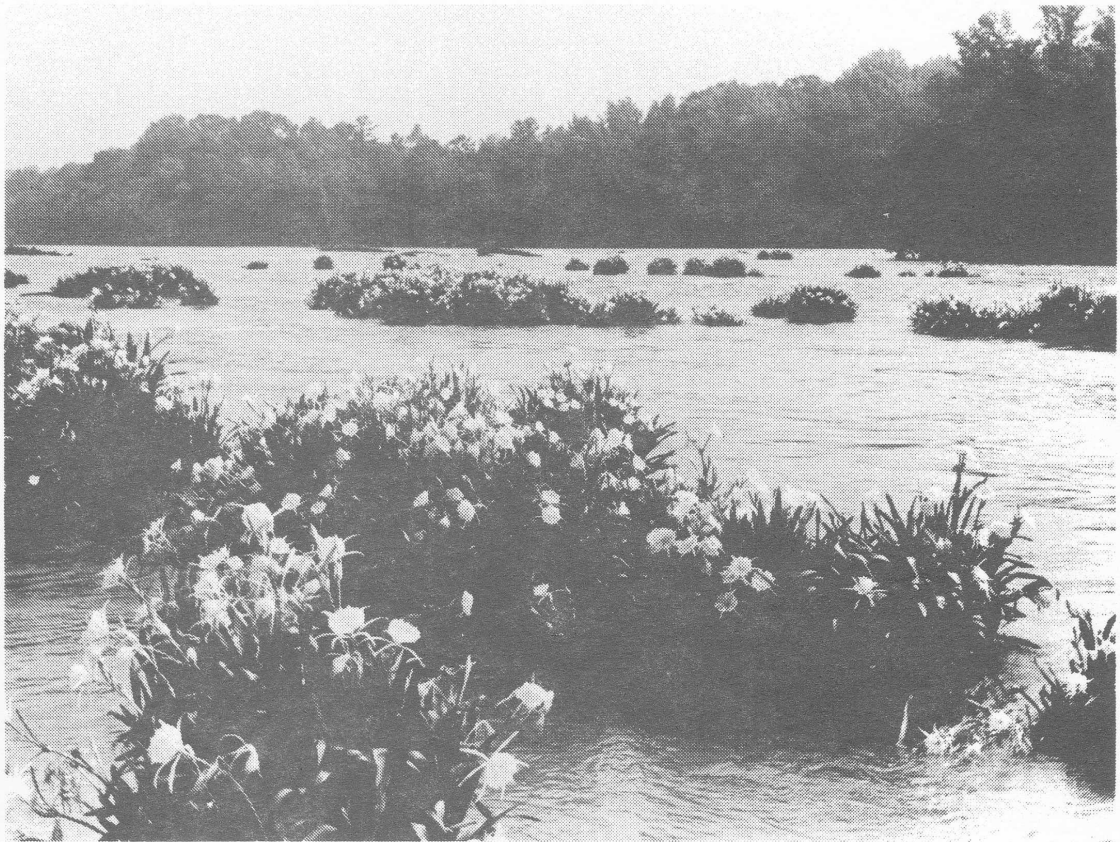


THE NATURAL COMMUNITIES OF SOUTH CAROLINA

Initial Classification and Description

John B. Nelson



S.C. Wildlife and Marine Resources Dept.
Division of Wildlife and Freshwater Fisheries
W. Brock Conrad, Jr., Director
Equal Opportunity Agency

THE NATURAL COMMUNITIES OF SOUTH CAROLINA

BY

JOHN B. NELSON

**SOUTH CAROLINA WILDLIFE & MARINE
RESOURCES DEPARTMENT
FEBRUARY 1986**

INTRODUCTION

The maintenance of an accurate inventory of a region's natural resources must involve a system for classifying its natural communities. These communities themselves represent identifiable units which, like individual plant and animal species of concern, contribute to the overall natural diversity characterizing a given region.

This classification has developed from a need to define more accurately the range of natural habitats within South Carolina. From the standpoint of the South Carolina Nongame and Heritage Trust Program, the conceptual range of natural diversity in the state does indeed depend on knowledge of individual community types. Additionally, it is recognized that the various plant and animal species of concern (which make up a significant remainder of our state's natural diversity) are often restricted to single natural communities or to a number of separate, related ones. In some cases, the occurrence of a given natural community allows us to predict, with some confidence, the presence of specialized or endemic resident species. It follows that a reasonable and convenient method of handling the diversity of species within South Carolina is through the concept of these species as residents of a range of natural communities.

Ideally, a nationwide classification system could be developed and then used by all the states. Since adjacent states usually share a number of community types, and yet may each harbor some that are unique, any classification scheme on a national scale would be forced to recognize the variation in a given community from state to state (or region to region) and at the same time to maintain unique communities as distinctive. Obviously, individual states must have fairly well-developed, workable classifications before interstate systems can be solidified. Ecologists from the Heritage Programs of the two Carolinas and Virginia have made initial attempts to standardize their states' community classifications. The development of a Heritage Program in Georgia would contribute to an even more standardized and workable system for this region.

This classification is immediately valuable as an index of South Carolina's natural community diversity. Its incorporation into the Heritage database, followed by an ongoing inventory for exemplary community types, may then take place. During this process, Heritage Trust staff will be able to prioritize South Carolina's natural communities and to formulate strategies for protection projects concerning the most imperiled types. It is hoped that this classification will also prove useful as a reference for other governmental agencies, ecologists, students, local conservation and preservation groups, and amateur naturalists.

This version represents the first approximation of South Carolina's natural community classification, and as such, is intended for use as an open-ended arrangement. Successive versions are expected to present increasingly accurate and detailed modifications of recognized community type and will, of course, treat any new types. Changes may then be expected in the prioritization of various community types for protection in our state. These later versions shall be based, in part, on additional field knowledge moving into the Heritage database. It is also hoped that additional information from its users will fill in some of the gaps present; any comments from such users are greatly appreciated. Succeeding versions can rightfully be thought of as progressively more refined approximations of the system in nature.

Some very basic problems must be considered during the development of any region's natural community classification. Some of these will be described briefly in the following paragraphs.

Natural communities exist in nature as continua, rather than as discrete and faithfully

repetitive units. The classification of such a system must involve some standard of convenience rather than a stringent adherence to scientific principles. Otherwise, the tendency would be for all of nature to be viewed as a myriad of unique communities, often differing from each other only in unrealistically fine detail. In general, a number of physical and biotic parameters of a given site are used together to indicate the type of community occurring there. When these parameters seem to repeat over and over again at different localities, a single community may be designated. The difficulty in recognizing variation among different examples of a single community type comes when trying to decide at what point subtypes of the community can be recognized.

The effects of succession must be considered in designating a classification. Certain good examples of a given community type may only be good examples temporarily. After a certain time, they may become less recognizable as the first community and more and more similar to a second. A clear conception of the variation within a given community type must involve knowledge of the successional relationships it shares with other types.

The manipulation of natural areas in South Carolina has been and will continue to be an important factor in the recognition of community types. An additional dimension can be used to compare various communities: each type will occur in a range from disturbed to pristine, complicating our attempt to recognize natural units.

Certain community types in South Carolina have not been specifically studied in depth. The accumulation of additional data on these communities is part of the goal of Heritage database management. Additional field work and subsequent study will be necessary for the ultimate disposition of some community types.

A stringent hierarchy for arranging communities has not been followed within this version. However, all of the communities described fall into a hydrological scheme as supplied by Cowardin et al. (1979). The great majority of the communities presented here are either terrestrial or palustrine types; a smaller number makes up the estuarine and marine types. One lacustrine community (Interdune Pond) is described. The next version of this classification shall incorporate a modified hierarchical scheme for subdividing communities and will deal with the rest of South Carolina's lacustrine and riverine community types. The difficulties encountered in classifying aquatic communities has often meant that they are treated after the non-aquatic types.

Within the description of each community type presented here, a listing of synonyms is supplied, followed by a brief description of the sites. Dominant species are listed under "Vegetation". These lists describe the most frequently encountered species (canopy, subcanopy, and ground cover, where appropriate) and are not presented as all-inclusive. Potential elements of concern are those plant and animal species which are currently being tracked in the Heritage database or are likely to be added to it in the future. Certain elements of concern appear to have much greater ecological tolerances than do others, and may be present in more than one community. Endemic species, however, are not used to define the natural community within which they reside. A short treatment of the "Dynamics" of each community is presented. Several communities are too poorly understood and/or inventoried to have detailed treatments, at present, concerning dynamics. An idea of the intergradation among related communities (and their geographical nearness to one another) is supplied under a listing of "Associations."

Alphabetical Listing of Communities

Acidic Cliff
Atlantic White Cedar Swamp
Bald Cypress--Tupelo Gum Swamp
Basic Forest
Bay Forest
Beech--Magnolia Hammock
Bottomland Hardwoods
Brackish Marsh
Calcareous cliff
Chestnut Oak Forest
Cove Forest
Depression Meadow
Estuarine Scour Hole
Granitic Dome
Granitic Flatrock
Hemlock Forest
High Elevation Seep
Hillside Herb Bog
Interdune Pond
Intertidal Beach
Intertidal Mud/Sand Flat
Levee
Limestone Sink
Limestone Sinkhole
Marine Deepwater
Maritime Forest
Maritime Grassland
Maritime Shrub Thicket
Marl Forest
Mesic Mixed Hardwood Forest
Middens
Montmorillonite Forest
Non-Alluvial Swamp Forest
Oak--Hickory Forest
Oyster Reef
Piedmont Seepage Forest
Pine Flatwoods
Pine--Oak Heath
Pine Savannah
Pine--Saw Palmetto Flatwoods
Pine--Scrub Oak Sandhill
Pocosin
Pond Cypress Pond
Pond Cypress Savannah
Pond Pine Woodland
Rhododendron Thicket
Salt Flat
Salt Marsh
Salt Shrub Thicket
Seagrass Bed
Seepage Pocosin
Shoal & Stream Bar
Small Stream Forest
Southern Mixed Hardwood Forest
Spray cliff
Spruce Pine--Mixed Hardwood Forest
Streamhead Pocosin
Swale Pocosin
Swamp Tupelo Pond
Talus Slope
Tidal Bald Cypress--Tupelo Gum Swamp
Tidal Freshwater Marsh
Unconsolidated Coastal Bottom
Upland Bog
Upland Depression Swamp Forest
Upland Pine--Wiregrass Woodland
Xeric Sandhill Scrub

ACIDIC CLIFF

Type: Terrestrial

Sites: These are rock faces with variable aspects of size, vegetation and moisture. Rock surface is generally sloped more than either flatrock or dome communities. Larson and Batson (1978) defined cliffs as having a sloping to vertical face with an angle of between 50 and 90 degrees; overhanging cliffs are an additional possibility. The acidic character of these cliffs arises from the weathering of a granitic substrate.

Location: Upper piedmont and mountains.

Vegetation: Acidic cliffs may range from bare rock, on the most open, steepest, driest sites, to those heavily vegetated. Pioneer genera present include many of those found on flatrocks or domes, including *Rhacomitrium*, *Andreaea*, *Cladonia* and *Selaginella*. Although canopy species may be present, and in fact well-represented, a discernable canopy usually is not. In general, woody plants present are the same as those in adjacent forested communities, and are often confined to rock fissures where sufficient soil has built up. These woody species include *Quercus prinus*, *Q. alba*, *Q. velutina*, *Q. rubra*, *Pinus virginiana*, *P. echinata*, *Carya tomentosa*, *C. glabra*, *Juniperus virginiana*, *Chionanthus virginicus*, *Acer rubrum*, *Tsuga canadensis*, *Oxydendrum arboreum*, *Vaccinium arboreum* and *Kalmia latifolia*. Herbaceous flora may be diverse, but is also usually confined to fissures, including *Saxifraga michauxii*, *Festuca octoflora*, *Aster pilosus* and *Carex scabrata*. Rock fissures may also support vegetation mats; *Houstonia longifolia* and *Deschampsia flexuosa* are commonly found on these.

Potential elements of concern: *Fothergilla major*. *Senecio millefolium*. *Viguiera porteri*. Green salamander. Peregrine falcon.

Dynamics: These communities are generally unstable, sharing many traits of flatrocks and domes. Their steepness makes colonization of vascular plants, particularly woody ones, quite difficult. Most woody plants are restricted to ledges or fissures that are able to collect detritus.

Associations: Granitic Dome. Granitic Flatrock. Spray Cliff. Upland forest types, such as Chestnut Oak Forest.

Comments: "Cliff", "dome" and "flatrock"---these are gradient situations. For instance, some large granitic flatrocks technically have all three present. Acidic cliffs as a group are probably fairly uniform in terms of potential floristics, but quite variable regarding areal extent, slope and exposure. Conceivably, the sides of single boulders could contain biotic assemblages referable to acidic cliffs. As well, a given cliff may have a significant area of wet seepage zones. Thus, these communities may be associated with Spray Cliffs and/or High Elevation Seepages. Granitic Cliffs probably have less floristic diversity than either domes or flatrocks.

References: Crandell 1977. Larson 1977. Larson & Batson 1978. Oosting & Anderson 1937. Oosting & Hess 1956.

ATLANTIC WHITE CEDAR SWAMP

Type: Palustrine

Synonyms: Atlantic white cedar forest. Cedar swamp.

Sites: Periodically or permanently wet swampy areas dominated by *Chamaecyparis thyoides*, with a number of other woody species characteristic of Pocosins.

Location: Sandhill drainages, some Carolina Bays, non-alluvial swamps.

Vegetation: *Chamaecyparis thyoides*, *Magnolia virginiana*, *Acer rubrum*, *Pinus serotina*, *Persea borbonia*, *Myrica cerifera*, *M. heterophylla*, *Cyrilla racemiflora*, *Lyonia lucida* and some other shrubs are commonly occurring woody plants. Herbaceous vegetation may include *Drosera capillaris*, *D. rotundifolia*, *Sarracenia flava*, *S. rubra*, *Peltandra virginica*, *Mayaca aubletii*, *Orontium aquaticum*, plus various species of other showy herbs, such as *Rhexia* and *Ludwigia*.

Potential elements of concern: *Rhynchospora alba*. *Syngonanthus flavidulus*. *Vaccinium sempervirens*. *Gaylussacia mosieri*. Pine-barrens tree frog.

Dynamics: Fire is occasional to rare, but very important in maintaining this community. Without fire, these swamps are thought to succeed to Bay Forest (Wells 1942). The dynamics of White Cedar Swamps are not completely understood. It appears that this community may represent a thickly-forested, tall extreme of the variation within the Pocosin "complex".

Associations: Pocosin, Bay Forest, Pond Pine Woodland, Streamhead Pocosin.

Comments: These communities are often thought of (and referred to) as bogs since peat accumulations are usually present. In general, little floristic variation is expected among different sites. White cedars are usually present in even-aged stands. Variation in subcanopy and herbaceous cover is probably due to previous burning or other disturbance. Diverse vertebrate assemblages are often present in this community. Birds, reptiles and amphibians are particularly well-represented.

References: Buell & Cain 1943. Kologiski 1977. Korstian 1924. Pittman 1978. Wells 1942.

BALD CYPRESS-TUPELO GUM SWAMP

Type: Palustrine

Synonyms: Deep freshwater swamp. Cypress-gum swamp. Brownwater/blackwater cypress-gum swamp.

Sites: These are seasonally-flooded forests on floodplains of river systems dominated by

Taxodium distichum and/or *Nyssa aquatica*. They represent the most deeply flooded of all the palustrine natural communities.

Location: Piedmont and coastal plain.

Vegetation: A well-formed canopy is present, consisting of *Taxodium distichum*, *Nyssa aquatica*, *N. biflora*, *Acer rubrum*, *Populus heterophylla*, *Planera aquatica*, *Fraxinus caroliniana*, *F. tomentosa* and other tree species. Shrub and herbaceous layers are less diverse.

Potential elements of concern: *Carex decomposita*. *Ilex amelanchier*. Wading-bird rookeries.

Dynamics: Cypressess have been extensively logged in many sites, and excellent examples of this community, as large tracts, are rare. Floating stumps and logs may have well-developed herbaceous communities on them. Extensive leaf fall occurs in the autumn. Sites include sloughs, guts, backwater places, etc. that are probably not distinctive as community types. Tree bases are very often swollen; cypresses and tupelo gum additionally have "knees". These communities are seriously affected by channelization of associated rivers. Porcher (1981) considers floating log communities to be microhabitats or dry phases of the swamp forest. Some feel that sufficient differences between alluvial (brownwater) and non-alluvial (blackwater) rivers warrant the separation of these forests into distinctive communities...a growing body of evidence supports this idea.

Comments: Larger guts and sloughs in these swamps seldom dry out completely. Smaller guts are sometimes full of cypress knees.

References: Hall & Penfound 1943. Mathies et al. 1983. Mitsch & Ewel 1979. Noble & Murphy 1975. Quarterman & Keener 1962. Stalter 1971. Wells 1942. Wharton 1970. Wharton 1977. Wharton et al. 1977. Wharton et al. 1982.

BASIC FOREST

Type: Terrestrial

Sites: Upland forests on slopes overlying basic or circumneutral soil, often associated with diabase dikes. The canopy is generally dense and made up of a diversity of hardwood species; herbaceous flora is similarly very diverse. This community is especially well-developed on north-facing or sheltered slopes.

Location: Piedmont.

Vegetation: *Quercus alba*, *Q. shumardii*, *Q. velutina*, other oaks, *Carya tomentosa*, *C. glabra*, *Aesculus pavia*, *Liriodendron tulipifera*, *Fagus grandifolia*, *Acer rubrum*, *A. saccharum*, plus other canopy species. The drier variants of this community often have a predominance of *Quercus alba* along with other drier-adapted oak species such as *Q. stellata*. Subcanopy species include *Nyssa sylvatica*, *Cornus florida*. Shrubs include *Euonymus americana*, *Symplocos*

tinctoria, plus various species of *Viburnum*, *Vaccinium* and *Rhododendron*. Herbs include *Luzula* and *Juncus* spp., *Stellaria pubera*, *Podophyllum peltatum*, *Anemone virginiana*, *A. quinquefolia*, *A. lancifolia*, *Trillium cuneatum*, *T. catesbaei*, *T. cernuum*, *Sanguinaria canadensis*, *Hepatica americana*, *Cynoglossum virginianum*, *Uvularia perfoliata*, *Hybanthus concolor* and *Iris cristata*.

