

**ADDENDUM TO THE**

**GUIDE TO THE NATURAL COMMUNITIES**

**OF THE DELAWARE ESTUARY**



**SEPTEMBER 2009**

Citation: Largay, E. and L. Sneddon. 2009. Addendum to the Guide to the Ecological Systems and Vegetation Communities of the Delaware Estuary. NatureServe. Arlington, Virginia. Partnership for the Delaware Estuary, Report #09-XX. 112 pp.

PDE Report No. 09-XX

Copyright © 2009 NatureServe

---

COVER PHOTOS

Top L: Overwash Dunes, photo from Delaware Natural Heritage Program

Top R: Coastal Plain Muck Pondshore, photo by Kathleen Strakosch Walz, New Jersey Natural Heritage Program

Bottom L: Dry Oak Hickory Forest, photo by Tony Davis, Pennsylvania Natural Heritage Program

Bottom R: Inland Dune and Ridge Forest/Woodland, Kathleen Strakosch Walz, New Jersey Natural Heritage Program

# ADDENDUM TO THE GUIDE TO THE NATURAL COMMUNITIES OF THE DELAWARE ESTUARY

Ery Largay  
Lesley Sneddon

September 2009



## **Acknowledgements:**

This work was made possible through funding from the Delaware Estuary Program (EPA 320 Funding). Kristin Snow and Mary Russo from NatureServe provided essential data management services to develop this report and report format. Robert Coxe and Bill McAvoy from the Delaware Natural Heritage Program, Kathleen Strakosch Walz from the New Jersey Natural Heritage Program, Tony Davis from the Pennsylvania Natural Heritage Program, Linda Kelly and Karl Anderson, independent botanists, provided ecological expertise, energy and insight. Mark Anderson and Charles Ferree from The Nature Conservancy developed ecological systems maps to accompany this work. Danielle Kreeger, Laura Whalen, and Martha-Maxwell Doyle from the Partnership for the Delaware Estuary provided support and guidance throughout this project. We thank everyone who helped us with this effort.

Established in 1996, the Partnership for the Delaware Estuary is a non-profit organization based in Wilmington, Delaware. The Partnership manages the Delaware Estuary Program (DELEP), one of 28 estuaries recognized by the U.S. Congress for its national significance under the Clean Water Act. DELEP is the only tri-state, multi-agency National Estuary Program in the country. In collaboration with a broad spectrum of governmental agencies, non-profit corporations, businesses, and citizens, the Partnership works to implement the Delaware Estuary's Comprehensive Conservation Management Plan to restore and protect the natural and economic resources of the Delaware Estuary and its tributaries. Lead agency partners include: Delaware Department of Natural Resources and Environmental Control; Delaware River Basin Commission; New Jersey Department of Environmental Protection; Pennsylvania Department of Environmental Protection; City of Philadelphia; National Park Service; National Oceanic and Atmospheric Administration; U.S. Environmental Protection Agency, Regions II and III; and, the U.S. Fish and Wildlife Service.

NatureServe is a non-profit conservation organization that provides scientific information and tools needed to help guide effective conservation action. NatureServe and its network of Natural Heritage programs are the leading source for information about rare and endangered species and threatened ecosystems. NatureServe represents an international network of biological inventories—known as natural heritage programs or Conservation Data Centers—operating in all 50 U.S. states, Canada, Latin America and the Caribbean.