Potential elements of concern: *Tradescantia hirsuticaulis*. *Isotria medeloides*. *Orchis spectabilis*. *Quercus durandii*. *Asarum canadense*. *Silene ovata*. *Menispermum canadense*. *Isopyrum biternatum*. *Delphinium carolinianum*. *Aconitum uncinatum*. *Caulophyllum thalictroides*. *Rhus michauxii*. *Euonymus atropurpurea*. *Panax quinquefolium*. *Scutellaria nervosa*. *Stachys clingmanii*. *Coreopsis latifolia*. *Solidago auriculata*.

Dynamics: This community is associated with basic soils, especially over parent materials which weather significantly (mafic rock). The availability of water is a significant factor in the overall appearance of this community, as well as a determinant of the variation within it. The drier slopes usually have a sparser canopy layer, and less herbaceous diversity than the optimally moist slope bottoms.

Associations: Various upland forest types.

Comments: This community may be indistinguishable from some other upland forest types, especially Cove Forests. Future investigation may suggest the inseparability of these two community types. In general, the expression of a "basic" flora is achieved when groundwater is plentiful. More mesic sites are thus most likely to have the richest herbaceous layers. Most of these sites are likely to be within the upper half of the Piedmont, in association with the extensive diabase dikes found there.

BAY FOREST

Type: Palustrine

Synonym: Bay swamp (Wharton et al. 1977).

Sites: Heavily forested wet sites (saturated seasonally or intermittently) on the coastal plain, dominated by "bay species".

Location: Drainages of sandhill streams, slopes and depressions. Also scattered through most of the coastal plain.

Vegetation: *Gordonia lasianthus*, *Magnolia virginiana*, and *Persea borbonia* are the three "bays" commonly referred to in literature. A number of other woody species occur, these also commonly found in Atlantic White Cedar Swamps and Pocosins: *Pinus serotina*, *Chamaecyparis thyoides*, *Myrica cerifera*, and *Smilax laurifolia*. Herbs are sparse; Sphagnum moss may be abundant. The canopy is generally quite thick, with very tangled subcanopy layers made up of viny growth and tall shrubbery.

Potential elements of concern: Black bear.

Dynamics: Bay Forests are thought to succeed from Atlantic White Cedar Swamp in absence of fire, to which they may revert after severe burning. Roots are often exposed and twisted on the boggy ground surface, as in White Cedar Swamps and alluvial river swamps (Bald Cypress--Tupelo Gum Swamp). Wharton (1977) suggests that Bay Forests may succeed from Gum Ponds following absence of fire and invasion of additional hardwoods.

Associations: This community may occur in a mosaic situation with Atlantic White Cedar Swamp, Pond Pine Woodland, Pocosin, and/or Streamhead Pocosin, especially in the sandhills. Otherwise, a number of palustrine communities may grade into Bay Forests.

Comments: The Florida Natural Areas Inventory (FNAI) recognizes a number of plant communities that have some connection with SC's Bay Forest type. "Baygall" is a natural community type of north Florida (primarily) found at the bases of sandhill slopes, very often associated with seepage slopes. These spots are essentially constantly wet, never drying out completely, but also never flooded. Water moves into the area from hillside run-off and from adjacent flatland drainage. This consistently wet soil has a lot of peat buildup, much more so than on the adjacent hillside slopes which often dry out and will maintain fire. FNAI also identifies streamhead bay forests of the western panhandle as "Baygalls"--although they differ slightly in soils and hydrology from the central Florida types. The same species are listed for both types.

References: Braun 1950. R. Jones 1981. Kologiski 1977.

BEECH--MAGNOLIA HAMMOCK

Type: Terrestrial

Synonym: Magnolia forest.

Sites: Shady forests dominated by many a number of hardwood species, many of which may have sclerified and/or leathery leaves.

Location: Outer coastal plain: Beaufort, Charleston and Jasper Counties.

Vegetation: *Fagus grandifolia*, *Magnolia grandiflora*, *Liquidambar styraciflua*, *Pinus glabra*, *Quercus laurifolia*, *Ilex opaca*, *Carya glabra* and *C. ovalis* may characterize the canopy. Subcanopy and shrubby species are usually rather diverse, and include *Persea borbonia*, *Callicarpa americana*, *Aralia spinosa*, *Ostrya virginiana*, *Osmanthus americana* and *Carpinus caroliniana*. Ground cover is generally sparse, but may include *Parthenocissus quinquefolia*, *Rhus radicans*, *Vitis rotundifolia*, *Tipularia discolor* and *Goodyera repens*.

Dynamics: This community is not completely understood, especially concerning aspects of

origin and succession. Fire is probably very infrequent, but would be quite significant; many of the species listed above cannot tolerate fire.

Associations: Maritime Forest. Mesic Mixed Hardwood Forest. Oak-Hickory Forest.

Comments: This community is perhaps related to some Florida hammock communities. It is arguably a sub-type or variant of the more widely distributed Mesic Mixed Hardwood Forest. Braun (1950) indicated that these forests may have calcareous soils. She also suggested that a high degree of variability may occur throughout its range, with *Quercus alba*, *Q. nigra*, *Acer floridanum* and *Cercis canadensis* contributing to the canopy/subcanopy layers.

Reference: Braun 1950.

BOTTOMLAND HARDWOODS

Type: Palustrine

Synonyms: Shallow freshwater swamps (Penfound 1952). Blackwater river bottomland hardwoods. Brownwater river bottomland hardwoods.

Sites: Flat, dissected areas on floodplains somewhat elevated above adjoining cypress-gum swamp.

Locations: Piedmont and coastal plain in association with river systems.

Vegetation: This community is characterized by a well-developed canopy of *Liquidambar styraciflua*, *Pinus taeda*, *Celtis laevigata*, *Quercus lyrata*, *Q. nigra*, *Q. phellos*, *Q. laurifolia*, *Q. michauxii*, *Q. falcata* var. *pagodaefolia*, *Fraxinus americana*, *Platanus occidentalis*, *Ilex opaca*, *Ulmus americana* and other species. A subcanopy of young canopy species, plus many tall shrubs (including *Asimina triloba*, *Ligustrum sinense*, *Viburnum dentatum* and *V. prunifolium*) occurs. Viny species are common, especially *Campsis radicans*, *Berchemia scandens*, *Rhus radicans*, *Vitis aestivalis*, *Matelea gonocarpa* and *Cayaponia boykinii*. Herbaceous flora is richest on driest spots: *Leersia lenticularis*, *Commelina virginica*, *C. communis*, *Spiranthes cernua*, *S. vernalis*, *Viola affinis*, *V. lanceolata*, *Boehmeria cylindrica*, *Lobelia cardinalis*, *L. elongata*, *Pilea pumila*, *Scutellaria lateriflora*, *Aster lateriflorus*, *Tovara virginiana*, *Microstegium vimineum*, *Onoclea sensibilis*, *Woodwardia areolata*, *Osmunda regalis*, *O. cinnamomea*, *Uniola latifolia*, *Asclepias perennans*, *Senecio glabellus*, *Thelypteris palustris* and *Asplenium platyneuron* are some possible species.

Potential elements of concern: *Osmunda claytoniana*. *Dryopteris spinulosa*. *Fimbristylis vahlii*. *Eriocaulon ravenelii*. *Trillium lancifolium*. *Spiranthes longilabris*. *Quercus durandii*. *Aristolochia tomentosa*. *Silene ovata*. *Ilex amelanchier*. *Trepocarpus arethusae*. *Halesia parviflora*. *Scutellaria nervosa*. *Physostegia leptophylla*. *Bacopa cyclophylla*. *Dyschoriste humistrata*. Swallow-tailed kite. Black bear.

Dynamics: Bottomland Hardwoods are extremely diverse in terms of life forms present, and are quite variable from one site to another. Most bottomland hardwoods have been logged to some degree. Some trees may reach immense size, especially loblolly pine, hackberry, sweetgum, laurel oak and swamp-chestnut oak. Windthrown trees (shallow root systems, broad area of root zone coverage) allow canopy openings and thus increased herbaceous diversity. Some herbs colonize the uplifted soil remaining on the roots once the tree is on the ground.

Associations: Levee. Bald Cypress-Tupelo Gum Swamp. Oak-Hickory Forest.

Comments: "Swamp Cane Island" has been thought of as a discrete community within Bottomland Hardwoods, but is probably best considered a microenvironment there. These spots have rich herbaceous vegetation and are sometimes found on the remaining alluvial ridges at some distance away from the river channel, well within the bottomland itself. Braun (1950) identified "ridge bottoms (or cane ridges)" as a recognizable subdivision of the bottomland forest, and added that "These ridges are (or were originally) covered by dense stands of cane." Bottomland Hardwood sites are generally very rich in both diversity and abundance of bird species.

References: Braun 1950. Noble & Murphy 1975. Porcher 1981. Stalter 1971. Wharton 1977. Wharton et al. 1982.

BRACKISH MARSH

Type: Estuarine

Synonyms: Needlerush marsh, Edge-zone marsh (Wharton 1977).

Sites: Edges of estuaries, generally upland from adjacent salt marshes; drained by dendritic or sinuous tidal creeks. These communities are often recognized by a nearly dominant growth of *Juncus roemerianus*.

Location: Outer coastal plain.

Vegetation: Brackish marshes generally have a large abundance of a few species, with grasses and sedges predominant. *Juncus roemerianus* sometimes forms what is close to a natural "monoculture". Other species of this community are *Spartina cynosuroides*, *S. patens*, *Scirpus robustus*, *S. americanus*, *Eleocharis parvula*, *Triglochin striata*, *Distichlis spicata*, *Polypogon monspeliensis*, *Sporobolus virginicus*, *Zizania aquatica*, *Zizaniopsis miliacea*, *Cladium jamaicense*, *Cyperus tetragonus*, *Fimbristylis spadicea*, *Typha angustifolia*, *Sagittaria falcata*, *S. subulata*, *Amaranthus cannabinus*, *Lilaeopsis chinensis*, *Limonium carolinianum*, *Aster tenuifolius* and *Solidago sempervirens*.

Potential elements of concern: *Eleocharis cellulosa*. *E. fallax*. *E. rostrulata*.

Dynamics: Fires are probably infrequent.

Associations: Salt Marsh, Salt Flat, Salt Shrub, Intertidal Mud/Sand Flats.

Comments: Many invertebrate species are found in Brackish Marshes, including a number of crustaceans (*Uca* spp., other crabs) and annelids. Bird life is generally rather poor, except for marsh hens, clapper rails and a few other species.

References: Cooper & Waits 1973. Jackson 1952. Johnson et al. 1974. Penfound 1952. Stalter 1973. Wells 1928. Zingmark 1978.

CALCAREOUS CLIFF

Type: Terrestrial

Synonyms: Calciphyte forest. Limestone cliff. Marl cliff.

Sites: Slopes or steep walls of marl, sometimes mixed with other mineral soils and/or shell "hash".

Location: Bluffs along rivers of outer coastal plain.

Vegetation: The representation of canopy members depends upon slope and exposure of substrate. Generally, woody plants are at a disadvantage in colonization of this community; canopy species present may in fact be more properly considered part of surrounding forests. Potential woody species include *Tilia heterophylla*, *Tilia caroliniana*, *Quercus muhlenbergii*, *Morus rubra*, *Cercis canadensis*, *Rhamnus caroliniana*, *Acer saccharum*, *Lindera benzoin* and *Ulmus americana*. Ferns are often well-represented on these communities. Other herbs which may occur are *Hybanthus concolor*, *Ponthieva racemosa*, *Elytraria caroliniensis* and *Campanula americana*.

Potential elements of concern: *Asplenium resiliens*. *A. heteroresiliens*. *Pellaea atropurpurea*. *Carex eburnea*. *Carya myristicaeformis*.

Dynamics: Poorly understood. Some calcareous cliffs may have little vegetation, especially on the steepest parts. Fire is probably never a factor. Certain cliffs may owe at least part of their origin to dredging or widening of rivers and the accompanying accumulation of spoil material.

Associations: Marl Forest. Upland forest types, including Oak-Hickory Forest, Spruce Pine-Mixed Hardwood Forest.

Comments: More field knowledge is definitely needed for this rare community.

Reference: Sloan 1908.

CHESTNUT OAK FOREST

Type: Terrestrial

Sites: Ridges and dry south-facing slopes, dominated by chestnut oak, and with several other xeric-adapted oaks, pines and hickories.

Location: Mountains and piedmont (higher elevations).

Vegetation: *Quercus prinus*, *Q. rubra*, *Q. alba*, *Q. coccinea*, *Q. velutina*, *Q. falcata*, *Pinus echinata*, *P. virginiana*, *Carya glabra*, *C. tomentosa*, *Oxydendrum arboreum*, *Nyssa sylvatica*, *Acer rubrum*, *Sassafras albidum*, *Castanea dentata* (stump sprouts), *Kalmia latifolia*, *Rhododendron minus*, *Pyrolaria pubera*. The herbaceous flora of this community is usually very sparse.

Potential elements of concern: *Xerophyllum asphodeloides*. *Anemone caroliniana*. *Arabis laevis* var. *missouriensis*. *Fothergilla major*. Black bear.

Dynamics: *Quercus prinus* and other associated hardwoods are taking over where *Castanea dentata* once dominated. Without disturbance, hardwoods increase in importance relative to pines. In mountainous areas, Chestnut Oak Forest is likely to be found on practically any exposure, whereas in the piedmont, they are best developed on north-facing sites, especially those with an acidic (quartzite-based) substrate.

Associations: Acidic Cliff. Cove Forest downslope. Oak-Hickory Forest.

Comments: This community may be found on monadnocks of the piedmont.

COVE FOREST

Type: Terrestrial

Synonyms: Cove Transition Forest. Montane Cove Forest.

Sites: Mesic ravines, sheltered slopes and rich broad flats next to streams. These are not restricted necessarily to northern exposures.

Location: Mountains and piedmont.

Vegetation: These forests are characterized by dense canopies of great diversity, including *Tilia heterophylla*, *Acer saccharum*, *Liriodendron tulipifera*, *Fagus grandifolia*, *Tsuga canadensis*, *Betula lenta*, and others. The shrub layer is reasonably open to quite dense, with *Rhododendron maximum*, *Hydrangea arborescens*, *Lindera benzoin* and *Cornus florida*. The herbaceous flora is particularly rich and diverse, with spectacular blooming during the spring.

Potential elements of concern: *Trichomanes petersii*. *Asplenium rhizophyllum*. *Carex austrocaroliniana*. *Disporum lanuginosum*. *Platanthera integrilabia*. *Isopyrum biternatum*. *Caulophyllum thalictroides*. *Shortia galacifolia*. *Circaea lutetiana*. *Cladrastis kentuckea*.

Dynamics: This is often recognized as a stable, climax community. Earlier disturbance is indicated by a preponderance of *Tsuga* and *Liriodendron*. Some canopy trees attain immense proportions.

Associations: Basic Forest. Rhododendron Thicket. Hemlock Forest. Chestnut Oak Forest. Spray Cliff.

Comments: The separation of this community from some Basic Forests may be particularly difficult. Differences among these communities may be centered around composition of herbaceous layer rather than canopy species, which are essentially the same. Of the communities within the mountains of South Carolina, this one is probably the most productive regarding songbird diversity and abundance.

References: Bratton 1978. Hardin & Lewis 1980. Whittaker 1956.

DEPRESSION MEADOW

Type: Palustrine

Synonyms: Depression marsh. Freshwater marsh. Bur-reed marsh (Hall & Penfound 1943). Grass/sedge bog. Wet prairie.

Sites: Wetland with widely fluctuating water level, usually every year, dominated by emergent grasses and sedges.

Location: Possibly throughout state, but probably best developed on Coastal Plain.

Vegetation: Shrubby vegetation is generally of minor importance in this community. Possible shrubby species are *Cephalanthus occidentalis*, *Diospyros virginiana* and *Ilex myrtifolia*. *Acer rubrum* and *Liquidambar styraciflua* may occur abundantly in certain sites. Vegetation is dominated by grasses and sedges, especially *Panicum* spp. (*P. hemitomin*, *P. verrucosum*, *P. dichotomiflorum*, etc.), *Rhynchospora* spp., *Carex* spp., *Fimbristylis* spp., *Eleocharis* spp., *Cyperus* spp., together with other graminoid genera and forbs, including *Leersia* spp., *Hydrochloa caroliniensis*, *Juncus repens*, other *Juncus* species, *Xyris* spp., *Ludwigia decurrens*, *L. sphaerocarpa*, *L. octovalvis*, *L. alternifolia*, *L. suffruticosa*, *L. pilosa*, other *Ludwigia* species, *Rhexia mariana*, *Sabatia bartramii*, *S. difformis*, *S. brevifolia*, *Lachnanthes caroliniana*, *Iris tridentata*, *I. prismatica*, *I. hexagona*, *I. virginica*, *Proserpinaca pectinata* and *Cuphea carthagensis*.

Potential elements of concern: *Amphicarpum muhlenbergianum*. *Fimbristylis vahlii*. *Rhynchospora inundata*. *R. tracyi*. *Cladium mariscoides*. *Sagittaria isoetiformis*. *Echinodorus*

parvulus. Stillingia aquatica. Litsea aestivalis. Polygala nana. Hypericum adpressum. H. nitidum. Ludwigia spathulata. Rhexia aristosa. Oxypolis canbyi. Ptilimnium nodosum. Coreopsis rosea.

Dynamics: These sites may be rounded or irregular in shape. A high degree of vegetational zonation may occur, which is most easily observed in the more rounded meadows. Peat accumulates at center? Fire is probably very important in maintenance. Exclusion of fire probably allows conversion of sites into shrub-dominated communities.

Associations: Pond Cypress Pond. Swamp Tupelo Pond. Pine Savannah. Limestone sink.

Comments: This community is frequently observed in many Carolina bays. Limestone sinks may have essentially the same species present, but dynamics (especially involving hydrology) probably allow consistent separation.