## TABLE OF CONTENTS

|  |    |
|--|----|
| INTRODUCTION .....   | 10 |
| CLASSIFICATION APPROACH .....  | 11 |
| International Terrestrial Ecological Systems Classification .....                          | 11 |
| U.S. National Vegetation Classification System.....  | 11 |
| DATA COLLECTION & MAINTENANCE .....  | 12 |
| NatureServe.....   | 12 |
| Data Gaps.....   | 12 |
| FORMAT OF THIS REPORT .....  | 13 |
| Ecological Systems.....  | 13 |
| Vegetation Communities.....  | 14 |
| <i>Ecological System:</i> Northern Atlantic Coastal Plain Hardwood Forest .....            | 18 |
| Inland Dune Ridge Forest.....  | 19 |
| Mixed Oak-Pine Forest .....  | 20 |
| Shortleaf Pine / (Southern Red Oak, Water Oak) / Hillside Blueberry Forest .....           | 21 |
| <i>Ecological System:</i> Northern Atlantic Coastal Plain Maritime Forest.....             | 24 |
| Mid-Atlantic Coastal Maritime Forest .....   | 25 |
| Loblolly Pine / Wax-myrtle / Saltmeadow Cordgrass Tidal Woodland.....                      | 27 |
| Coastal Loblolly Pine Wetland Forest .....   | 28 |
| North Atlantic Coast Maritime Post Oak Forest .....  | 29 |
| Maritime Holly Forest.....   | 31 |
| Maritime Red-cedar Woodland .....  | 32 |
| Successional Maritime Forest.....  | 34 |
| Chesapeake Bay Tall Maritime Shrubland.....  | 35 |
| Northern Tall Maritime Shrubland .....   | 37 |
| Ecological System: Northern Atlantic Coastal Plain Basin Swamp & Wet Hardwood Forest ..... | 40 |
| Red Maple - Sweetgum Swamp .....   | 41 |
| Central Coastal Plain Basin Swamp .....  | 42 |
| Pond Pine Woodland .....   | 44 |
| Swamp Cottonwood Coastal Plain Pond .....  | 45 |
| Ecological System: Northern Atlantic Coastal Plain Basin Peat Swamp .....                  | 48 |
| Twig-rush Peat Mat.....  | 49 |
| <i>Ecological System:</i> Northern Atlantic Coastal Plain Pitch Pine Barrens.....          | 52 |

|  |     |
|--|-----|
| Pine Barrens Pine – Oak Woodland .....   | 53  |
| <i>Ecological System:</i> Northern Atlantic Coastal Plain Pitch Pine Lowland .....               | 56  |
| Pine Barrens Lowland Forest.....   | 57  |
| <i>Ecological System:</i> Northern Atlantic Coastal Plain Stream and River.....                  | 58  |
| Chesapeake/ Piedmont Red Maple / Lizard's-tail Swamp .....                                       | 59  |
| Coastal Plain Atlantic White-cedar - Red Maple Swamp .....                                       | 60  |
| Atlantic White-cedar / Seaside Alder Swamp.....  | 61  |
| Southern Red Maple - Blackgum Swamp Forest .....   | 62  |
| Red Maple - Sweetgum Swamp .....   | 64  |
| Swamp-loosestrife Shrub Swamp.....   | 66  |
| <i>Ecological System:</i> Northern Atlantic Coastal Plain Pond .....                             | 68  |
| Smartweed - Cutgrass Beaver Pond .....   | 70  |
| Swamp Cottonwood Coastal Plain Pond .....  | 71  |
| Chainfern Small Depression Pond .....  | 72  |
| <i>Ecological System:</i> Northern Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh .... | 74  |
| Brackish Tidal Creek Shrubland .....   | 75  |
| Oligohaline Mixed Forbs Tidal Marsh .....  | 76  |
| <i>Ecological System:</i> Northern Atlantic Coastal Plain Tidal Salt Marsh.....                  | 78  |
| Loblolly Pine / Wax-myrtle / Saltmeadow Cordgrass Tidal Woodland.....                            | 79  |
| Eastern Tidal Salt Shrub .....   | 80  |
| Wax Myrtle Swale .....   | 82  |
| <i>Ecological System:</i> Northern Atlantic Coastal Plain Dune and Swale .....                   | 84  |
| Mid-Atlantic Coast Backdune Grassland.....   | 85  |
| <i>Ecological System:</i> Northeastern Interior Dry-Mesic Oak Forest.....                        | 88  |
| Central Appalachian Dry-Mesic Chestnut Oak - Northern Red Oak Forest .....                       | 89  |
| Northern Piedmont Mesic Oak - Beech Forest .....   | 90  |
| Northeastern Dry Oak-Hickory Forest.....   | 91  |
| <i>Ecological System:</i> North-Central Appalachian Acidic Cliff and Talus.....                  | 94  |
| Eastern Temperate Acidic Cliff .....   | 95  |
| <i>Ecological System:</i> Central Appalachian River Floodplain .....                             | 98  |
| Riverine Floodplain Forest (Early-Successional Type) .....                                       | 99  |
| <i>Ecological System:</i> Central Appalachian Stream and Riparian .....                          | 102 |
| Central Appalachian / Piedmont Bedrock Floodplain Woodland.....                                  | 103 |
| Central Appalachian Basic Seepage Swamp.....   | 105 |
| Central Appalachian Cutgrass Marsh .....   | 107 |
| Southern New England Red Maple Seepage Swamp.....  | 109 |
| Willow River-Bar Shrubland .....   | 110 |