ESTUARINE SCOUR HOLE

Type: Marine

Sites: Holes 15-30 meters deep, and 2-5 times deeper than adjacent tidal channels. These depressions extend below marsh and channel sediments, and cut into Tertiary Cooper marl lime bedrock.

Location: About 25 sites located to date up and down SC coast.

Vegetation: None known; presumably, restricted to algae.

Dynamics: Scouring action occurs during flood (inflow). Sites are swept clear of unconsolidated sediments by receding tide (outflow). Ebb-dominant currents tend to introduce sand from upstream. Cooper marl exposures on bottom are kept bare.

Associations: Unconsolidated Marine Bottom.

Comments: Practically no field knowledge is available. Molluscs (especially pelycypods and bivalves), crustaceans and echinoderms are known to be present.

References: Kjerfve et al. 1979. Zingmark 1978.

GRANITIC DOME

Type: Terrestrial

Sites: Extruded granite/gneiss at the surface of the surrounding soil, with varyingly sloping angle; not flat.

Location: Piedmont and mountains.

Vegetation: This community shares many vegetational elements with Acidic Cliff and Granitic Flatrock sites. Pioneer species present are essentially the same among all three. Woody vegetation tends to be more abundant here than on Acidic Cliffs. Larson & Batson (1978) list *Krigia montana*, *Danthonia spicata*, *Selaginella tortipila*, *Panicum tennesseense* as the dominant herb species on Granitic Domes.

Potential elements of concern: *Juniperus communis*. *Senecio millefolium*. *Solidago bicolor*.

Dynamics: Mosaic communities on these rock faces are perhaps not as well "defined" as on flatrocks, due to the rapid run-off of water. Solution pools and resultant circular mats and vegetation zones are not found. Successional trees (especially *Juniperus virginiana*, *Pinus virginiana*, etc.) on these sites are more likely to topple over due to windthrow than they are on flatrocks. Crevices and ledges provide the only habitats for larger plants, once sufficient soil has built up. Dome communities are reasonably unstable, as are those of flatrocks and cliffs; their demise is often brought about by heavy rain, prolonged drought or strong winds. Granite domes represent sites for "water-slides", which are best considered as palustrine communities (High Elevation Seeps) on the domes themselves. Crandell (1977) identifies *Krigia*, *Danthonia* and *Calamagrostis* as "surface"-occupying plants, and *Chionanthus virginica*, *Quercus prinus* and *Pinus virginiana* as "fissure" plants.

Associations: Acidic Cliff. Granitic Flatrock. Upland forest types, such as Oak-Hickory Forest and Chestnut Oak Forest.

Comments: Granitic Domes receive some threat from nature enthusiasts, but certainly not as much as do Flatrocks.

References: Crandell 1977. Larson 1977. Larson & Batson 1978. Oosting & Anderson 1937.

GRANITIC FLATROCK

Type: Terrestrial

Synonym: Granite outcrop.

Sites: Extrusive or intrusive granite/gneissic material as more or less flat outcrops, but usually with at least some rolling topography. Elevation is essentially the same as the surrounding ground, as opposed to the situation with Domes and Cliffs.

Location: Piedmont.

Vegetation: Canopy species tend to be diverse, but individual plants are often stunted. *Juniperus virginiana*, *Ulmus alata*, *Quercus alba*, *Q. prinus*, *Pinus echinata* and *Gleditsia*

triacanthos are often seen as trees on Flatrocks. In general, canopy species present may be the same as those from immediately surrounding communities, and are not especially indicative of the Flatrock community. The same is true for shrubby and/or understory species. On the other hand, the herbaceous flora of Granitic Flatrocks is highly specialized, and a large number of endemic species occurs on them. Most of these endemics are quite rare, and are especially sensitive to disturbance. Other than the elements of concern, the herbaceous flora of Flatrocks may include *Erythronium americanum*, *Hypericum gentianoides*, various species of *Rubus*, *Andropogon*, *Juncus*, *Fimbristylis*, *Yucca*, *Aster* and *Chrysopsis*. A number of bryophyte genera are known from these Flatrocks. Some of these are considered important bare-rock colonizers, leading the way for the vegetational succession of vascular plants.

Potential elements of concern: *Isoetes melanocarpa*. *Hemicarpha micrantha*. *Schoenolirion croceum*. *Quercus georgiana*. *Arenaria uniflora*. *Arabis laevigata* var. *missouriensis*. *Draba aprica*. *Oenothera linifolia*. *Diamorpha smallii*. *Portulaca umbraticola*. *Sedum pusillum*. *Lepuropetalon spathulatum*. *Phacelia maculata*. *Amphianthus pusillus*. *Viguiera porteri*. *Aster avitus*.

Dynamics: Well-documented accounts of primary succession on bare rock occur in the literature. Fire is not a factor except perhaps within larger herbaceous micro-communities on the rock itself. Soil mats tend to accumulate organic matter and fragmented rock, and thus expand. This process may be interrupted by windthrown trees. Gneiss soils contain high amounts of iron and aluminum. Both of these elements are characteristic solutes of the typically low-pH water associated with granite. Low pH interferes with the functioning of decay organisms, allowing higher amounts of organic matter to build up than might accumulate on limestone soils, for instance (Balter & Loeb 1983).

Associations: Granitic Dome. Acidic Cliff. Upland forest types, such as Oak-Hickory Forest and Chestnut Oak Forest; transitions are usually rather well-demarcated.

Comments: This is a very specialized community, one that is seriously threatened in South Carolina. Quarrying and recreational activities represent the greatest threats from man.

References: Balter & Loeb 1983. Burbank & Platt 1964. Knox 1974. Oosting & Anderson 1937. Smith 1941.

HEMLOCK FOREST

Type: Terrestrial

Sites: Hemlock-dominated forests on sites slightly less mesic than Cove Forests, usually on steep slopes, high elevation flats, or adjacent to streams.

Location: Mountains.

Vegetation: Predominantly *Tsuga canadensis*, with *Pinus strobus* usually present together with

other Cove Forest canopy, understory and shrub layer species, such as *Betula lutea*, *Rhododendron maximum*, *Kalmia latifolia*, *Euonymus americana*, *Pyrularia pubera*, *Hamamelis virginiana*, *Vaccinium constablei*, and *Leucothoe axillaris*. Herbaceous species are usually few, but may include *Mitchella repens*, *Viola blanda*, *V. rotundifolia*, *Cimicifuga racemosa*, *Medeola virginiana* and *Polystichum acrostichoides*.

Potential elements of concern: *Trillium persistens*. *Isotria medeoloides*. *Triphora trianthophora* on flats adjacent to streams. *Buckleya distichophylla*. *Caulophyllum thalictroides*. *Viola macloskeyi*. *Shortia galacifolia*.

Dynamics: This is presumably a stable community.

Associations: Cove Forest. Drier communities upslope, such as Chestnut Oak Forest.

Comments: The association of hemlock and rhododendron may suppress other species. Boundaries between this and other montane communities are often rather distinct. More variation occurs within these communities in NC, where the presence of *Tsuga caroliniana*, in sufficient abundance and in slightly different ecological settings, has led to suggestions on further division of these community types. Some examples of this community tend to have a scattered layer of ericaceous shrubs and a relatively high diversity of herbaceous species; more xeric examples tend to have a thick shrubby layer with a relatively depauperate herb layer.

HIGH ELEVATION SEEP

Type: Palustrine

Sites: Wet places of variable size on granitic rock of Acidic Cliffs and Domes. Hydrology differs widely from site to site, and seasonally at a given seep.

Location: Piedmont and mountains.

Vegetation: This community usually contains a diverse assemblage of bryophytes, ferns and herbs; woody plants are not particularly well represented nor characteristic. Frequently encountered species are *Saxifraga michauxii*, *Helenium autumnale*, *Calamagrostis cinnoides*, *Oenothera fruticosa*, *Chelone lyonii*, *Rudbeckia laciniata*.

Potential elements of concern: *Carex biltmoreana*. *C. prasina*. *Platanthera integrilabia*. *Trautvetteria caroliniensis*. *Sarracenia jonesii*. *Parnassia asarifolia*. *P. grandifolia*. *Saxifraga micranthidifolia*. *Boykinia aconitifolia*. *Oenothera perennis*. *Castilleja coccinea*.

Dynamics: The most highly vegetated High Elevation Seeps are characterized by abundant available sunlight. During dry times of the year these communities may have little water actually moving through them, but they are generally saturated at the soil level all the time.

Associations: Acidic Cliff. Granitic Dome. Spray Cliff.

Comments: These communities are very often quite scenic, even if on a very small scale (due to their patchiness). Very often, a number of Seeps will be separated from each other by stretches of bare rock or forested ground, in association with a larger terrestrial community such as a Granitic Dome. Because of the attraction these sites have for botanists and naturalists, they are in danger of being over-collected and otherwise trampled. However, most of these communities are reasonably isolated and fairly inaccessible.

References: Larson & Batson 1978.

HILLSIDE HERB BOG

Type: Palustrine

Synonym: Seepage Herb Bog.

Sites: Seasonally or permanently saturated slopes on sandhills dominated by many herbaceous species, including grasses, insectivorous plants and orchids that are more commonly considered savannah species.

Location: Fall-line sandhills, possibly entire coastal plain.

Vegetation: Canopy species are usually absent from this community, but potential woody plants are *Liriodendron tulipifera*, *Acer rubrum*, *Liquidambar styraciflua*, *Alnus serrulata*, *Clethra alnifolia* and *Rhus vernix*. Grasses and sedges include *Aristida* spp., *Andropogon virginicus*, *A. gerardii*, *Ctenium aromaticum*, *Scleria triglomerata*, *Rhynchospora* spp., *Fimbristylis* spp. Insectivorous plants are *Sarracenia flava*, *S. purpurea*, *S. rubra*, *Utricularia* spp., *Pinguicula caerulea*, *Drosera* spp. Orchids include *Pogonia ophioglossoides*, *Spiranthes* spp., *Habenaria ciliaris*, *Calopogon barbatus* and potentially other species. Additional showy species include *Tofieldia racemosa*, *Lilium catesbaei*, *Amianthium muscaetoxicum*, *Iris virginica*, *I. tridentata*, *Mayaca fluviatilis*, *Polygala* spp., *Rhexia alifanus*, *R. lutea*, *R. mariana* and *Asclepias rubra*. Other common bog genera include *Sphagnum*, *Osmunda* and *Lycopodium*.

Potential elements of concern: *Aristida spiciformis*. *A. affinis*. Pine-barrens tree frog.

Dynamics: These bogs are probably dependent on fire for maintenance. Shrub invasion from adjacent communities occurs without fire. There may be more artificial representatives of this community type than the "natural" type; construction of gas and power line rights-of-way, and their maintenance, has often resulted in the presence of these bogs.

Associations: Xeric communities uphill and laterally. Bay Forest. Atlantic White Cedar Swamp. Streamhead Pocosin, Seepage Pocosin.

Comments: These probably represent mosaic situations within larger sandhill systems. Their relationship to other communities of the Pocosin "complex" is unclear. The dynamics of these bogs are conceivably largely those of wet pine savannahs (especially the non-canopied "wet

meadows"), but differences between them involve hydrology and topography.

INTERDUNE POND

Type: Lacustrine

Synonym: Marsh Pond (Wharton 1977).

Sites: Permanent or semi-permanent bodies of water located in swales between beach dunes and ridges.

Location: Outer coastal plain, barrier islands.

Vegetation: Many rooted, floating, and/or emergent aquatic species may occur, including *Azolla caroliniana*, *Lemna* spp., *Wolffiella floridana*, *Hydrocotyle bonariensis*, *H. ranunculoides*, *Typha* spp., *Cladium jamaicense*, *Potamogeton diversifolius*, *P. pulcher*, *Nymphaea odorata* and *Nuphar luteum*. *Mikania scandens* is sometimes very abundant at the edges of these ponds.

Potential elements of concern: *Cyperus distinctus*. *Lilaeopsis carolinensis*. American alligator.

Dynamics: These ponds are quite variable from site to site with respect to seasonality of flooding, tidal effects, connection with lagoons, salinity and depth.

Associations: Salt Shrub. Maritime Grassland.

References: Zingmark 1978.

INTERTIDAL BEACH

Type: Marine

Synonym: Sand strand (Oosting 1954).

Sites: Unconsolidated, regularly inundated sands at shoreline.

Location: Outer coastal plain, barrier islands.

Vegetation: Typically none, although sometimes a few species from the associated dunes may be present.

Potential elements of concern: Green sea turtle. Loggerhead turtle. Least tern. Brown pelican. Osprey. Bald eagle.

Dynamics: This is a specialized community, and is quite harsh in many ways. Unstable sands

constantly shift due to tides. The presence in SC of low-energy coastlines at the ocean edge is a possibility, but little is known concerning this.

Associations: Seaward into Unconsolidated Coastal Bottom. Landward, almost always grades into Maritime Grassland. Very narrow beaches may be directly adjacent to Maritime Forest.

Comments: These sites are sometimes destroyed by erosion, whether natural or human-caused. Ghost forests are present in spots where erosion of the beach and dunes has encroached upon the maritime forest present. Undisturbed, or minimally disturbed Intertidal Beaches are typically very rich in animal life. Large invertebrate assemblages may occur, including many crustaceans, annelids and molluscs. Most of the animals present (living on the beach rather than merely feeding there) are "sand-dwellers". The diggers and burrowers collectively make up the "endopsammon". Some of these invertebrate genera are *Arenicola* (polychaete worm), *Balanoglossus* (acorn worm), *Donax* and *Cardium* (clams), *Haustoria*, *Orchestia* and *Talorchestia* (amphipods), *Ocypoda* (ghost crab), *Callinectes* (blue crab), *Oliva* and *Terebra* (snails), *Clibarius* and *Pagurus* (hermit crabs), and *Busycon* (whelk). Many shore bird species (plovers, sanderlings, sandpipers, turnstones, etc.) feed on the shore line. Mammals include foragers such as mice, voles and raccoons. Deer are known to cool themselves off in the surf.

References: Johnson et al. 1974. Pinson 1973. Reise 1985. Wharton 1977. Zingmark 1978.

INTERTIDAL MUD/SAND FLAT

Type: Marine, Estuarine

Synonyms: Mud, sand bar. Mud, sand flat.

Sites: Unconsolidated mud, sand, sediment and silt either separated from ('bar') or continuous with ('flat') permanently emersed land masses. These sites are regularly or irregularly inundated.

Location: Outer coastal plain, barrier islands.

Vegetation: None, except for ephemeral adventives. There is generally not enough time during exposure to allow for rooting of seeds and/or vegetative fragments.

Dynamics: These are often ephemeral sites, especially if located as barrier island associates. They are commonly just below the water while the tide is in, and are usually subject to at least some wave action. While flooded, these sites are characterized by "mega-ripples" and "sandwaves" (Findlay 1981). "Bars" and "flats" are loosely separated by nontechnical features: bars have a steeper slope down to the water edge than do flats. Also, bars are surrounded on all sides by water, whereas a flat will have a connection with some other land mass at the point of highest flooding (i.e. high tide).

Associations: Grades into Unconsolidated Marine Bottom, and often occurs at edges of Salt Marshes in estuaries.

Comments: Findlay (1981) lists organisms common to sand flats: nematodes, copepods, nauplii, gastrotrichs and polychaete worms. Sand and Mud Flat fauna may be strongly structured vertically, with this segregation relieving competition pressures. Grant (1981) lists these crustaceans on sandflats from Debidue Island: *Acanthohaustorius millsi*, *Pseudohaustorius carolinensis* and *Monoculodes edwardsi* (amphipods), and *Cyathura burbancki* (isopod). Bacteria present constitute a major source of food for resident invertebrates.

References: Findlay 1981. Grant 1981. Reise 1985. Zingmark 1978. Zobell & Feltham 1942.

LEVEE

Type: Terrestrial

Synonyms: Blackwater river natural levee, brownwater river natural levee.

Sites: Natural overflow barriers along river channels.

Location: This community occurs parallel to major river systems; sites are especially well-represented on the coastal plain.

Vegetation: *Platanus occidentalis*, *Betula nigra*, *Quercus laurifolia* and *Salix* spp. are the major tree components of this community. Other canopy members include *Quercus michauxii*, *Liriodendron tulipifera*, *Liquidambar styraciflua*, *Fraxinus caroliniana*, *F. tomentosa*, *F. pennsylvanica*, *Carya aquatica*, *C. ovata*, *Acer rubrum*, *A. negundo*, *A. saccharinum*, *Planera aquatica* and *Carpinus caroliniana*. Commonly seen shrubs are *Asimina triloba*, *Crataegus marshallii*, *C. viridis* and *Lindera benzoin*. Herbaceous cover varies extensively from site to site, but usually includes *Uniola latifolia*, *Arundinaria gigantea*, *Microstegium vimineum*, *Boehmeria cylindrica*, and on larger levees, *Podophyllum peltatum* and *Corydalis flavula*.

Potential elements of concern: *Aristolochia tomentosa*. *Euonymus atropurpurea*.

Dynamics: Availability of light allows greater plant diversity and density. These communities are seasonally or periodically flooded, and sometimes destroyed this way. The soil is generally very fertile, especially along alluvial rivers. Blackwater rivers are not expected to have as well-developed levees due to lower amount of alluvium. Much variation occurs among sites with respect to width, relation to adjacent river channel, and species composition.

Associations: Small Stream Forest. Bottomland Hardwoods. Shoal and Stream Bar. Levees of smaller rivers (narrow floodplains) probably grade into adjacent upland forests.

Comments: Braun (1950) identifies "bottomland forest" on the landward side of the levee, and "stream margin" communities on the channel side. Some of the early "Cane Bottoms" in South Carolina were probably associated with large levees; the extensive areas of *Arundinaria* once so widespread are now essentially gone, except for isolated patches, mostly on the piedmont,

References: Braun 1950. Wharton 1977. Wharton et al. 1982.

LIMESTONE SINK

Type: Palustrine

Sites: Irregularly shaped or rounded depressions underlain by limestone, which are seasonally saturated, and with standing water during at least three months of the year.

Location: Coastal plain, especially Orangeburg and Berkeley Counties.