|   |     |
|---|-----|
| Semi-Natural / Altered Vegetation & Conifer Plantations ..... | 112 |
| Northeastern Modified Successional Forest .....               | 113 |
| Successional Sweetgum Forest.....                             | 114 |
| Successional Tuliptree Forest (Circumneutral Type) .....      | 115 |
| Successional Tuliptree Forest (Acidic Type).....              | 117 |
| Virginia Pine Successional Forest .....                       | 118 |
| Early- to Mid-Successional Loblolly Pine Forest .....         | 120 |
| Old-field Eastern Red-cedar Forest .....                      | 122 |
| White Pine Plantation .....                                   | 123 |
| Loblolly Pine Plantation .....                                | 124 |
| Norway Spruce Plantation .....                                | 125 |
| Red Pine Plantation .....                                     | 126 |
| Japanese Black Pine Forest .....                              | 127 |
| Northeastern Successional Shrubland.....                      | 128 |
| Steeplebush / Reed Canarygrass Successional Wet Meadow .....  | 129 |
| Golden Bamboo Shrubland.....                                  | 130 |
| Wisteria Vineland .....                                       | 131 |
| Northeastern Old Field.....                                   | 132 |
| Upland Switchgrass Vegetation .....                           | 133 |
| Eastern Reed Marsh.....                                       | 134 |
| River Seedbox Marsh .....                                     | 135 |

|  |     |
|--|-----|
| APPENDIX A. UPDATES TO THE <i>GUIDE TO THE NATURAL COMMUNITIES OF THE DELAWARE ESTUARY</i> ..... | 138 |
|--|-----|

|                |     |
|----------------|-----|
| GLOSSARY ..... | 140 |
|----------------|-----|

|                   |     |
|-------------------|-----|
| BIBLIOGRAPHY..... | 148 |
|-------------------|-----|





## TABLE OF FIGURES

|  |    |
|--|----|
| Figure 1. Delaware Estuary Watershed .....   | 10 |
| Figure 2. Categories used to describe the spatial pattern of an ecological system within the landscape.....                      | 14 |
| Figure 3. Global ranks indicate the relative rarity or imperilment of an ecological community or species at a global scale ..... | 15 |



## INTRODUCTION

The Delaware Estuary Watershed is comprised of a rich mosaic of natural communities across a diverse landscape. Natural communities are unique assemblages of plants and animals that reoccur within specific environmental settings. These unique assemblages can reflect ecological conditions at a scale broader than the species population, yet more refined than the landscape. Natural communities can address both species and function. In this sense, natural communities can be barometers of ecological health. Communities such as mixed oak forests and serpentine barrens, salt marsh and salt pannes, support a wide array of life and perform important ecological functions. Upland forests help recharge aquifers while lowland wetlands provide natural flood control. When taken as an interconnected whole, the health of our natural communities helps determine the overall well-being of the watershed.

The Delaware Estuary Watershed encompasses nearly 7,000 square miles in Delaware, New Jersey, and Pennsylvania. It consists of the entire drainage basin of the Schuylkill River, Lower Delaware River, and Delaware Bay. It includes portions of twenty-two counties, over five hundred townships, and contains three major metropolitan areas: Philadelphia, Pennsylvania; Camden, New Jersey; and Wilmington, Delaware.

The Delaware Estuary's unique assemblage of ecological systems and natural communities indicates a rich diversity across a varied landscape. The significant biological diversity of the region is owed, in part, to its physical location, crossing four eco-regions: the Central Appalachian Forest; the Lower New England/Northern Piedmont; the North Atlantic Coast; and, the Chesapeake Bay Lowlands (Figure 1). Eco-regions represent geographically distinct assemblages of vegetation types that have similar ecological dynamics, comparable environmental conditions, and share many of the same species (Comer et al. 2003).

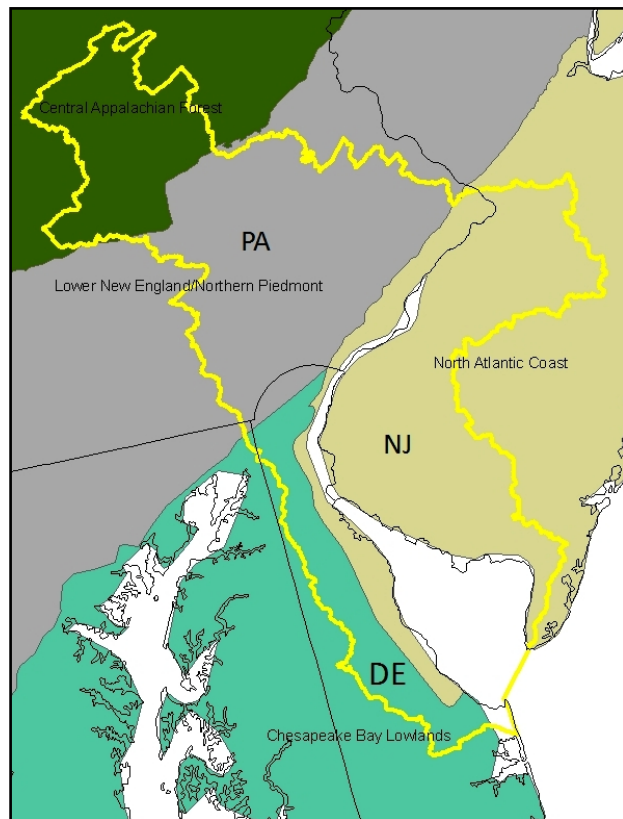


Figure 1. The Delaware Estuary watershed crosses four eco-regions and three states.

This document provides updated ecological system descriptions and identifies additional natural communities that occur in the estuary from those presented in the *Guide to the Natural Communities of the Delaware Estuary (Guide)* developed by the Partnership for the Delaware Estuary, NatureServe and its network of Natural Heritage Programs in 2006. It also provides a summary of changes from the *Guide* in Appendix A.

## **CLASSIFICATION APPROACH**

Two complementary classification systems are used to identify and describe the terrestrial portion of the Delaware Estuary. Ecological systems are identified using the International Terrestrial Ecological Systems Classification and natural communities are identified using the U.S. National Vegetation Classification System (USNVC), a subset of the International Vegetation Classification System.

### **International Terrestrial Ecological Systems Classification**

An ecological system represents a recurring group of natural community types that are found in similar physical environments. Ecological systems are defined, in part, by the influences of dynamic processes, such as fire or flooding, environmental features, substrates, and the biological communities associated with them. Multiple environmental factors are evaluated and combined in different ways to explain the spatial co-occurrence of plant communities. These include: bioclimate; biogeographic history; physiography; landform; physical and chemical substrates; dynamic processes; landscape juxtaposition; and, vegetation structure and composition. These factors help to explain why particular natural communities tend to be found together in a given ecological system (Comer et al. 2003).

NatureServe and its Natural Heritage program members developed the International Terrestrial Ecological System Classification to provide a reasonable scale for conservation assessment, mapping, land management, monitoring, and species habitat modeling. Ecological systems are practical mid-scale units that can be mapped from remote imagery and are readily identifiable in the field. They use both spatial and temporal scales to define them. The spatial scale of an ecological system ranges from 10s to 1,000s of hectares and temporal scales range from 50 to 1,000 years. The temporal scale allows typical successional dynamics to be integrated into the concept of each ecological system. Within any given ecological system, associated natural communities may be a representation of various successional stages of development (Comer et al. 2003).

### **U.S. National Vegetation Classification System**

Vegetation communities in this document refer to the plant association level of the U.S. National Vegetation Classification System (USNVC). The USNVC provides a complete, standardized listing and description of all the vegetation types that represent the variation in biological diversity at the community level. It is a comprehensive system that classifies all terrestrial vegetation in the country under a common framework (Grossman et al. 1998). It identifies vegetation units based on both qualitative and quantitative data at a scale that is practical for conservation.

The USNVC was adopted by the Federal Geographic Data Committee as the reporting standard for all federal agencies involved in the management of vegetation. This standardization allows for the comparison of vegetation types across political, jurisdictional, and geographic boundaries. This is incredibly important to conservation professionals working in multiple states. It provides a common language for ecological communities, thereby making it possible to assess, monitor, compare, and evaluate across jurisdictions.