Vegetation: Diverse trees, shrubs and herbs, including *Acer rubrum*, *Pinus taeda*, *Lyonia lucida*, *Alnus serrulata*, *Myrica cerifera*, *Baccharis halimifolia*, *Aristida* spp., *Andropogon* spp., *Rhynchospora* spp., *Carex* spp., *Scirpus* spp., *Limnobium spongia*, *Nymphaea odorata*, *Myriophyllum* spp., and *Lindernia dubia*.

Potential elements of concern: *Scirpus erismanae*. *Amphicarpum muhlenbergianum*. *Lindera melissaefolium*. *Litsea aestivalis*. *Myriophyllum laxum*.

Dynamics: Not completely understood.

Associations: Pine Savannah. Depression Meadow. Upland Pine-Wiregrass Woodland. Pine Flatwoods.

Comments: Limited knowledge is available for this community. Much more field work is necessary, especially concerning the separation of this from Limestone Sinkhole and Depression Meadow.

LIMESTONE SINKHOLE

Type: Terrestrial

Synonyms: Sinkhole.

Sites: Cavities or depressions, extremely variable in exposure and size, associated with partially or completely collapsed limestone-based rock. Outcropped rock is usually present at the ground surface.

Location: Coastal plain, especially Berkeley, Calhoun and Orangeburg Counties.

Vegetation: The amount and diversity of vegetation depends largely on the conditions of the limestone itself. Large sinkholes may provide a great deal of relief, and may be associated with forest systems typical of the surrounding communities. Smaller sinkholes are likely to be drier,

and with less diverse vegetation. Calciphilic shrubs and herbs normally characterize these sites.

Potential elements of concern: *Asplenium resiliens*. *A. heteroresiliens*.

Dynamics: Much variation occurs in size and depth. Limestone walls may be bare or extensively vegetated. Fire is probably rare or lacking. Some sites are quite deep, reportedly up to 70 feet. Conic or cylindric holes may have clear streams associated, sometimes as disappearing spring runs.

Associations: Oak--Hickory Forest. Mesic Mixed Hardwood Forest.

MARINE DEEPWATER

Type: Marine

Sites: Subtidal zone, constantly inundated. No sea-water dilution ever occurs. Bottom composed of consolidated or unconsolidated sand, mud, sediments, shells, shell fragments and other non-living detritus.

Location: Outer coastal plain, barrier islands.

Vegetation: Benthic macrophytes, if present, at a depth which precludes the development of extensive plant and/or animal colonies.

Associations: Seaward into oceanic benthos. Landward, into Unconsolidated Coastal Bottom.

Comments: It has been suggested that insufficient light reaches the bottom to allow much biological diversity. This may be a simplistic idea, however. Depth/light relationship is probably variable from site to site, and may depend on other oceanic or meteorological phenomena. More research is needed; it is not anticipated that high priority values will be assigned to this community.

References: Zingmark 1978.

MARITIME FOREST

Type: Terrestrial

Synonyms: Maritime live oak forest (Bordeau & Oosting 1959). Salt spray climax (Wells 1939). Mature live oak hammock (Laessle & Monk 1961). Maritime closed dunes (Rayner & Batson 1976). Maritime strand forest, upland maritime strand forest (Wharton 1977).

Sites: Forests behind dunes on mainland and barrier islands, characterized by slow-growing, evergreen, salt-tolerant species.

Location: Outer coastal plain, barrier islands.

Vegetation: Canopy species include *Quercus virginiana*, *Q. laurifolia*, *Magnolia grandiflora*, *Pinus taeda*, *P. elliotii* and *P. palustris*. Understory plants include *Juniperus silicicola*, *J. virginiana*, *Sabal palmetto*, *Ilex opaca*, *Persea borbonia*, *Myrica cerifera*, *Ilex vomitoria*, *Lyonia ferruginea*, *Osmanthus americana* and *Baccharis halimifolia*. *Rhus radicans*, *Cnidocolus stimulosus*, *Mitchella repens*, *Houstonia procumbens*, *Opuntia compressa*, *Passiflora incarnata*, *P. lutea*, *Scleria triglomerata* and *Stipa avenacea* are frequently seen as members of the herbaceous cover, which is often rather depauperate.

Potential elements of concern: *Agrimonia incisa*. *Sageretia minutiflora*. *Cynanchum scoparium*.

Dynamics: Prevalence of high wind induces shearing effect on the most exposed shrubs at the seaward edges of this community, causing gradual merger (usually) with the forest proper. Much potential exists for the subdivision of this community based on cover type. Fire is uncommon; there is generally not enough material on the ground to provide very hot fires. Forests with abundant palmettos will burn more frequently. In general, *Sabal palmetto* is quite fire-resistant once it acquires some height. Severe erosion destroys dune systems and adjacent forests, producing 'ghost forests' at the beach line itself. Laessle & Monk (1961) suggest that more mesic species would move in successionaly, but are probably eliminated by fire. These mesic species are probably capable of tolerating more salt spray than is commonly thought, but the poor, dry soils of the Maritime Forests contribute to their exclusion. Maritime forests may be destroyed by shifting dunes.

Associations: Maritime Shrub Thicket. Salt Shrub. Dune Grassland.

Comments: A large amount of site-to-site variability occurs within this community, Various ideas have been proposed to separate out smaller community types. A rather convincing argument is that of separating barrier-island maritime forests from those found on the mainland, based largely on the differences in vegetational diversity found between them. Mainland forests have much more species diversity than those on the barrier islands, which must deal with the most severe conditions (very high wind, salt-spray, etc.). Hammock-like islands of vegetation identical to Maritime Forest communities may be situated well away from the influence of the ocean within marsh systems. A number of possible subtypes of this community have been suggested for SC.

References: Boyce 1954. Burk 1962. Doult 1941. Johnson et al. 1974. Laessle & Monk 1961. Rayner & Batson 1976. Wells 1939.

MARITIME GRASSLAND

Type: Terrestrial

Synonyms: Dune grassland. Interdune swales. Dune meadow.

Sites: Xeric grassland (grasses, herbs and vines) on tops of stable or shifting dunes and ridges that are well-elevated above highest flood mark, plus intermittently xeric/mesic sites behind foredunes and between adjacent (parallel) backdunes farther inland.

Location: Outer coastal plain, barrier islands.

Vegetation: Various tussock-forming and for rhizomatous grasses, especially *Uniola paniculata*, characterize this community. Other grass species include *Panicum amarum*, *Spartina patens*, *Cenchrus tribuloides*, *Andropogon* spp. and *Triplasis purpurea*. Herbs frequently seen on the seaward margins of this community are *Cakile harperi*, *Salsola kali*, *Heterotheca subaxillaris*, *Erigeron canadensis*, *Sesuvium portulacastrum*, *Atriplex arenaria*, *Ipomoea stolonifera*, *Hydrocotyle bonariensis* and *Oenothera humifusa*. A rather diverse group of shrubs and herbs occurs together behind the seaward dunes, including some from the Maritime Shrub Thicket. Possible species here include *Myrica* spp., *Yucca* spp., *Xanthoxylum clava-herculis*, *Iva imbricata*, *Bumelia tenax*, *Lycium carolinianum*, *Euphorbia polygonifolia*, *Croton punctatus*, *Physalis viscosa*, *Dichromena latifolia*, *Fimbristylis* spp., *Eleocharis* spp., *Scirpus* spp., *Cyperus* spp., *Lippia nodiflora*, *Sabatia stellaris*, *Smilax* spp., *Vitis rotundifolia* and *Solidago sempervirens*.

Potential elements of concern: *Muhlenbergia filipes*. *Amaranthus pumilus*. *Paronychia floridana*. *Ipomoea macrorhiza*. *Heterotheca floridana*. Glass lizard. Sea turtles (nesting sites). Brown pelican.

Dynamics: This community is probably not affected by fires, or only rarely. Sand may be strongly leached of salt. The effects of overwashing and erosion are most noticeable following severe storms. Maritime Grassland will conceivably develop in old outwash spots. This community is easily characterized as a harsh environment, with full sun, deep sand, salt spray and high wind affecting the organisms present. Beach erosion may destroy the dunes; overwash activity and "blow-outs" occur.

Associations: Interdune Ponds may be present. Dune Grassland. Maritime Shrub Thicket.

Comments: The presence of a large number of shrub species has been used to differentiate the interdune swales from the leading edges of the dunes, which are dominated by non-woody plants.

References: Celosi and McCormick 1978. Johnson et al. 1974. Oosting 1945. Oosting and Billings 1942. Pinson 1973. Wagner 1964. Zingmark 1978.

MARITIME SHRUB THICKET

Type: Terrestrial

Synonyms: Wax myrtle thicket (Sharitz 1975). Temperate coastal strand (Florida Natural Areas Inventory Classification). Interdune type, in part (Wharton 1977).

Sites: Shrubby zones in upland areas (tops of stabilized dunes, edges of maritime forests). Trees are absent.

Location: Outer coastal plain, barrier islands.

Vegetation: A variety of salt-tolerant shrubs occurs, especially *Myrica cerifera*, *Ilex vomitoria*, *Iva imbricata*, with perhaps *Sabal minor*, *S. palmetto* (rarely), and *Serenoa repens*. *Quercus geminata* may be present. Vines may include *Vitis rotundifolia*, *Rhus radicans*, *Berchemia scandens*, *Lonicera japonica*, *Smilax* spp., *Parthenocissus quinquefolia* and *Passiflora incarnata*.

Potential elements of concern: *Sageretia minutiflora*. *Cynanchum scoparium*.

Associations: Maritime Forest. Maritime Grassland.

Comments: This community is closely related to Salt Shrub, but differs in: (1) hydrology - maritime shrub is never flooded, (2) location - seaward of maritime forest rather than landward, (3) no wind-pruning in Salt Shrub community. Maritime Shrub Thickets imperceptibly grade into Maritime Forest, especially at tops of dunes where most shearing takes place, producing stunted shrubby growth. Stalter (1984) suggests that "Maritime Shrub" and "Salt Shrub" make up a single community. Eleuterius (1972) refers to a shrub zone "normally on a sharp rise from the marsh to the terrestrial habitat of trees", although this seems referable to the Salt Shrub community.

References: Boyce 1954. Eleuterius 1972. Sharitz 1975. Wharton 1977.

MARL FOREST

Type: Terrestrial

Synonyms: Calciphyte forest.

Sites: Forested areas over buried or exposed marl.

Location: Coastal plain; very rare.

Vegetation: A diverse assemblage of trees, shrubs and herbs is present, many of which are thought to be calciphilic, including *Cercis canadensis*, *Tilia americana*, *Ulmus rubra*, *Quercus shumardii*, *Juniperus virginiana*, *Cornus florida*, *C. asperifolia*, *Thelypteris kunthii*, other ferns, *Elytraria carolinense*, *Peltandra virginica* and *Echinodorus cordifolius*. Herbaceous cover is sometimes sparse on exposed outcrops.

Potential elements of concern: *Asplenium heteroresiliens*. *A. resiliens*. *Carya myristicaeformis*.

Menispermum canadense.

Dynamics: Incompletely known. Fire is probably not common.

Associations: Calcareous Cliff. Spruce Pine--Mixed Hardwood Forest.

Comments: This is apparently a very rare community in South Carolina, and the few remaining known sites are probably in danger of being developed. Bartgis & Long (1984) report on wetland marl areas in West Virginia, but these do not seem to share much in common with the South Carolina forests.

References: Bartgis & Long 1984.

MESIC MIXED HARDWOOD FOREST

Type: Terrestrial

Synonyms: Piedmont cove forest. Beech ravine.

Sites: Forested slopes and ravines.

Location: Piedmont (steep north-facing slopes and ravines associated with acidic rock) and coastal plain (mesic uplands, especially on north-facing river bluffs and ravine slopes).

Vegetation: Canopy and understory is variously composed of many hardwoods including *Fagus grandifolia*, *Liriodendron tulipifera*, *Nyssa sylvatica*, *Oxydendrum arboreum*, *Quercus alba*, *Q. rubra*, *Q. velutina*, *Liquidambar styraciflua*, *Acer rubrum*, *A. saccharum* (piedmont), *Tilia heterophylla* (piedmont), *T. floridana* (coastal plain), *Carpinus caroliniana*, *Cornus florida*, *Ilex opaca*, *Hamamelis virginiana* and *Ostrya virginiana*. Shrubby species are usually numerous, and include *Symplocos tinctoria*, *Styrax grandifolia*, *Kalmia cuneata*, *Calycanthus floridus* and *Rhododendron nudiflorum*. The herbaceous flora is fairly rich, with many spring ephemerals especially in piedmont sites. Potential members of the herbaceous layer include *Goodyera repens*, *Chrysogonum virginianum*, *Hieracium venosum*, *Uvularia perfoliata*, *Spigelia marilandica*, *Mitchella repens*, *Podophyllum peltatum*, *Sanguinaria canadensis* and *Iris cristata*.

Potential elements of concern: *Trichomanes petersii*. *Triphora trianthophora*. *Quercus durandii*. *Actaea pachypoda*. *Waldsteinia lobata*. *Panax quinquefolium*.

Dynamics: This is a stable community, apparently burning only very rarely. It may be difficult or impossible to recognize a single dominant in the canopy.

Associations: Oak-Hickory Forest.

Comments: The beech-dominated "cove" forests of the piedmont may owe their presence to soil type rather than exposure. If so, it makes some sense to consider their inclusion within Basic

Forest. Braun (1950) lists the following species from a Pender County (NC) site: *Fagus grandifolia*, *Carya tomentosa*, *Quercus alba*, *Acer floridanum*, *Liriodendron tulipifera*, *Liquidambar styraciflua*, *Quercus velutina*, *Carya pallida*, *Ilex opaca*, *Castanea pumila*, *Asimina parviflora*, *Hamamelis virginiana*, *Ilex glabra*, *Euonymus americana*, *Vaccinium arboreum* and *Callicarpa americana*. Oosting (1942) indicates *Fagus* as part of the "Postclimax" forest. In general, the Mesic Mixed Hardwood Forests seem vegetatively similar to a number of other forest communities. These sites often appear quite rich, at least initially, but usually do not have any rare plant species associated with them.

References: Braun 1950. Nesom & Treiber 1977. Oosting 1942.

MIDDENS

Type: Terrestrial

Synonyms: Indian middens. Kitchen middens. Shell mounds.

Sites: Natural or man-related accumulations of shell material and detritus in marshes and at tips of landmasses within estuaries.

Location: Outer coastal plain.

Vegetation: This community may support a number of shrub and herb species, especially calciphiles. Various members of the Salt Shrub and Maritime Forest communities are likely to be present. These sites frequently have *Quercus virginiana*, *Sabal palmetto*, *Aesculus pavia*, *Prunus caroliniana*, along with *Juniperus virginiana*, *Ilex vomitoria*, *Rhus radicans*, *Callicarpa americana*, *Tilia heterophylla*, *Zanthoxylum clava-herculis*, *Cynanchum palustre* and *Celtis laevigata*.

Potential elements of concern: *Sageretia minutiflora*. *Lycium carolinianum*. *Bumelia tenax*. *Cynanchum scoparium*.

Dynamics: Fire is probably rare. Piles of shells naturally occurring, however small they (the piles and the shells) might be, would arguably have the same flora/fauna and dynamics as the recognizable middens of Indian origin. Some middens of Indian origin are of distinctive shapes, often round or ringshaped. Middens are particularly distinctive when surrounded by Salt Marsh or Salt Shrub.

Associations: Salt Shrub. Maritime Forest.

Reference: Dorroh 1968.

MONTMORILLONITE FOREST

Type: Terrestrial

Sites: Upland slopes or flat areas over basic rock, with clay soil becoming very hard during drought.

Location: Piedmont, probably restricted to York, Chester, Union and Fairfield Counties, and possibly McCormick, Abbeville and Greenwood.

Vegetation: A thin to dense canopy occurs, including *Juniperus virginiana*, *Pinus echinata*, *P. taeda* (infrequent), together with a number of hardwoods, including *Quercus phellos*, *Q. velutina*, *Q. stellata*, *Q. nigra*, *Q. marilandica*, *Ulmus rubra*, *U. americana*, *Cercis canadensis*, *Fraxinus americana*, *Celtis laevigata*, *Acer saccharum*, *Prunus serotina*, *Carya tomentosa*, *C. ovalis* and *C. carolinae-septentrionalis*. Species of *Viburnum* and *Crataegus* may contribute to the understory, together with *Ulmus alata* and *Rhamnus caroliniana*, below which *Ceanothus americanus* may be expected. Typical herbs include *Clematis ochroleuca*, *Blephilia ciliata*, *Opuntia compressa*, *Andropogon* spp., *Danthonia spicata*, *Penstemon* spp. and *Hypericum* spp.

Potential elements of concern: *Camassia scilloides*. *Carya carolinae-septentrionalis*. *Scutellaria parvula*. *Silphium terebinthinaceum*.

Dynamics: Not known. Hydrology presumably varies widely over the year.

Associations: Oak-Hickory Forest.

Comments: This is a rare community in SC, frequently associated with Iredell and Elbert soils. Remaining examples of this community are in danger of agriculturalization. It is likely that future field efforts will uncover differences between hydrologic regimes at given sites that may be sufficient to warrant the splitting out of additional communities.

References: Batson 1952. Peet and Christensen 1980.

NON-ALLUVIAL SWAMP FOREST

Type: Palustrine

Synonyms: Non-riverine swamp forest. Swamp hardwoods.

Sites: Poorly-drained lowlands not associated with river channels.

Location: Coastal plain.

Vegetation: A diverse assemblage of canopy and subcanopy species occurs, including a number of components from more easily defined pocosin and alluvial swamp forest systems, such as *Nyssa sylvatica* var. *biflora*, *N. aquatica*, *Taxodium ascendens*, *T. distichum*, *Pinus serotina*, *P. taeda*, *Liquidambar styraciflua*, *Acer rubrum*, *Gordonia lasianthus*, *Magnolia virginiana*,

Quercus michauxii, *Q. phellos*, *Q. laurifolia*, *Liriodendron tulipifera*, *Populus heterophylla* and *Carpinus caroliniana*. Shrubs include *Lyonia lucida*, *Persea borbonia*, *Cyrilla racemiflora*, *Cephalanthus occidentalis*, *Lindera benzoin* and *Itea virginica*. Herbs include *Osmunda regalis*, *O. cinnamomea*, *Saururus cernuus*, *Tovara virginiana*, *Boehmeria cylindrica* and *Peltandra virginica*. Sphagnum moss is sometimes abundant. Viny species are often abundant, and include *Smilax* spp., *Rhus radicans*, *Vitis* spp., *Decumaria barbara* and *Bignonia capreolata*, combinations of which may form dense bowers.