Just as ecological systems are comprised of vegetation communities, vegetation communities are comprised of species. They are unique assemblages of species that co-occur in defined areas at certain times and that have the potential to interact with one another (Maybury 1999). A vegetation community has also been defined as "a recurring plant association with a characteristic range in species composition, specific diagnostic species, and a defined range in habit conditions and physiognomy or structure" (Vegetation Classification Panel, Ecological Society of America, 2002). All types of vegetation—natural and cultural—may be classified by the USNVC, but efforts have been largely focused on mid-to late-seral (successional-stage), natural/near-natural vegetation. Less-natural and early successional vegetation are classified on an as-needed basis for use in various applications (Grossman et al 1998).

The USNVC uses a systematic approach to classifying a continuum. It uses a combined physiognomic-floristic hierarchy to organize vegetation types. There are seven levels in the USNVC. Five levels are based on physiognomic classifiers including vegetation structure (forest, woodland, shrubland, dwarf shrubland, herbaceous vegetation, and sparse vegetation); leaf phenology (evergreen, deciduous, mixed); leaf characteristics (needle-leaf, broad-leaf); natural/semi-natural or cultural vegetation; and, environmental setting. The two lower levels of the classification, the alliance and the association, are based on floristics. Both levels are based on dominant or diagnostic species. The alliance is a group of associations and of wider geographic extent than the association. The basic unit of the classification is the association, or vegetation community.

## **DATA COLLECTION & MAINTENANCE**

The *Addendum* represents the compilation of existing data from Natural Heritage Programs in New Jersey, Pennsylvania, and Delaware. Information is entered into NatureServe's database where it is updated regularly and queried for periodic reports.

### **NatureServe**

NatureServe is the parent organization of the Natural Heritage Programs in all 50 states, plus the Conservation Data Centres in Canada, Latin America, and the Caribbean. NatureServe maintains data collected through the heritage network in their Biotics database and serves as a clearinghouse for scientific conservation information. NatureServe maintains a searchable database that can be accessed at [www.natureserve.org](http://www.natureserve.org).

### **Data Gaps**

As with many classification projects, the *Addendum* is the product of an iterative process and a "snapshot" of the current state of the information and provides updates to the initial vegetation classification for the estuary, *Guide to the Natural Communities of the Delaware Estuary* completed in 2006. The data, however, will continue to be refined and updated as more data are collected and analyzed over time. This document represents an addendum to the watershed's vegetation classification. Additional ecological inventory is needed to identify vegetation communities that may occur in the watershed but have not been classified or described in this report. Further, some community types that have been classified are missing information and require further inventory to

fill those data gaps. This data may be pertinent to restoration efforts and can include information on successional trajectory, management concerns, noteworthy species, and reference site locations.

## FORMAT OF THIS REPORT

The *Addendum* contains updated descriptions for most of the ecological systems described in the *Guide* and provides descriptions for natural vegetation communities that have been confirmed to occur in the Delaware Estuary since the publication of the *Guide*. These occurrences have been verified by Natural Heritage data. The descriptions of the vegetation communities are arranged in this document by ecological systems. Community descriptions have photographs (where available), vegetation and environmental descriptions, reference site locations, links to raw plot data, and conservation ranks. The data for this report was extracted from NatureServe's database, Biotics 4, and are current as of July 2009. Nomenclature for plants follows Kartesz 1999. A glossary of terms is provided at the end of this document.

## Ecological Systems

The International Terrestrial Ecological Systems Classification includes components that communicate aspects of the system's characteristics. Below is an explanation of the information contained in the ecological system descriptions in the *Addendum*.

Name of Ecological System: The nomenclature for the classification includes three primary components that communicate aspects of the system's characteristics, including its regional distribution (predominant Ecological Division), vegetation physiognomy and composition, and/or environmental setting. The final name used is a combination of these ecological characteristics, with consideration given to local usage and practicality (e.g. length of name).

Summary: This is a brief description of the range, structure, composition, environmental setting, and dynamics associated with the ecological system.

High-Ranked Species: This field reports at-risk species that are closely associated with an ecological system. High-ranked species are considered animals, vascular plants, non vascular plants, and USNVC plant associations ranked as critically imperiled (G1), imperiled (G2), or vulnerable (G3). Relationships between species, communities, and ecological systems were determined by expert review conducted by NatureServe and Natural Heritage zoologists, botanists, and ecologists as well as available data on element occurrences (Comer et al. 2005). It should be noted that the database was queried for the global range of the ecological systems, so not all species listed will be known from the Mispillion Watershed. Common names are included for the plant and animal species; however, some of the non-vascular species (liverworts, mosses, lichen) do not have common names assigned to them.