Potential elements of concern: *Psilotum nudum*. *Carex prasina*. *C. projecta*. *Cliftonia monophylla*. *Nyssa ogeche*. *Physostegia leptophylla*. Swallow-tailed Kite. Black bear.

Dynamics: Largely unknown. These apparently share some community dynamics, both physical and biological, with pocosins and alluvial swamps.

Associations: Pocosin. Pond Pine Woodland. Bald Cypress-Tupelo Gum Swamp. Bottomland Hardwoods. Swamp Tupelo Pond.

Comments: More field work is needed on this community type; its variability, community structure and successional features are poorly understood.

OAK--HICKORY FOREST

Type: Terrestrial

Sites: Upland slopes, especially north-facing on the piedmont, dominated by a diverse assemblage of hardwoods (primarily oaks and hickories) in combination with pines.

Location: Essentially throughout the state; on lower elevations within mountains. Within the coastal plain on upland slopes between rivers and tributaries.

Vegetation: Many hardwoods are present, with oaks and hickories the codominants. Typical canopy and subcanopy species are *Quercus alba*, *Q. velutina*, *Q. rubra*, *Q. marilandica*, *Q. stellata*, *Q. coccinea*, *Q. prinus* (piedmont & mountains), *Carya tomentosa*, *C. glabra*, *C. ovata*, *Acer rubrum*, *Cornus florida*, *Liriodendron tulipifera*, *Pinus taeda*, *P. echinata*, *P. virginiana* (mountains), *P. strobus* (mountains), *Nyssa sylvatica*, *Robinia pseudo-acacia* and *Oxydendron arboreum*. A high predominance of pines and sweet-gum generally indicates past disturbance. The understory includes *Oxydendron arboreum* and *Cornus florida*. Shrubby species include *Euonymus americana*, *Calycanthus floridus*, *Viburnum* spp., *Symplocos tinctoria* and *Vaccinium* spp. The herbaceous layer varies considerably from site to site, but may include *Cypripedium acaule*, *Tipularia discolor*, *Chimaphila maculata*, *Goodyera pubescens*, *Desmodium nudiflorum*, *Rhynchosia tomentosa*, *R. reniformis*, *Stylosanthes biflora* and other species.

Potential elements of concern: *Oryzopsis canadensis*. *Liparis liliifolia*. *Magnolia pyramidata*. *Halesia parviflora*. *Forestiera ligustrina*. *Frasera carolinensis*. *Solidago bicolor*.

Dynamics: All of these sites are somewhat transitional. Fire is probably only occasional to rare. Suppression of fire leads to a greater domination by hardwoods. Shade intolerance keeps "poor site" species out of "good sites". Drought intolerance keeps "good site" species out of "poor sites".

Associations: Many upland forest types.

Comments: This is an abundantly distributed community with much variation from site to site. Very good examples are probably rare, due to forestry, but the community itself is probably not particularly endangered. Some problems exist in attempting to separate this community from some adjacent forest types. Also, the wide variation seen within this community has prompted some to further subdivide it into "dry" and "mesic" subtypes. Obviously, the amount of soil moisture present from site to site weighs heavily in this usually subjective determination. The "poorest" Oak-Hickory Forests are usually typified by blackjack and post oaks (Nehmeth 1968).

Reference: Nehmeth 1968.

OYSTER REEF

Type: Estuarine, Marine

Synonyms: Intertidal oyster reef. Mollusk reef. Oyster rock.

Sites: Living and nonliving portions of structure formed by oysters, together with sponges, marine worms, and whatever macrophytic algae may be present. Located on top of (presumably) dead reef base, all of which is formed on a more or less consolidated surface. Many of the reefs of both Carolinas are composed of Trent marl, in which the dominant fossil is *Venus gardeneri* (Williams 1951).

Location: Outer coastal plain, barrier islands.

Vegetation: Algae.

Animal life: Dominant bivalves are *Crassostrea virginica*, *Brachidontes exustus*, *Geukensia demissa*. *Melita nitida* (amphipod). *Balanus eburneus* (barnacle). *Panopeus*, *Eurypanopeus* (predatory crustaceans). *Amphitrite ornata*, *Heteromastus filiformis*, *Nereis succinea*, *Phyllodocea fragilis* (polychaetes). All of these organisms are common to reefs of NC, SC and GA.

Dynamics: Reefs may or may not be exposed at low tide. The reefs themselves are quite diverse, if unaffected by pollution, with various invertebrate assemblages. Some of these invertebrates utilize shell surface and inter-shell crevices as habitats. Reefs in SC are mostly found within Tidal Creeks and bordering Salt Marshes. Farther south (GA), most reefs are strictly subtidal and farther offshore.

Associations: Generally with distinct boundaries, although oysters can occur in small patchy groups on Intertidal Sand and Mud Flats, Seagrass Beds and edges of Salt Marsh.

Comments: Important community economically.

References: Dame 1971. Dame 1979. Lawrence 1971. Williams 1951. Zingmark 1978.

PIEDMONT SEEPAGE FOREST

Type: Palustrine

Sites: Essentially saturated flat areas with closed canopy and distinctive herbaceous flora.

Location: Upper piedmont.

Vegetation: Canopy of *Acer rubrum*, *Nyssa sylvatica* var. *biflora* and other hardwoods. Shrubs include *Viburnum cassinoides*, *Cornus stricta* and *Rhus vernix*. Herb layer includes many grasses and sedges.

Potential elements of concern: *Carex baileyi*. *Sagittaria fasciculata*. *Hexastylis naniflora*. *Cornus racemosa*. *Helenium brevifolium*.

Dynamics: This community is characterized by a nearly constant seepage of cool ground water. The ground thus tends to be saturated year-round, and so separates this community from temporarily wet spring seeps, which are found essentially throughout the state.

Associations: Forested communities.

Comments: Much more information is needed concerning this rare community.

PINE FLATWOODS

Type: Terrestrial

Synonym: Upland Pine-Wiregrass Woodland, in part.

Sites: Essentially flat or rolling terrain with canopy of pines and well-developed subcanopy of several tall shrub species. The soil is generally sandy and with a high water table.

Location: Coastal Plain.

Vegetation: *Pinus palustris* (most frequently encountered pine), *P. taeda* and *P. elliotii* are all possible. Understory and shrub layers include *Liquidambar styraciflua*, *Quercus marilandica*, *Magnolia virginiana*, *Gordonia lasianthus*, *Ilex glabra*, *I. coriacea*, *Myrica cerifera*, *M. inodora*, *Lyonia* spp., *Gaylussacia dumosa*, *Kalmia hirsuta*, *Vaccinium tenellum*, *Cyrilla racemiflora*,

Viburnum nudum and *Quercus pumila*. Herbaceous layer is dominated by grasses, notably *Andropogon*, *Aristida*, with *Rhexia* spp., *Pycnanthemum flexuosum*, *Chaptalia tomentosa*, *Aster paludosus*, *A. squarrosus*, *A. tortifolius*, *Ctenium aromaticum*, *Helianthus angustifolius*, *H. radula* and *Pteridium aquilinum*, *Pterocaulon pycnostachyum*, *Tephrosia virginica* and *T. spicata*.

Potential elements of concern: *Anthaenantia rufa* (most likely to be found in ecotones between flatwoods and adjacent savannahs). *Eriocaulon ravenelii*. *Polygala nana*. *Pycnanthemum nudum*. *Schwalbea americana*. *Dyschoriste humistrata*. Red-cockaded woodpecker.

Dynamics: Fire frequent, but probably not as frequent as in savannah. Flatwoods are successional from "cropland abandonment" in upper coastal plain (Christensen 1979). If left unburned, would probably succeed to deciduous hardwood-dominated forests.

Associations: Commonly grades into Pine Savannah. "The distinction between flatwoods and savannas is, to a certain extent, artificial" (Christensen 1979).

References: Braun 1950. Christensen 1979. Heyward 1939.

PINE-OAK HEATH

Type: Terrestrial

Synonyms: A number of phases of subtypes are recognized in the old SC system. Pine leads (Cooper 1963).

Sites: Forests on higher ridgetops with open canopy of stunted pines and oaks.

Location: Upper piedmont and mountains.

Vegetation: Mostly pines and oaks, including *Pinus virginiana*, *P. pungens*, *P. rigida*, *P. echinata* (lower elevations). *Quercus prinus*, *Q. coccinea* and *Q. velutina* as possible canopy members. *Castanea dentata* occurs as stumpsprouts. *Kalmia latifolia*, *Rhododendron minus*, *Gaylussacia dumosa*, *G. ursina*, *G. baccata*, *Vaccinium arboreum*, *V. stamineum* and *V. atrococcum* contribute to the subcanopy and shrub layers. Herbaceous flora is sparse.

Potential elements of concern: *Xerophyllum asphodeloides*. *Gaultheria procumbens*. *Fothergilla major*.

Dynamics: This community may succeed to more closed hardwood systems. Southwest or south-southwest exposures are usually necessary for the best development of pines.

Associations: Chestnut Oak Forest. Hemlock Forest. Granitic Dome.

Comments: *Pinus pungens* is found at the highest elevations, with *P. rigida* and *P. virginiana*

below (and in that order). Slightly less xeric slopes, below the ridgetops, are often dominated by dense stands of *Kalmia latifolia* and *Rhododendron minus*. This represents an essentially treeless variant of Pine-Oak Heath which is closely associated with Rhododendron Thicket and Chestnut Oak Forest, and may warrant separation as a distinctive community.

References: Cooper 1963. Racine 1966.

PINE SAVANNAH

Type: Palustrine

Synonyms: Open savannah (in part), wet prairie, grass-sedge bog, herb bog, pitcher-plant bog.

Sites: Flat areas with thin canopy of pines, thin or no understory, and rich herbaceous flora.

Location: Outer coastal plain, rare on inner coastal plain.

Vegetation: Canopy of pines, almost always *Pinus palustris*, but *P. taeda* and *P. serotina* are possible. The understory is essentially absent or very scattered. Herbaceous flora consists of many grasses and sedges (especially *Aristida* spp., *Ctenium aromaticum*, *Anthaenantia rufa*, *Scleria* spp., *Rhynchospora* spp.), insectivorous plants (*Sarracenia flava*, *S. minor*, *Drosera* spp., *Pinguicula caerulea*, *Utricularia* spp.) and orchids (*Cleistes divaricata*, *Calopogon* spp., *Platanthera* spp., *Spiranthes* spp.).

Potential elements of concern: *Sporobolus teretifolius*. *Calamovilfa brevipilis*. *Habenaria quinqueseta*. *Spiranthes longilabris*. *Platanthera integra*. *P. lacera*. *Xyris brevifolia*. *Syngonanthus flavidulus*. *Parnassia caroliniana*. *Asclepias pedicellata*. Flatwoods salamander.

Dynamics: Fire-maintained. Without fire, succeeds to closed canopy systems, starting with pine flatwoods. The ground is saturated for at least part of the year.

Associations: Pine Flatwoods. Bay Forest. Pocosin. Includes "Open Savannah". These open places are floristically the richest spots of the pine savannahs (at least as far as the herbaceous species go); however, their dynamics are essentially the same as those of the canopied regions. Arguments for the separation of open vs. closed savannahs include: Open savannah consistently without canopy, with wettest ground, and with richest herb coverage. Argument against the separation involves the small patchy nature of the open savannah, plus its presence next to the canopied savannah. "Oak Savannah" has been separated in the past as a distinctive community. Again, these are generally patchy, small areas within the Pine Savannahs that appear to have slightly different dynamics, and a correspondingly different canopy (of post oaks). Until more information comes in on these sites, Oak Savannah will be retained as a part of the larger Pine Savannah.

Comments: Blue Ash-Oak Savannah of Kentucky (Bryant et al. 1980) is not the same as the "oak savannah" entity in SC. Our oak savannahs appear on ridges within wetter pine savannahs,

and are dominated by oaks (especially *Q. marilandica*, *Q. stellata*) and hickories.

References: Braun 1950. Bryant et al. 1980. Christensen 1979. Dyksterhuis 1957. Gaddy 1982. Wells 1942. Wells & Shunk 1928. Wharton 1977.

PINE-SAW PALMETTO FLATWOODS

Type: Terrestrial

Synonym: Saw-palmetto flatwoods.

Sites: Pine flatwoods dominated by *Pinus palustris*, *P. elliotii* or occasionally *P. serotina*. Low shrub layer dominated by *Serenoa repens*.

Location: Outer coastal plain (Jasper, Beaufort Counties).

Vegetation: A thin to dense canopy of *Pinus palustris*, *P. elliotii*, and/or *P. serotina* occurs. Subcanopy is usually sparse, but *Ilex coriacea*, *I. glabra* are present, with perhaps some other flatwoods shrub species. *Serenoa repens* is probably best thought of as a tall ground cover. The herbaceous flora is usually sparse, but with *Smilax pumila*, *Trilisa paniculata*, *T. odoratissima*, etc.

Potential elements of concern: *Lyonia ferruginea*. *L. fruticosa*.

Dynamics: Fire is definitely a factor in the maintenance of this community. Suppression of fire leads to invasion of shrubs, as in the more typical Pine Flatwoods. Probably occasionally flooded, or at least saturated.

Associations: Pine Flatwoods. Pine Savannah. Maritime Forest.

Comments: This community much more common along Atlantic Coast in both Georgia and Florida, where it is more frequent and more variable.

References: Allen 1956. Braun 1950. Waggoner 1973.

PINE-SCRUB OAK SANDHILL

Type: Terrestrial

Synonyms: Xerophytic deciduous forest (Pessin 1933). Clay ridge forest (Wharton 1977). Blackjack oak-milkpea association (Bozeman 1971). Scrub oak barren (Duke 1961).

Sites: Flat or hilly terrain on lower or middle slopes of sandhills, or on sandhills with relatively high amounts of organic matter, or on higher spots with more moisture.

Location: Fall-line, and scattered throughout coastal plain.

Vegetation: A canopy of *Pinus palustris* occurs, with an increasing percentage of scrub oaks, especially *Quercus marilandica*, *Q. incana*, *Q. stellata* and *Q. margareta*. *Quercus laevis* is of less importance here than in Xeric Sandhill Scrub. Shrubs present include *Vaccinium stamineum* and other species, as well as *Gaylussacia dumosa*. Grasses are present as ground cover; *Andropogon* and *Aristida* usually dominate. Other herbs include *Tephrosia virginiana*, *Liatris* spp., *Epigaea repens* and *Pteridium aquilinum*.

Potential elements of concern: *Nolina georgiana*. *Pyxidantha barbulata*. *Rhus michauxii*. *Ruellia carolinensis*. *R. ciliosa*. *Chrysopsis pinifolia*. Red-cockaded woodpecker.

Dynamics: Fire is probably not as frequent as in Xeric Sandhill Scrub. *Quercus marilandica* is usually thought to be a less xeric species than *Q. laevis*. Evidence suggests that the distribution of *Q. marilandica* is not so dependent on water as it is on a sufficiently organic component of the otherwise sterile sandy soil.

Associations: Upward to (usually) Xeric Sandhill Scrub. Swale Pocosin, Seepage Pocosin, Streamhead Pocosin.

References: Bozeman 1971. Braun 1950. Christensen 1979. Duke 1961. Pessin 1933. Wharton 1977.

POCOSIN

Type: Palustrine

Synonyms: Low pocosin. High pocosin. Evergreen shrub thicket.

Sites: Flat or depressed sites, intermittently flooded or saturated, and dominated by a number of evergreen shrub species.

Location: Sandhills and coastal plain.

Vegetation: The canopy may vary greatly in composition and height, and almost always includes some of these species: *Pinus serotina*, *P. palustris*, *P. taeda* (the last two as minor components), *Acer rubrum*, *Magnolia virginiana*, *Liquidambar styraciflua* and *Gordonia lasianthus*. A real "canopy" of tall trees may be absent, however; some of the above listed species may be present as tall, much-branched shrubs. A well-developed shrub layer of various ericaceous species, such as *Lyonia lucida*, *Leucothoe racemosa*, *Zenobia pulverulenta*, *Cassandra calyculata*, *Vaccinium corymbosum*, *V. atrococcum*, *Rhododendron viscosum*, as well as *Cyrilla racemiflora*, *Clethra alnifolia*, *Myrica cerifera*, *Ilex glabra*, *I. coriacea*, *Persea borbonia*, *Rhus vernix* and *Sorbus arbutifolia* occurs. Viny species: *Rhus radicans*, *Vitis* spp., *Smilax* spp., especially *S. laurifolia*. Herbaceous flora is usually sparse. At some sites, however,

variously-sized wet depressions or pools may harbor more herbaceous diversity. A number of *Sphagnum* species may be found in Pocosins.

Potential elements of concern: *Syngonanthus flavidulus*. *Peltandra sagittaefolia*. *Tofieldia tenuifolia*. *Nartheceum americanum*. *Lindera subcoriacea*. *Kalmia cuneata*. *Lysimachia asperulifolia*. *Asclepias pedicellata*. *Ruellia pinetorum*. (All of these species may be thought of as preferring ecotones between pocosins and adjacent communities; they are most likely to be found at pocosin margins.) Black bear.

Dynamics: This is a fire-maintained community. The absence of fire leads to increase in number and diversity of tree species. "Low Pocosin" is found on substrate with very deep peat, while "High Pocosin" is found on shallower peats. Increased depth of peat inhibits root growth and results in short, shrubby vegetation, essentially without an arboreal canopy. Practically all species within this community will sucker-sprout vigorously following fire or other natural disturbance.

Associations: Pine Flatwoods. Upland Pine-Wiregrass Woodland. Bay Forest. Atlantic White Cedar Swamp. Sometimes merges gradually with sandhill communities.

Comments: The vegetation list above includes species that may be found practically anywhere on the coastal plain, and in some widely varying situations.

POND CYPRESS POND

Type: Palustrine

Synonym: Cypress dome (Wharton 1977).