Range: Current total extent of the ecological system, and states and other geographic areas where the system is known to occur.

Delaware Estuary Addendum Associations: Additional communities from those in the *Guide* that have been identified as occurring in the Delaware Estuary within the specified ecological system. These communities tend to co-occur within landscapes with similar ecological processes, substrates, and/or environmental gradients.

Classifiers: Classifiers help with the identification of an ecological system. They impart classification information including: primary division, an assigned sub-continental ecological landscape area reflecting both climate and biogeographic history; land cover class, a general vegetation type that corresponds with the National Land Cover Data; spatial scale and pattern (see Figure 2); required classifiers, the environmental factors always contained within an ecological system; diagnostic classifiers; and, non-diagnostic classifiers.

Similar Ecological Systems in the Delaware Estuary: These are often adjacent or related ecological systems located within the Delaware Estuary.

### **Vegetation Communities**

The terms "Community" and "USNVC Association" are used interchangeably and refer to the plant-association scale of the USNVC hierarchy. Below is an explanation of the information contained in the natural community descriptions.

Name of Vegetation Community Type: The first name listed in each description is the common or colloquial name of the vegetation community (association) used by NatureServe. The scientific name is listed next. Scientific names are based on the dominant and diagnostic species. Species occurring in the same stratum are separated by a hyphen (-). Those occurring in different strata are separated by a slash (/). Species occurring in the uppermost strata are listed first, followed successively by those in lower strata. Within the same stratum, the order of species names generally reflects decreasing levels of dominance, constancy, or indicator value. In types where there is a dominant herbaceous layer with a scattered woody layer, names can be based on species found in either the herbaceous layer or the woody layer, whichever is more diagnostic of the type. If both layers are used, then the uppermost layer is always listed first, regardless of which may be more diagnostic. Species found less consistently are placed in parentheses (). In cases where a particular genus is dominant or diagnostic, but individual species of the genus may vary among occurrences, only the specific epithets are placed in parentheses.

Range: This is a description of the total range (present and historic) of the community, using names of nations, subnations or states, ecoregions, etc.

### **Classifier: Spatial Scale and Pattern**

One of four spatial categories defined by Anderson et al. 1999 and Poiani et al. 2000 to describe the spatial pattern of the ecological system within the landscape:

Matrix: Systems that form extensive and contiguous cover and have wide ecological tolerances. Disturbance patches typically occupy a relatively small percentage (e.g. <5%) of the total occurrence. In disturbed conditions, typical occurrences range in size from 2,000 to 10,000 ha.

Large-patch: Systems that form large areas of interrupted cover and have narrower ranges of ecological tolerances than matrix types. Individual disturbance events tend to occupy patches that can encompass a large portion of the overall occurrence (e.g. >20%). Given common disturbance dynamics, these types may tend to shift somewhat in location within large landscapes over time spans of several hundred years. In undisturbed conditions, typical occurrences range from 50 to 2,000 ha.

Small patch: Systems that form small, discrete areas of vegetation cover typically limited in distribution by localized environmental features. In undisturbed conditions, typical occurrences range from 1 to 50 ha.

Linear: Systems that occur as linear strips. They are often ecotonal between terrestrial and aquatic ecosystems. In undisturbed conditions, typical occurrences range in linear distance from 0.5 to 100 km.

Figure 2. Categories used to describe the spatial pattern of an ecological system within the landscape.

Environmental Description: This is a summary field that describes environmental site factors including aspect, elevation, landform, slope, topographic position, soil type, soil moisture, and hydrologic modifiers. Landscape context and geology may also be included. In general, the flow of information is from the broad to the specific.

Vegetation Description: This is a summary of information available on the leaf type and phenology, species composition and structure, and variability of the vegetation within the community.

Noteworthy Associated Plant and/or Animal Species: These are plants and animals that may occur within the community or use the community as habitat. Typically these are rare, endangered, or threatened species at the state or national level.

Characteristic Species: This field lists plant species that are almost always found in a particular community and are used in establishing the boundary of that community. It may include the more analytical concepts of diagnostic species, indicator species, and differential species.

Dynamics/Successional Trajectory: This summarizes important natural disturbance regimes, successional status, and temporal dynamics of a community.

Management Concerns: This is a summary of existing information on the challenges related to maintaining the integrity of an ecological community. This includes threats such as invasive species, browsing, pests, diseases, etc.

Reference Sites: This field identifies locations of high quality examples of communities located on public lands. This field is especially useful to restoration practitioners interested in locating systems of reference, validating restoration targets, establishing performance standards based on the reference state, and monitoring based on performance standards (Society for Ecological Restoration International, 2004).

Global and State Conservation Rank and Reasons: This field refers to the relative rarity or imperilment of the community type and summarizes the reasons why the rank was assigned (Figure 3). G ranks refer to the conservation status of the community type from a range-wide global perspective. S ranks refer to the status of the community type throughout its range in a state. State and global ranks are used to prioritize conservation efforts so that the rarest natural communities receive more immediate protection. Ranks are determined by the number of known occurrences of a particular natural community, field investigations, and consensus in the

| Global/State<br>Conservation Status Ranks   |
|---|
| G1/S1 = Critically imperiled globally/state-wide, generally 5 or fewer occurrences and/or very few remaining acres or very vulnerable to elimination throughout its range |
| G2/S2 = Imperiled globally/statewide, generally 6-20 occurrences  |
| G3/S3 = Rare or uncommon, generally 21-100 occurrences  |
| G4/S4 = Apparently secure   |
| G5/S5 = Demonstrably widespread, abundant and secure  |
| GH/SH = Historical, presumed eliminated throughout its range  |
| GX/SX = Extirpated  |
| GNA = Rank not applicable   |
| GNR/SNR = Not ranked  |
| GNR = Globally not ranked   |

Figure 3. Global ranks indicate the relative rarity or imperilment of an ecological community or species at a global scale.



scientific community. S ranks are demarcated along the same scale as G ranks.

VegBank Link for Plot Data: This is a web link to the plot data for the specific community where the data exists. VegBank is the vegetation plot database of the Ecological Society of America's Panel on Vegetation Classification. VegBank consists of three linked databases that contain (1) the actual plot records, (2) vegetation types recognized in the U.S. National Vegetation Classification and other vegetation types submitted by users, and (3) all plant taxa recognized by ITIS/USDA as well as all other plant taxa recorded in plot records. Vegetation records, community types, and plant taxa may be submitted to VegBank and may be subsequently searched, viewed, annotated, revised, interpreted, downloaded, and cited. The website for VegBank is: <http://vegbank.org> (ESA 2005).

References: This field provides a list of references that have contributed directly to the concept of the described community. Full-text citations are listed at the end of the report.

Most Abundant Species: This is a summary table naming the most abundant species of each strata for the community. These tables should be updated in future iterations of this report as more plot data is collected on vegetation communities.



---

## ECOLOGICAL SYSTEM: NORTHERN ATLANTIC COASTAL PLAIN HARDWOOD FOREST

---

**Summary:** This system is comprised of dry hardwood forests largely dominated by oaks, ranging from sandy glacial and outwash deposits of Cape Cod, Massachusetts, and Long Island, New York, south to the Coastal Plain portions of Maryland and Virginia south to about the James River. In the northern half of the range, conditions can grade to dry-mesic, reflected in the local abundance of *Fagus grandifolia* (American beech).



Photo by NatureServe

These forests occur on acidic, sandy to gravelly soils with a thick duff layer, often with an ericaceous shrub layer.

**Range:** This system ranges from sandy glacial and outwash deposits of Massachusetts and Long Island, New York (and occasionally north to southern Maine), south to the Coastal Plain portions of Maryland and Virginia, south to about the James River. United States: CT, DE, MA, MD, ME?, NH?, NJ, NY, VA

**Addendum Comment:** This ecological system replaces Atlantic Coastal Plain Mesic Hardwood Forest included in the *Guide* because the range of the ecological system has been revised and occurs south of the Delaware Estuary. All natural communities listed in the *Guide* are included in this Northern Atlantic Coastal Plain Hardwood Forest ecological system. Additional natural communities not listed in the *Guide* are described below.

### Delaware Estuary Addendum Associations:

- Inland Dune Ridge Forest
- Mixed Oak-Pine Forest
- Shortleaf Pine / (Southern Red Oak, Water Oak) / Hillside Blueberry Forest

### CLASSIFIERS FOR NORTHERN ATLANTIC COASTAL PLAIN HARDWOOD FOREST

Primary Division: 203

Land Cover Class: Forest and Woodland

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Forest and Woodland (Treed); Long Disturbance Interval; Broad-Leaved Deciduous Tree

---

## INLAND DUNE RIDGE FOREST

*Pinus virginiana* - *Quercus falcata* - *Carya pallida* Forest

---

**Range:** This association is currently described for the central Atlantic Coastal Plain, from New Jersey, Delaware, Maryland, and Virginia. It occurs in the New Jersey portion of the Delaware Estuary and possibly the Delaware portion.