Sites: Elliptical, circular or irregularly-shaped lowland with canopy dominated by *Taxodium ascendens*; generally with some water on the surface throughout the year.

Location: Sandhills and coastal plain.

Vegetation: *Taxodium ascendens*, *Nyssa sylvatica* var. *biflora* are the overwhelming canopy dominants. The latter may be practically absent, however. Shrubs include *Ilex cassine* var. *myrtifolia*, *Cephalanthus occidentalis*, and *Cyrilla racemiflora*. Herbs are very often limited to species that can root on floating logs or stumps, such as *Boehmeria cylindrica*, *Hypericum* spp., *Eupatorium* spp.

Potential elements of concern: *Litsea aestivalis*. *Sabatia bartramii*.

Dynamics: Fire is probably not an important factor except in periods of severe drought; its absence may eventually lead to domination by swamp tupelo. Floating logs and stumps provide sites for a number of species usually found in drier areas. Various sites are known locally as "domes". Those associated with Carolina Bays are usually without an easily recognizable dome-

like appearance.

Associations: Pocosin. Cypress Savannah. Pine Savannah. Swamp Tupelo Pond.

Comments: This community is important as breeding habitat for many birds, including egrets, ibises, herons and perching birds, as well as for a number of amphibians. Owls are commonly seen in Pond Cypress Ponds. These sites are sometimes utilized by waterfowl as stop-over points during migration.

References: Wharton 1977. Ewel & Mitsch 1978. Mitsch & Ewel 1979.

POND CYPRESS SAVANNAH

Type: Palustrine

Sites: Flat, poorly drained land with canopy of *Taxodium ascendens*. General aspect is as in pine savannah, but seasonally much wetter.

Location: Coastal plain.

Vegetation: *Taxodium ascendens* forms a canopy which is usually rather open. *Nyssa sylvatica* var. *biflora* and *Acer rubrum* may also be present. Few shrub species occur other than *Ilex cassine* var. *myrtifolia*, some woody Hypericums, *Cephalanthus occidentalis* and *Diospyros virginiana*. Herbaceous flora is often quite rich, with many showy species (*Rhexia* spp., *Ludwigia* spp., *Iris* spp. *Bartonia paniculata*, *Burmammia biflora*, *Boltonia caroliniana*, etc.) blooming throughout spring, summer and fall.

Elements of concern: *Rhynchospora tracyi*. *Scleria baldwinii*. *Spiranthes longilabris*. *S. laciniata*. *Croton elliotii*. *Oxypolis canbyi*. *Hypericum nitidum*. *Rhexia aristosa*. *Lobelia boykinii*.

Dynamics: Some of these sites may have a rather stunted canopy of cypress, resembling the more extensive dwarf cypress habitats of north Florida. Cypressess apparently tolerate a longer hydroperiod than do pines. Ditching and draining efforts, along with absence of fire, has greatly reduced the number of Cypress Savannahs in South Carolina, as well as Pine Savannahs.

Associations: Bay Forests. Pocosins. Pine Savannah. Depression Meadow.

Comments: Rarities in these communities are not the same as those known from Pine Savannahs. Many of the best remaining examples of this community are within Carolina bays.

References: Christensen 1979. Gaddy 1982. Mitsch & Ewel 1979.

POND PINE WOODLAND

Type: Palustrine

Synonym: Pond pine forest.

Sites: Forested peatlands dominated by *Pinus serotina*, with associated pocosin species.

Location: Coastal plain.

Vegetation: A variable canopy is formed by *Pinus serotina*, *Gordonia lasianthus*, *Chamaecyparis thyoides*, *Acer rubrum* and *Magnolia virginiana*. Shrub species present are the same ones found in Pocosins, but they are usually much taller.

Potential elements of concern: *Peltandra sagittaeifolia* (within interior pools). *Kalmia cuneata* (most likely at margins, in ecotonal areas). Black bear.

Dynamics: This is a fire-maintained community, closely related to Pocosin. Dynamics for sites in South Carolina are not completely known; more field work is necessary. Presumably, peat soil is deeper than for pocosin. Severe fires probably result in the formation of semi-permanent pools on the surface. As in the Pocosins, most of these species re-sprout very vigorously following fires. Sites are usually difficult to walk through, which may be one reason that more is not known about them.

Associations: Pocosin. White Cedar Swamp. Bay Forest. Seepage Pocosin.

RHODODENDRON THICKET

Type: Terrestrial

Synonym: Streamside thicket.

Sites: Usually thick, shady, shrub-dominated areas at edges of streams.

Location: Mountains and upper piedmont.

Vegetation: Dominated by *Rhododendron maximum*. Associated shrub species are *Leucothoe axillaris*, *Kalmia latifolia*, *Xanthorrhiza simplicissima*, *Pyrolaria pubera*. Herbaceous flora is sparse to non-existent.

Potential elements of concern: *Trillium persistens* (in ecotonal areas with substantial sunlight).

Dynamics: Occasionally to frequently flooded during rainy seasons. Piles of leaf litter and detritus often collect. Dynamics depend to a degree on the size, etc. of the associated stream.

Associations: Shoal & Stream Bar. Chestnut Oak Forest. Hemlock Forest. Cove Forest. Spray cliff.

SALT FLAT

Type: Estuarine

Synonyms: Salt Pan (Eleuterius 1972). Panne (Godfrey & Godfrey 1974). Saltgrass-Glasswort Zone (Duncan 1974).

Sites: Distinct zones of succulent halophytes, salt-loving grasses and other herbs, plus any other adjacent barren ground. Soil is hyper-saline due to evaporation, composed of mud and/or sand.

Location: Outer coastal plain, barrier islands.

Vegetation: This community contains a number of specialized species, including *Distichlis spicata*, *Suaeda linearis*, *Salicornia virginica*, *Limonium carolinianum*, *Chenopodium berlandieri*, *Atriplex patula*, *Aster tenuifolius*, *Spartina* spp. and *Sporobolus virginiana*.

Dynamics: Fire is probably never a factor in community development. Usually one tide per day floods the site.

Associations: Grades into Salt Marsh, Salt Shrub, Maritime Grassland. Barrens may be dissected by intermittent tidal streams.

Comments: These communities are generally associated with drainage systems in salt marshes behind dunes, or on the landward sides of barrier islands.

References: Duncan 1974. Eleuterius 1972. Godfrey & Godfrey 1974. Uphof 1941. Zingmark 1978.

SALT MARSH

Type: Estuarine

Synonyms: Smooth cordgrass marsh. Saltgrass marsh (Wharton 1977).

Sites: Regularly flooded flat areas dominated by salt-tolerant grasses.

Location: Outer coastal plain, barrier islands.

Vegetation: This community is reasonably species-poor. It is often nearly totally dominated by *Spartina* spp., especially *S. alterniflora* (smooth cordgrass). This species is sometimes recognized as tall, medium and short, depending on where it is growing. *Spartina patens* and

Distichlis spicata are common associates.

Dynamics: Salt marshes are regularly flooded. Adams (1963) suggests that tidal elevation influences are the principle factors in controlling distribution of salt-marsh plants. "High marsh" has been used to describe areas regularly flooded at places adjacent to tidal creeks. "Low marsh" is conceived of as drier, and on slightly elevated ground, usually flooded only during the highest spring tides or during storms. Apparently, the spots at the edge of the tidal creek are less saline than those areas slightly farther away. Height of the *Spartina* is at a maximum next to the creeks; plant density decreases farther away from them.

Associations: Grades into Brackish Marsh, Mud Flat, Sand Flat, Salt Shrub, Salt Flat.

Comments: This is probably the most widely-known estuarine community, and has been the subject of a great deal of research involving community productivity.

References: Adams 1963. Cooper & Waites 1973. Duncan 1974. Eleuterius 1972. Godfrey & Godfrey 1974. Johnson et al. 1974a Jackson 1952. Penfound 1952. Wells 1928. Zingmark 1978.

SALT SHRUB THICKET

Type: Estuarine

Sites: Narrow areas between maritime forests and marsh systems, dominated by various shrubs and grasses.

Location: Outer coastal plain, barrier islands.

Vegetation: Shrubby species include *Baccharis angustifolia*, *B. glomeruliflora*, *B. halimifolia*, *Iva frutescens*, *Borrchia frutescens*, *Myrica cerifera*, *Sabal palmetto* and *Juniperus virginiana*. *Cynanchum palustre*, *Juncus roemerianus*, *Andropogon* spp., *Spartina patens* and *Solidago sempervirens* are possible herbs.

Dynamics: Fires are probably occasional to frequent. This community is probably rarely affected by flooding.

Associations: Grades upland into Maritime Forest. Grades into marshes and Salt Flat. Middens.

Comments: *Iva frutescens* and *Borrchia frutescens* may be the most indicative species. More field knowledge is needed.

References: Duncan 1974. Eleuterius 1972.

SEAGRASS BED

Type: Marine, Estuarine

Synonyms: Temperate grass flat. Seagrass bed (Phillips 1974). Tropical marine meadow (Odum 1974). Eelgrass bed (Akins & Jeffcoat 1973). Turtlegrass bed (Eleuterius 1973).

Sites: Shallow offshore regions with unconsolidated substrate (mud, sand, silt or combinations).

Location: Outer coastal plain, barrier islands; offshore sites.

Vegetation: Algae and vascular plants, unless currents preclude attachment. Algae attach by means of holdfasts for penetration of substrate with rhizoids; vascular plants have root systems. Vascular species largely made up of these species (the presence of some of these in SC has not been documented, but may be in the future): *Ruppia maritima* (widgeon-grass), *Cymodocea filiformis* (manatee-grass), *Halodule beaudettei* (shoalgrass), *Zostera marina* (eelgrass). Algal genera include *Sargassum*, *Codium*, *Batophora*, *Champia*, *Gracilaria*, *Grateloupia*, *Chondrus* and *Ulva*.

Potential elements of concern: *Cymodocea*, *Halodule*, *Zostera*--if present at all in SC.

Dynamics: Wave action, currents, temperature, salinity, substrate characteristics and light penetration determine the composition of flora and fauna. Possibly exposed at some points, but probably very rarely. As in Florida, probably the only vegetated natural community which is never affected directly by fire. Violent storms may disrupt or rearrange community makeup.

Associations: Seaward, grades into Unconsolidated Coastal Bottom or Deepwater Coastal Bottom. Landward, may grade into a number of estuarine communities.

Comments: Much more field work needed, especially in Jasper, Beaufort and Charleston Counties. Sites are potentially rich in vertebrate and invertebrate assemblages, including annelids, sponges, crustaceans, mollusks, echinoderms and fish.

References: Akins & Jeffcoat 1973. Eleuterius 1973. Harlin et al. 1982. Odum 1974. Phillips 1974. Zingmark 1978.

SEEPAGE POCOSIN

Type: Palustrine

Synonym: Hillside Bog.

Sites: Seasonally or permanently saturated slopes on sandhills with hard clay lens below peaty/sandy soil. Water percolating downhill is forced to the surface where hardpan rises relative to the soil surface.

Location: Fall-line sandhills.

Vegetation: In general, the same species occur in Seepage Pocosins as in Streamhead Pocosins, but with much less diversity. Canopy species include *Pinus palustris*, and perhaps *P. serotina* and *Oxydendrum arboreum*. *Cyrilla racemiflora*, *Kalmia latifolia* and *Ilex opaca* are well-represented; *Leiophyllum buxifolium* can probably be considered a reasonable indicator of this community in the sandhills.

Potential elements of concern: *Vaccinium sempervirens*. Pine-barrens tree frog.

Dynamics: An abrupt transition may occur from xeric sandhill situations to this community, which may or may not be dominated by *Leiophyllum buxifolium*. Aspects of fire influence are incompletely known. These slopes probably burn less frequently than the drier woodlands surrounding them. Total fire suppression probably effects some sort of hardwood-dominated mesic forest.

Associations: Xeric communities uphill and laterally. Bay Forest. White Cedar Swamp. Streamhead Pocosin.

Comments: These pocosins are sometimes quite dry, and may have outcrops of sandstone present.

References: Hartshorn 1972. Wells 1928. Wells & Shunk 1931.

SHOAL & STREAM BAR

Type: Palustrine

Synonyms: Sand Bar. Point Bar.

Sites: Regularly or seasonally flooded rocky/sandy/alluvial places in streams. Much variation in size and persistence.

Location: Throughout state.

Vegetation: Many shrubs and trees characteristic of floodplains or otherwise wet places. *Alnus serrulata*, *Platanus occidentalis*, *Betula nigra*, *Viburnum dentatum*, *Sambucus canadensis*, *Salix* spp., *Cornus foemina*, *Acer negundo*, *Populus* spp., *Justicia americana*, *Alternanthera philoxeroides*, *Potamogeton* spp., *Podostemum ceratophyllum*.

Potential elements of concern: *Fimbristylis perpusilla*. *F. vahlii*. *Hemicarpha micrantha*. *Hymenocallis coronaria* (piedmont rocky shoals). *Echinodorus parvulus*. *Cardamine clematidis*. *Sabatia kennedyana*. *Coreopsis rosea*.

Dynamics: Temporariness varies within these sites. Trees and shrubs are usually not able to reach large size before sites are destroyed or altered by flooding. Canopy species may be

knocked off rocks or swept off sand, etc. The best shoal development is within the piedmont and fall line, where boulders form part of the substrate. In general, the larger particles are deposited first, that is, at the upstream end of each site.

Associations: Bottomland Hardwoods. Levee.

Comments: More field work is needed for this community. These sites are interesting from the standpoint of successional phenomena occurring on them. Threats to these communities may be natural (normal flooding) or human-effected (stream manipulation, damming, etc.). Coastal plain rivers will have shoals and bars mostly composed of sand (and mud); the dynamics of these sites are somewhat different from those in the upcountry. The inclusion of piedmont and coastal plain sites together may prove to be too broad for easy conceptualization. Subtypes of this community, as based on location in the state, may be desirable.

References: Barnes 1985. McBride & Strahan 1984.

SMALL STREAM FOREST

Type: Palustrine

Sites: Seasonally or intermittently flooded lowlands bordering small streams.

Location: Throughout state.

Vegetation: Essentially the same as Bottomland Hardwoods and/or Bald Cypress Swamp, but in dissected, mosaic situations. Very heterogeneous.

Potential elements of concern: *Lygodium palmatum*. *Thalictrum subrotundum*. *Forestiera ligustrina*.

Dynamics: Flooding regime is different than that of main channels. Duration of standing water not as great, although the floods themselves may be very heavy.

Associations: Upstream to Streamhead Pocosin. Downstream to more discrete floodplain communities.

Comments: There are several unresolved problems with this community. One question concerns its size relationships. It may be that some alluvial or non-alluvial rivers of sufficient size could be considered as having the same vegetation in a system that has smaller streams. Also, alluvial rivers probably have different dynamics due to the presence of well-developed levees.

SOUTHERN MIXED HARDWOOD FOREST

Type: Terrestrial

Synonym: Xeric Hammock (Florida Natural Areas Inventory).

Sites: Forested lowlands protected from fire, with fairly deep well-drained loamy sands. These sites apparently occur on relictual sand ridges.

Location: One site is known to date, near the Savannah River within Jasper County.

Vegetation: A well-developed canopy of many hardwoods exists, made up of *Quercus hemisphaerica*, *Q. virginiana*, *Carya* spp., *Ilex opaca* and *Liquidambar styraciflua*. Spruce pine and loblolly pine are also characteristic. One of the most striking aspects of this community is the great diversity of subcanopy and understory species. These include *Ostrya virginiana*, *Osmanthus americana*, *Cornus florida*, *Nyssa biflora*, *Platanus occidentalis*, *Prunus caroliniana*, *P. serotina* and *Carpinus caroliniana*. Shrubs include *Vaccinium arboreum*, *V. elliotii*, *Serenoa repens*, *Halesia diptera*, *Cornus asperifolia*, *Callicarpa americana*, *Sebastiania ligustrina*, *Asimina* spp., *Bumelia tenax*, *Sabal minor*, *Ilex decidua*, *I. ambigua* and *I. vomitoria*.

Potential elements of concern: *Cyperus tetragonus*. *Halesia diptera*. *Rhapidophyllum hystrix*.

Associations: Maritime Forest.

Comments: The occurrence of this community in SC may represent its northern geographical limit. Dynamics are incompletely known, especially concerning the relationship of these sites to those in north Florida.

References: Aulbach-Smith 1984. Monk 1965. Monk 1968.

SPRAY CLIFF

Type: Palustrine

Sites: Vertical or sloping spray and splash zones at the edges and bases of waterfalls. Separated from High Elevation Seepages by constant water flow.

Location: Mountains and upper piedmont.

Vegetation: Usually limited to shrubs, herbs and bryophytes able to withstand the effects of rapidly flowing water, including occasional flooding and high wind. In general, vascular plants are unable to colonize areas within the stream itself, and are essentially restricted to the walls of the waterfall. Soil buildup is confined to holes and crevices, further limiting colonization by plants of large size. Extremely rich bryophyte and fern floras are possible. Larson and Batson (1978) suggest *Selaginella apoda*, *Asplenium trichomanes*, *Thalictrum clavatum*, and less frequently *Parnassia grandifolia*, as "hydric species" occupying these sites.

Potential elements of concern: *Hygrohypnum alpestre*. *Trichomanes petersii*. *T. boschianum*. *Sphaeroconium* sp. *Hymenophyllum tunbridgense*. *Saxifraga micranthidifolia*.

Dynamics: Spray cliffs are largely affected by the size and rate of the associated stream's flow. The combination of very high humidity and high wind is unusual for natural communities; in this case, however, these factors impart a tropical influence to the bryophyte assemblages. High Elevation Seeps, which are found in the same geographical region, and may, in fact, be associated with Spray Cliffs, have a flora reflecting the differences in water flow rate and humidity.

Associations: Adjacent terrestrial forest types. Rhododendron Thicket. Shoal and Stream Bar. High Elevation Seep.

Comments: Rock type probably has some effect on floristics. Without high velocity water, these communities would probably be considered as some variant of High Elevation Seepage or Acidic Cliff.

References: Larson & Batson 1978. Pittillo 1975.

SPRUCE PINE--MIXED HARDWOOD FOREST

Type: Terrestrial

Synonym: Bluff & Slope Forest (Wharton 1977).

Sites: Thickly canopied forest on dry to mesic, mostly poorly-drained deep sandy soils, generally low in organic content.

Location: Outer coastal plain.

Vegetation: The canopy is composed of various combinations of *Pinus glabra*, *Magnolia grandiflora*, *Liquidambar styraciflua*, *Carya* spp., *Quercus nigra*, *Q. laurifolia*, *Q. virginiana* and *Ilex opaca*. Subcanopy and shrubby species include *Carpinus caroliniana*, *Ostrya virginiana*, *Ilex vomitoria*, *Sebastiania ligustrina*, *Callicarpa americana*, *Persea palustris*, *Sabal minor*, *Cornus asperifolia* and *Myrica cerifera*. *Oplismenus setarius*, *Scleria triglomerata*, *Elephantopus* spp., *Cyperus* spp., *Rhynchospora* spp., and other species may contribute to the herbaceous layer.

Potential elements of concern: *Trillium pusillum*.

Dynamics: *Pinus glabra* is the only shade-tolerant pine on the coastal plain. Fire is probably only occasional to very rare; spruce pine is not fire-adapted.

Associations: Oak-Hickory Forest. Mesic Mixed Hardwood Forest. Beech-Magnolia Hammock. Southern Mixed Hardwood Forest.

References: Dial et al. 1976. Wharton 1977.

STREAMHEAD POCOSIN

Type: Palustrine

Synonym: Steephead.

Sites: Generally thickly vegetated sites at headwaters and along margins of sandhill streams.

Location: Fall line sandhills, riverine sandhills of coastal plain.

Vegetation: Pocosin species, with additional canopy species usually present. Diverse species assemblages usually occur, possibly including any or all of the following: *Liriodendron tulipifera*, *Liquidambar styraciflua*, *Acer rubrum*, *Pinus serotina*, *Nyssa biflora*, *Persea borbonia*, *Rhus vernix*, *Lyonia lucida*, *Sorbus arbutifolia*, *Clethra alnifolia*, *Kalmia latifolia*, *Magnolia virginiana*, *Viburnum* spp., *Ilex glabra*, *I. coriacea*, *Symplocos tinctoria*, *Sambucus canadensis*, *Arundinaria gigantea*, *Vitis* spp., *Smilax laurifolia*, *Sarracenia rubra*, *S. flava*, *Osmunda* spp., *Sphagnum* spp., *Polytrichum* spp. and others.

Potential elements of concern: *Rhynchospora alba*. *Lysimachia asperulifolia*.

Dynamics: Fire is an important factor in surrounding and adjacent sandhills, but is probably occasional to rare in Streamhead Pocosin. Presumably, fires that do occur limit the dominance of canopy species in these sites.

Associations: Seepage Pocosin. Atlantic White Cedar Swamp. Bay Forest. Uphill and laterally to various sandhill communities.

Comments: In Florida, this community includes "steepheads" which are readily recognizable, present in the western Panhandle. Extensive bluff systems may be present at these sites. The very uppermost part of the streams associated with these systems is constantly eroding into the bluff behind it. Such a situation, which is largely an effect of topography, is probably rarely (if ever) achieved in the SC sandhills. The more common situation in SC is that of gradual change from xeric hilltops to the mesic slopes adjacent to the stream. Some questions may exist concerning the separation of this community from Hillside Seepage Bogs, which occur in the same regions, but may have distinctive dynamics governing them. Our examples of Streamhead Pocosin tend to be patchy and discontinuous, and little specific information occurs for them. Thus, it is reasonably difficult to characterize them all at once. Additional field work is necessary for better understanding of community dynamics. It is likely that various elements of concern present in the associated communities would also be found in Streamhead Pocosin, although perhaps mostly in ecotonal situations. Included in this concept of Streamhead Pocosins are the narrow to broad bands of vegetation bordering sandhill streams, but not directly associated with the xeric areas on top of the ridges.

References: Wells 1928.

SWALE POCOSIN

Type: Palustrine

Sites: Small irregularly-shaped depressions between or paralleling sandhill ridges, with poor drainage, that accumulate and hold water indefinitely. Usually no distinct inlet or outlet.

Location: Fall-line sandhills, and possibly elsewhere on the coastal plain.

Vegetation: A variable and tangled association of shrubs and vines occurs, plus canopy species of more mesic areas. Otherwise, the vegetation is essentially similar to Pocosin. Typical species are *Pinus serotina*, *Liquidambar styraciflua*, *Acer rubrum*, *Nyssa biflora*, *Aronia arbutifolia*, *Alnus serrulata*, *Cyrilla racemiflora*, *Erianthus* spp., *Arundinaria gigantea*, *Sphagnum* spp. and *Smilax laurifolia*. Herbaceous flora is probably always sparse.

Potential elements of concern: *Polygala nana*.

Dynamics: Fire is probably infrequent, unless drought is extensive. Dynamics are probably much like those of adjacent sandhills.

Associations: Xeric Sandhill Scrub. Pine-Scrub Oak Sandhill. Upland Pine-Wiregrass Woodland.

Comments: This community may arguably be too small to consider as separate from some sandhill community types; it remains distinctive, however, if only as microsites within the more xeric sandhills. Some open boggy places in the sandhills may be more or less permanently wet, and without a real canopy. These are more likely to be dominated by grasses and sedges.

SWAMP TUPELO POND

Type: Palustrine

Synonym: Gum Pond (Wharton 1977).

Sites: Rounded or irregularly-shaped depressions on poorly draining lowlands.

Location: Coastal plain, especially within some Carolina bays and on floodplains.

Vegetation: The canopy consists mostly of hardwoods, especially *Nyssa sylvatica* var. *biflora* and *Acer rubrum*. Shrubs include *Ilex cassine* var. *myrtifolia*, *Leucothoe racemosa* and *Lyonia lucida*. Pond cypress may be present in varying proportions, but is not nearly as abundant as the

Nyssa. Aquatic flora may be well-developed, depending on extent of canopy.

Potential elements of concern: *Rhynchospora inundata*. *R. tracyi*. *Heteranthera reniformis*. *Oxypolis canbyi*. *Rhexia aristosa*. *Ilex amelanchier*.

Dynamics: Water table probably does not fluctuate as much as in Pond Cypress Pond. Swamp Tupelo Ponds burn less frequently than Pond Cypress Pond (Wharton 1977), from which they may develop if fire is completely suppressed. Ponds with relatively high water level have less shrubbery within.

Associations: Burning at times of low water reduces amount of peat present, presumably favoring formation of Pond Cypress Pond, or at least allows invasion of more cypress. Increasing peat level tends to allow build-up of shrubs and other hardwoods, and so may result in succession to less hydric communities.

Comments: Floating logs and stumps provide spots for additional herbaceous species. Pond cypress, when present, will increase in dominance due to fires; swamp tupelo is readily removed by burning.

References: Wharton 1977.

TALUS SLOPE

Type: Terrestrial

Synonym: Boulder Field.

Sites: Piles of rock at bases of steep slopes.

Location: Mountains.

Vegetation: Very heterogeneous, and perhaps indistinctive. North Carolina system lists *Betula lutea* as an important tree species on these sites.

Potential elements of concern: *Aconitum uncinatum*.

Dynamics: Not completely known. Bare talus slopes (unvegetated) are unknown currently in SC, although present in Virginia and possibly North Carolina. Shifting, unstable talus slopes are probably always undergoing succession. Presumably, the areas adjacent to an old stabilized talus slope will be forested over, so that rock is not visible above the ground. In that case, there is arguably no longer a Talus Slope present.

Associations: Dry to mesic forest situations of the uplands.

Comments: Possibly not present in SC at all; much more field work needed. The chemistry of

the rocks themselves obviously has a great deal to do with whatever flora develops over them.

References: Hupp 1983. Oosting 1942. Pittillo & Smathers 1979.

TIDAL BALD CYPRESS-TUPELO GUM SWAMP

Type: Estuarine

Synonym: Tidewater River Swamp (Wharton 1977).

Sites: Swamp forest at edge of estuaries on rivers, present at the upper limit of tidal influence.

Location: Outer coastal plain.

Vegetation: Canopy members are essentially the same as in more inland swamp forests and bottomland hardwoods, with *Taxodium distichum*, *Nyssa aquatica*, *N. sylvatica* var. *biflora* and *Liquidambar styraciflua* as dominant species. *Sabal palmetto*, *Persea borbonia*, *Viburnum* spp., *Salix* spp., *Planera aquatica* and *Alnus serrulata* may occur in the subcanopy and shrub layers. Typical herbs include *Arisaema triphyllum*, *Osmunda* spp., *Physostegia virginiana*, *Lobelia cardinalis*, *Impatiens capensis*, *Saururus cernuus* and *Hymenocallis crassifolia*.

Elements of concern: *Isoetes riparia*. *Physostegia leptophylla*. *Nyssa ogeche*. American alligator. Swallow-tailed Kite. Wood stork.

Dynamics: An unusual hydrological regime characterizes this community. Very strong currents may take place during ebb flow, but the river may hardly flow at all when the tide is coming in. Depending on specific sites, the subcanopy and shrub layers may be well-represented or depauperate. The ground surface may be very boggy, and covered with many twisted roots. This community may represent an inland limit for estuarine fauna (crabs, etc.).

Associations: Tidal Freshwater Marsh. Brackish Marsh. Bottomland Hardwoods. Oak-Hickory Forest.

References: Odum et al. 1984. Wharton 1977.

TIDAL FRESHWATER MARSH

Type: Estuarine

Sites: Upward limit of salinity in tidal creeks; areas generally flooded regularly, and with an average annual salinity of 0.5 ppt or below, except during periods of extreme drought (Odum et al. 1984).

Location: Outer coastal plain.

Vegetation: The floristic composition of these sites is quite heterogeneous, and variable from site to site. They are much more diverse than either salt or brackish marshes. Characteristic species are *Phragmites communis*, *Typha latifolia*, *T. angustifolia*, *T. domingensis*, *Zizaniopsis miliacea*, *Zizania aquatica*, *Sium suave*, *Alternanthera philoxeroides*, *Scirpus validus*, *S. robustus*, *S. cyperinus*, *Sagittaria graminea*, *S. latifolia*, *Peltandra virginica*, *Pontederia cordata*, *Iris virginica*, *Fuirena squarrosa*, *Limnobiium spongia*, *Nuphar luteum*, *Nymphaea odorata*, *Myriophyllum brasiliense*, *M. heterophyllum*, *Orontium aquaticum*, *Lemna perpusilla*, *Kosteletzkya virginica*, *Lythrum lanceolatum*, *Impatiens capensis*, *Ludwigia* spp., *Polygonum* spp. and *Saururus cernuus*.

Potential elements of concern: *Isoetes riparia*. *Zostera dubia*. *Vallisneria americana*. *Pilea fontana*. *Cardamine longii*.

Dynamics: These marshes occasionally exhibit some salinity; the dominant force is flooding with fresh water due to heavy rains (seasonal) or heavy scattered storms. Site boundaries are very indistinct from the aspect of species composition, with imperceptible merging into surrounding community types.

Associations: Downstream to Brackish Marsh. Upstream to Tidal Bald Cypress - Tupelo Gum Swamp.

Comments: Various microcommunity types could be described within the Tidal Freshwater Marsh. However, the general floristic structure of this community is usually so heterogeneous that it is not particularly well-suited to such subdivision (Odum et al. 1984). Zonation within these marshes is often evident, but as a rule does not repeat consistently from site to site.

References: Jervis 1969. Odum et al. 1984. Stalter 1973. Wells 1928. Zingmark 1978.

UNCONSOLIDATED COASTAL BOTTOM

Type: Marine

Sites: Subtidal zone composed of loose sand (plus sediments) or mud, with shells and shell fragments.

Location: Outer coastal plain, barrier islands.

Vegetation: None.

Potential elements of concern: Cetaceans.

Associations: Seaward into Deepwater Coastal Bottom. Landward into Intertidal Sand/Mud Flat, Seagrass Bed.

Comments: This community can be fairly far-removed from any land mass, and yet remain

relatively shallow. Clearly, more knowledge on these sites' community characteristics is needed.

References: Zingmark 1978.

UPLAND BOG

Type: Palustrine

Synonyms: Montane bog, Sphagnum bog.

Sites: Poorly drained wet seepage areas at heads of small streams, which are nearly always saturated. In South Carolina, this community is probably not found below elevations of 2800 feet.

Location: Mountains. One site is currently known in Greenville County.

Vegetation: Upland Bogs are characterized by Sphagnum and many bog species: orchids, sedges, etc., many of which are also found on the Coastal Plain. Zonation of shrubbery may be evident, but a real canopy is usually absent, unless fire has been excluded long enough to allow its development.

Potential elements of concern: *Lygodium palmatum*. *Juncus gymnocarpus*. *Carex folliculata*. *Arethusa bulbosa*. *Helonias bullata*. *Platanthera lacera*. *Trautvetteria carolinensis*. Bog turtle.

Dynamics: Apparently fire-controlled. Without burning, succeeds to wetland dominated by woody vegetation.

Associations: Upland forest communities.

Comments: This community type is more abundant and diverse in North Carolina, Virginia, and more northern states. More field work is needed.

References: Dansereau & Segadas-vianna 1952. Wieder et al. 1981.

UPLAND DEPRESSION SWAMP FOREST

Type: Palustrine

Synonym: Hardwood semi-bog (old SC system).

Sites: Poorly drained upland flats over basic soil, with high diversity of herbaceous flora.

Location: Piedmont, especially York, Chester Counties.

Vegetation: Bottomland canopy species include *Nyssa biflora*, *Quercus phellos*, *Q. lyrata*, *Q. shumardii*, *Juniperus virginiana*, *Liquidambar styraciflua*, *Fraxinus* spp., *Ilex opaca*, *Liriodendron tulipifera*, *Cercis canadensis*, *Ulmus americana* and *Acer negundo*. Shrubs: *Symphoricarpos orbiculatus*, *Lindera benzoin* and *Viburnum* spp. Herbs: *Camassia scilloides*, *Isoetes* spp., *Ranunculus* spp., *Claytonia virginica*, *Zephyranthes atamasco*, *Cardamine bulbosa*, *Ranunculus* spp., etc.

Potential elements of concern: *Isoetes virginica*. *Camassia scilloides*. *Melanthium virginicum*. *Quercus bicolor*.

Dynamics: The hydrology of these sites fluctuates markedly. Soil present is usually of the Elbert series, which is often derived from Iredell types.

Associations: Basic Mesic Forest. Oak-Hickory Forest. Montmorillonite Forest.

References: Batson 1952. Dayton 1966.

UPLAND PINE-WIREGRASS WOODLAND

Type: Terrestrial

Synonym: Longleaf Pine Upland Forest (Wharton 1977).

Sites: Upland sites on rolling sandhills with open to closed canopy of pines, with shrub layer below, and a reasonably diverse herbaceous layer.

Location: Coastal plain.

Vegetation: A rather thin canopy of pines is present, made up of *Pinus palustris* and perhaps some *P. serotina*. A definite subcanopy may occur, mostly of various species associated with less mesic sandhill systems, such as *Quercus marilandica*, *Q. stellata*, *Cornus florida* and *Carya* spp. Shrubs present may include *Ilex glabra*, *Lyonia mariana*, *Gaylussacia dumosa*, *G. frondosa* and *Vaccinium tenellum*. A dense layer of *Aristida* is usually present. Other herbaceous plants may include *Tephrosia virginiana*, *Elephantopus* spp., *Liatris* spp. and *Chrysopsis* spp.

Potential elements of concern: *Elliottia racemosa*. *Chrysopsis pinifolia*. Gopher tortoise. Red-cockaded woodpecker.

Dynamics: This community is drier than flatwoods; it is never flooded and usually never wet. Organisms within it are generally very adapted to occasional fires. The absence of fire leads to rapid invasion of additional hardwood species and numerous shrubs.

Associations: Sandhill communities. Pine Flatwoods. Streamhead Pocosin.

Comments: This community is conceivably restricted to the interior Coastal Plain, or on

elevated ridges of the outer Coastal Plain. It is probably always present in ecotonal situations on hillsides between drier sandhills and wetter pocosins.

References: Wharton 1977.

XERIC SANDHILL SCRUB

Type: Terrestrial

Synonyms: Xerophytic deciduous forest (Pessin 1933). Turkey-oak barren (Duke 1961). Dwarf oak forest, Pine-turkey oak sandhill (Wharton 1977).

Sites: Flat or hilly areas on driest parts of sandhills. Formed on deep, well-drained sands.

Location: Fall-line sandhills and coastal plain.

Vegetation: The canopy is dominated by *Pinus palustris*. A recognizable subcanopy of *Quercus laevis* and some tall shrubs usually occurs. Shrubs: *Gaylussacia frondosa*, *Vaccinium* spp., *Ceratiola ericoides*. Herbs: *Stipulicida setacea*, *Opuntia compressa*, *Arenaria caroliniana*, *Euphorbia ipecacuanhae*, *Warea cuneifolia*. Important grass genera are *Aristida*, *Andropogon*, *Sporobolus* and *Triplasis*.

Potential elements of concern: *Nolina georgiana*. *Licania michauxii*. *Stylisma pickeringii*. *Chrysoma pauciflosculosa*. A variant of this community in lower Jasper County includes *Polygonella gracilis*, *Dicerandra odoratissima* and *Rudbeckia mollis*. Indigo snake.

Dynamics: This community is very much dependent on fire for maintenance. Wire grass and leaf-litter generally carry fire well; *Pinus palustris* is the best fire-adapted pine in our state. Where fire is excluded, turkey oaks (and some other scrubby oaks) increase in importance.

Associations: Pine-Scrub Oak Sandhill. Swale Pocosin. Seepage Pocosin. Streamhead Pocosin.

Comments: Within this community there sometimes occurs an easily discerned sub-community, Sandstone Outcrop, which may be more correctly considered distinctive. Except for the presence of rock, these sites may share practically all the attributes of other sandhill communities.

References: Braun 1950. Christensen 1979. Duke 1961. Ebinger 1979. Pessin 1933. Wharton 1977. Van Cleave 1933.

Literature Cited

Adams, D.S. 1963. Factors influencing vascular plant zonation in North Carolina salt marshes. Ecology 44: 445-456.

- Akins, G.J. and C.Q. Jefferson. 1973. Coastal wetlands of Oregon. Oregon Coastal Conservation and Development Commission. Florence, Oregon. 159 pp.
- Allen, R.M. 1956. Relation of saw-palmetto to longleaf pine reproduction on a dry site. *Ecology* 37: 195-195.
- Aulbach-Smith, C. 1984. Inventory of Botanical Natural Areas in Jasper County, South Carolina. Final Report. S.C. Wildlife and Marine Resources Dept. 1984.
- Baden, J., W.T. Batson, and R. Stalter. 1975. Factors affecting the distribution of vegetation of abandoned rice fields. *Georgetown Co., South Carolina. Castanea* 40: 171-184.
- Balter, H. and R. E. Loeb. 1983. Arboreal relationships on limestone and gneiss in northern New Jersey and southeastern New York. *Bull. Torr. Bot. Club* 110: 370-379.
- Barnes, W.J. 1985. Population dynamics of woody plants on a river island. *Can. J. Bot.* 63: 647-655.
- Barry, J.M. Natural vegetation of South Carolina. USC Press. 1980.
- Bartgis, R.L. and G.E. Long. 1984. Marl wetlands in eastern West Virginia: distribution, rare plant species, and recent history. *Castanea* 49: 1725.
- Batson, W.T. 1952. The floristics of the Iredell soil series in the Central Piedmont of North Carolina. Ph.D. Dissertation, Duke University.
- Boyce, S.G. 1954. The salt spray community. *Ecol. Monogr.* 24: 29-67.
- Bozeman, J.R. 1971. A sociologic and geographic study of the sand ridge vegetation in the Coastal Plain of Georgia. Ph.D. Dissertation. UNC Chapel Hill.
- Bratton, S.P. 1976. The response of understory herbs to soil depth gradients in high and low diversity communities. *Torreya* 103: 165-172.
- Braun, E.L. 1950. Deciduous forests of Eastern North America. The Blakiston Co., Philadelphia. 596 pp.
- Bryant, W.S., M.E. Wharton, W.H. Martin, and J.B. Varner. 1980. The blue ash/oak savannah-woodland, a remnant of presettlement vegetation in the Inner Bluegrass of Kentucky. *Castanea* 45: 149-165.
- Buell, M.F. and R.L. Cain. 1943. The successional role of Southern White Cedar, *Chamaecyparis thyoides* in southeastern North Carolina. *Ecology* 24: 85-93.
- Burbanck, M.P. and R.B. Platt. 1964. Granite outcrop communities on the piedmont plateau in Georgia. *Ecology* 45: 292-306.

- Burk, C.J. 1962. The North Carolina Outer Banks: a floristic interpretation. J. Elisha Mitchell Sci. Soc. 78: 21-28.
- Celosi, J.C. and J.F. McCormick. 1978. Population structure of *Iva imbricaria* in five coastal dune habitats. Bull. Torr. Bot. Club 105: 175-186.
- Christenson, N.L. 1979. The xeric sandhill and savanna ecosystems of the Southeastern Atlantic Coastal Plain. Veroff. Geobot. Inst. ETH Stiftung Rubel. 68: 246-262.
- Cooper, A.W. 1963. A survey of the vegetation of the Toxaway River gorge with some remarks about early botanical explorations and annotated list of the vascular plants of the gorge area. J. Elisha Mitchell Sci. Soc. 79: 1-22.
- _____ and E.D. Waits. 1973. Vegetation types in an irregularly flooded salt marsh on the North Carolina Outer Banks. J. Elisha Mitchell Sci. Soc. 89: 78-91.
- Cowardin, L.M., V. Carter, F.C. Golet and E.T. LaRoe. 1979. Classification of Wetland and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service, Washington, D. C.
- Crandell, A.E. 1977. A vegetation study of Jones Gap, South Carolina: Floristic and some ecological considerations. M.S. Thesis, USC-Columbia.
- Dame, R.F. 1979. The abundance, diversity and biomass of macrobenthos on North Inlet, South Carolina, intertidal oyster reefs. Proc. Nat. Shellfisheries Assoc. 69: 6-10.
- Dansereau, P. and F. Segadas-vianna. 1952. Ecological study of the peat bogs of eastern North America. I. Structure and evolution of vegetation. Can. J. Bot. 30: 490-520.
- Dayton, B.W. 1966. The relationship of vegetation to Iredell and other Piedmont soils in Granville County, North Carolina. J. Elisha Mitchell Sci. Soc. 82: 108-118.
- Dial, S.C., W.T. Batson, and R. Stalter. 1976. Some ecological and morphological observations of *Pinus glabra* Walter. Castanea 41: 361-377.
- Dorroh, R.J. 1968. The vegetation of Indian shell mounds and rings of the South Carolina coast. M.S. Thesis, USC-Columbia.
- Doutt, J.K. 1941. Wind pruning and salt spray as factors in ecology. Ecology 22: 195-196.
- Duke, J.A. 1961. The psammophytes of the Carolina fall-line sandhills. J. Elisha Mitchell Sci. Soc. 77: 3-25.
- Duncan, W.H. 1974. Vascular halophytes of the Atlantic and Gulf coasts of North America north of Mexico. In Reimold, R. J. and W. H. Queen, eds. Ecology of Halophytes. Academic

Press. p. 23-50.

- Dyksterhuis, E.J. 1957. The savannah concept and its use. *Ecology* 38: 435-442.
- Ebinger, J.E. 1979. Vascular flora of sandstone outcrops in Clark County, Illinois. *Castanea* 44: 38-44.
- Eleuterius, L.N. 1972. The marshes of Mississippi. *Castanea* 37: 153-168.
- Ewel, K.C. and W.J. Mitsch. 1978. The effects of fire on species composition in cypress dome ecosystems. *Florida Scientist* 41: 25-31.
- Findlay, S.E.G. 1981. Small-scale spatial distribution of meiofauna on a mud- and sandflat. *Est. Coastal and Shelf Sci.* 12: 471-484.
- Gaddy, L.L. 1982. The floristics of three South Carolina pine savannahs. *Castanea* 47: 393-402.
- Gardner, L.R. and M. Bohn. 1980. Geomorphic and hydraulic evolution of tidal creeks on a subsiding beach ridge plain, North Inlet, S.C. *Mar. Geology* 34: 91-97.
- Godfrey, P.J. and M.M. Godfrey. 1974. The role of overwash and inlet dynamics in the formation of salt marshes on North Carolina barrier islands. In Reinold, R. J. and W. H. Queen, eds. *Ecology of Halophytes*. Academic Press, N.Y.
- Grant, J. 1981. Sediment transport and disturbance on an intertidal sandflat: infaunal distribution and recolonization. *Mar. Ecol. Prog. Ser.* 6: 249-255.
- Hall, T.F. and W.T. Penfound. 1943. Cypress-gum communities in the Blue Girth Swamp near Selma, Alabama. *Ecology* 24: 208-217.
- Hardin, E.D. and K.P. Lewis. 1980. Vegetation analysis of Bee Branch Gorge, a hemlock-beech community on the Warrior River basin of Alabama. *Castanea* 45: 248-256.
- Harlin, M.M., B. Thorne-Mill, J.C. Boothroyd. 1982. Seagrass-sediment dynamics of a flood-tidal delta in Rhode Island (USA). *Aq. Bot.* 14: 127-138.
- Hartshorn, G.S. 1972. Vegetation and soil relationships in southern Beaufort County, North Carolina. *J. Elisha Mitchell Sci. Soc.* 38: 226-238.
- Heyward, F. 1939. The relation of fire to stand composition of long-leaf pine forests. *Ecology* 20: 287-304.
- Hupp, C.R. 1983. Seedling establishment on a landslide site. *Castanea* 48: 89-98.
- Jackson, C.R. 1952. Some topographic and edaphic factors affecting plant distribution in a tidal marsh. *Quart. J. Fla. Acad. Sci.* 15: 137-145.

- Jervis, R.A. 1969. Primary production in the freshwater marsh ecosystem of Troy Meadows, New Jersey. *Bull. Torr. Bot. Club* 96: 209-231.
- Johnson, A.S., H.O. Hillestad, S.F. Shanholtzer, and G.F. Shanholtzer. 1974. An Ecological Survey of the Coastal Region of Georgia. *Nat. Park Service Sci. Monogr. Series No.* 3.
- Jones, R.H. 1981. A classification of lowland forests in the northern coastal plain of South Carolina. M.S. Thesis. Clemson Univ.
- Kjerfve, B., C.C. Shao and F.W. Stapor, Jr. 1979. Formation of deep scour holes at the junction of tidal creeks: an hypothesis. *Marine Geol.* 33: 9-14.
- Knox, J.N. 1974. A floristic study of Bogg's Rock, a granite gneiss outcrop in Pickens Co., S.C. M.S. Thesis, Clemson Univ.
- Kologiski, R.L. 1977. Phytosociology of the Green Swamp, North Carolina. *N.C. Agr. Exp. Sta. Tech. Bull.* #250.
- Korstian, C.F. 1924. Natural regeneration of southern white cedar. *Ecology* 5: 199-191.
- Laessle, A.M. and C.D. Monk. 1961. Some live oak forests of northeastern Florida. *Quart. J. Fla. Acad. Sci.* 24: 39-55.
- Larson, S.S. 1977. The vegetation of vertical rock faces in Pickens and Greenville Counties, S.C. M.S. Thesis, USC-Columbia.
- _____ and W.T. Batson. 1978. The vegetation of vertical rock faces in Pickens and Greenville Counties, S.C. *Castanea* 43: 255-260.
- Lawrence, D.R. 1971. Shell orientation in oyster communities. *Abstract, Bull. S.C. Acad. Sci.* 33: 34.
- Mathies, P.S., W.C. Holmes, and A.S. Allen. 1983. The vascular flora of Cunningham Brake, a cypress-gum swamp in Natchitoches Parish, Louisiana. *Castanea* 48: 24-31.
- McBride, J.R. and J. Strahan. 1984. Establishment and survival of woody riparian species on gravel bars of an intermittent stream. *Am. Midl. Nat.* 112: 235-245.
- Mitsch, W.J. and K.C. Ewel. 1979. Comparative biomass and growth of cypress in Florida wetlands. *Am. Midl. Nat.* 101: 417-426.
- Monk, C.D. 1965. Southern Mixed Hardwood Forest of north central Florida. *Ecol. Monogr.* 35: 335-354.
- _____ . 1968. Succession and environmental relationships of the forest vegetation of north

- central Florida. *Am. Midl. Nat.* 79: 441-457.
- Nehmeth, J.C. 1968. The hardwood vegetation and soils of Hill Demonstration Forest, Durham Co., N.C. *J. Elisha Mitchell Sci. Soc.* 84: 482-491.
- Nesom, G.L. and M. Treiber. 1977. Beech-Mixed Hardwoods Communities: A topo-edaphic climax on the North Carolina Coastal Plain. *Castanea* 42: 119-140.
- Noble, R.E. and P.K. Murphy. 1975. Short term effects of prolonged backwater flooding on understory vegetation. *Castanea* 40: 228-238.
- Odum, H.T. 1974. Tropical Marine Meadows. In Odum, H.T., B.J. Copeland, and E.A. McMahan, eds, *Coastal Ecological Systems of the U.S. Vol. 1. The Conservation Foundation, Washington, D.C.*
- _____, T.J. Smith III, J.K. Hoover and C.C. Melvor. 1984. The Ecology of Tidal Freshwater Marshes of the United States East Coast: a Community Profile. U. S. Fish and Wildlife Serv. FWS/OBS-83/17.
- Oosting, H.J. 1942. An ecological analysis of the plant communities of piedmont N.C. *Am. Midl. Nat.* 28: 1-126.
- _____. 1945. Tolerance to salt spray of plants of coastal dunes. *Ecology* 26: 85-89.
- _____. 1954. Ecological processes and vegetation of the maritime strand in the southeastern United States. *Bot. Rev.* 20: 226-262.
- _____ and L.E. Anderson. 1937. The vegetation of a bare-faced cliff in western North Carolina. *Ecology* 18: 280-292.
- _____ and W.D. Billings. 1942. Factors effecting vegetation zonation on coastal dunes. *Ecology* 23: 131-142.
- _____ and D.W. Hess. 1956. Microclimate and a relict stand of *Tsuga canadensis* in the lower Piedmont of North Carolina. *Ecology* 37: 28-39.
- Peet, R. K. and A. L. Christensen. 1980. Hardwood forest vegetation of the North Carolina piedmont, Veroff, *Geobot. Inst. ETH Stiftung Rubel.* 69: 14-39.
- Penfound, W. 1952. Southern swamps and marshes. *Bot. Review* 18: 413-446.
- Pessin, L.S. 1933. Forest associations in the uplands of the lower Gulf Coastal Plain (longleaf pine belt). *Ecology* 14: 1-14.
- Phillips, R.C. 1974. Temperate grass flats. In Odum, H.T., B.J. Copeland, and E.A. McMahan, eds. *Coastal Ecological Systems of the U.S. Vol. 2. The Conservation Foundation,*

Washington, D.C.

- Pinson, J.N. 1973. A floristic analysis of open dunes in S.C. Ph.D. Dissertation, USC-Columbia.
- Pittillo, J.D. 1976. Potential natural landmarks of the southern Blue Ridge portion of the Appalachian Ranges Natural Region. Dept. of Biology, Western Carolina Univ., Cullowhee.
- _____ and G.A. Smathers. 1979. Phytogeography of the Balsam Mountains and Pisgah Ridge, Southern Appalachian Mountains. *Veroff. Geobot. Inst. ETH* 68: 206-245.
- Pittman, A.B., Jr. 1978. Survey of the vascular flora of Shealy's Pond, a southern white cedar bog. M.S. Thesis, USC-Columbia.
- Porcher, R.D. 1981. The vascular flora of the Francis Beidler Forest in Four Holes Swamp, Berkeley and Dorchester Counties, South Carolina. *Castanea* 46: 248-280.
- Quarterman, E. and C. Keener. 1962. Southern mixed hardwood forest: climax in the Southeastern coastal plain. *Ecol. Monogr.* 32: 167-185.
- Racine, C.H. 1966. Pine communities and their site characteristics in the Blue Ridge escarpment. *J. Elisha Mitchell Sci. Soc.* 82: 172-181.
- Rayner, D.A. and W.T. Batson. 1976. Maritime closed dunes vegetation in South Carolina. *Castanea* 41: 58-70.
- Reise, K. 1985. Tidal Flat Ecology. *Ecological Studies Volume 54.* Springer-Verlag.
- Rodgers, C.L. 1965. The vegetation of Horsepasture Gorge. *J. Elisha Mitchell Sci. Soc.* 81: 103-112.
- Sharitz, R.R. 1975. Forest communities of Kiawah Island. In Campbell, W.M., J.M. Dean, and W.D. Chamberlain. *Environmental inventory of Kiawah Island, South Carolina.* Environmental Research Center, Columbia, S.C.
- Sloan, E. 1908. Catalogue of the mineral localities of South Carolina. S.C. Geol. Survey, Series 4. Bull. 2. 1908.
- Stalter, R. 1971. Age of mature pine (*Pinus taeda*) stand in South Carolina. *Ecology* 52: 532-533.
- _____. 1973. Factors influencing the distribution of vegetation of the Cooper River estuary. *Castanea* 38: 18-24.
- _____. 1984. The flora of Bulls Island, Charleston County, South Carolina. *Bartonia* 50: 27-30.

- Uphof, J.C.T. 1941. Halophytes. *Bot. Rev.* 7: 1-59.
- Van Cleave, H.J. 1933. An amphibious habitat on vertical sandstone cliffs. *Ecology* 14: 149-151.
- Waggoner, G.S. 1973. Eastern deciduous forest. Vol. 1. Southeastern Evergreen and Oak-Pine region. Nat. Park Serv., Government Printing Office, Washington, D.C.
- Wagner, R.H. 1964. The ecology of *Uniola paniculata* L. in the dune-strand habitat of North Carolina. *Ecol. Monogr.* 34: 79-96.
- Wells, B.W. 1928. Plant communities of the Coastal Plain of North Carolina and their successional relations. *Ecology* 9: 230-242.
- _____. 1939. A new forest climax: the salt spray climax of Smith Island, North Carolina. *Bull. Torr. Bot. Club* 66: 629-634.
- _____. 1942. Ecological problems of the southeastern United States coastal plain. *Bot. Rev.* 8: 533-561.
- _____ and I.V. Shunk. 1928. A southern upland grass-sedge bog. *N.C. Agr. Exp. Sta. Tech. Bull.* 32.
- _____ and I.V. Shunk. 1931. The vegetation and habitat factors of the coarser sands of the N.C. Coastal Plain: an ecological study. *Ecol. Monogr.* 1: 465-520.
- Wharton, C.W. 1970. The Southern River Swamp - a multiple-use environment. Bureau of Business and Economic Research, Georgia State University. Atlanta.
- Wharton, C.H. 1977. The Natural Environments of Georgia. Georgia Department of Natural Resources. Atlanta. 1977.
- _____, H.T. Odum, K. Ewel et al. 1977. Forested wetlands of Florida: their management and use. Final report to Division of State Planning on a contract for a forested wetlands manual.
- _____, W.M. Kitchens, E.C. Pendleton, and T.W. Sipe. 1982. The ecology of bottomland hardwood swamps of the southeast: a community profile. U.S. Fish and Wildlife Service, Biol. Services Progr., Washington, D.C. 1982.
- Whittaker, R.H. 1956. Vegetation of the Great Smoky Mountains. *Ecol. Monogr.* 26: 1-80.
- Wieder, R.K., A.M. McCormick, and G.E. Lang. 1981. Vegetational analysis of Big Run Bog, a non-glaciated Sphagnum bog in West Virginia. *Castanea* 46: 16-29.
- Williams, L.G. 1951. Life of the reefs off the Carolinas. Abstract, *Bull. S.C. Acad. Sci.* 8: 22-23.

Zingmark, R.G. ed. 1978. An annotated checklist of the biota of the coastal zone of South Carolina. Belle Baruch Institute. USC Press, Columbia.

Zobell, C.E. and C.B. Feltham. 1942. The bacterial flora of a marine mud flat as an ecological factor. *Ecology* 23: 69-78.