**Environmental Description:** This xeric pine forest occurs on inland sand dune ridges and sandy loam soils at the edge of the Pine Barrens.

**Vegetation Description:** *Pinus virginiana* (Virginia pine) is codominant with a variety of oak species, including *Quercus falcata* (southern red oak), *Quercus alba* (white oak), *Quercus stellata* (post oak), and *Quercus velutina* (black oak). *Carya pallida* (sand hickory) and *Carya alba* (mockernut hickory) can also occur. Other canopy and subcanopy associates may include *Sassafras albidum* (sassafras), *Pinus taeda* (loblolly pine), *Quercus prinus* (chestnut oak), *Quercus marilandica* (blackjack oak), *Prunus serotina* (black cherry), *Cornus florida* (flowering dogwood), *Nyssa sylvatica* (blackgum), and *Diospyros virginiana* (eastern persimmon). The shrub layer may include *Gaylussacia frondosa* (dangleberry), *Ilex opaca* (American holly), *Vaccinium pallidum* (hillside blueberry), *Gaylussacia baccata* (black huckleberry), *Kalmia angustifolia* (sheep laurel), *Comptonia peregrina* (sweet-fern), and *Vaccinium stamineum* (deerberry). The herbaceous layer is generally sparse but is more abundant in openings. Characteristic herbs may include *Cypripedium acaule* (pink lady's-slipper), *Carex nigromarginata* (black-edge sedge), *Carex albicans* (white-tinge sedge), *Carex albicans* var. *emmonsii* (emmons' sedge), *Tephrosia virginiana* (goat's-rue), *Dichantherium commutatum* (variable rosette grass), *Dichantherium ovale* (eggleaf rosette grass), *Chimaphila maculata* (striped pipsissewa), *Melampyrum lineare* (narrowleaf cow-wheat), and *Mitchella repens* (partridgeberry). Less frequent species may include *Baptisia tinctoria* (yellow wild indigo), *Lupinus perennis* (wild lupine), *Pteridium aquilinum* (bracken fern), *Chimaphila umbellata* (prince's-pine), *Monotropa uniflora* (Indian-pipe), and *Desmodium strictum* (pineland tick-trefoil). Lichens of the genera *Cladonia* (cup lichen) and *Cladina* (reindeer lichen) are common. Vines such as *Smilax glauca* (whiteleaf greenbrier), *Smilax rotundifolia* (roundleaf greenbrier), *Parthenocissus quinquefolia* (Virginia creeper), and *Vitis rotundifolia* (muscadine) are common at low cover.

**Characteristic Species:** *Pinus virginiana* (Virginia pine)

**Reference Sites:** Unexpected Refuge, Maurice River, NJ; potentially Cape Henlopen, DE

**Global and State Conservation Ranks and Reasons:** GNR (1-Dec-1997). DE: SNR.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.683939](http://vegbank.org/natureserve/element_global.2.683939)

**References:** Bartgis 1986, Berdine 1998, Bowman 2000, Breden et al. 2001, Clancy 1996, Eastern Ecology Working Group n.d., Fleming et al. 2001, Harrison 2004, Harrison pers. comm., Windisch pers. comm.

| MOST ABUNDANT SPECIES |                              |   |
|-----------------------|------------------------------|---|
| STRATUM               | LIFEFORM                     | SPECIES                                   |
| Tree canopy           | Needle-leaved tree           | <i>Pinus virginiana</i> (Virginia pine)   |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Quercus alba</i> (white oak)           |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Quercus falcata</i> (southern red oak) |
| Short shrub/sapling   | Broad-leaved deciduous shrub | <i>Gaylussacia frondosa</i> (dangleberry) |

---

## MIXED OAK-PINE FOREST

*Pinus rigida* - *Quercus coccinea* - *Quercus falcata* / (*Quercus marilandica*) / *Gaylussacia frondosa*  
Woodland

---

**Range:** This association occurs on the Coastal Plain of New Jersey and Maryland.

**Environmental Description:** This community is associated with xeric, sublevel, sandy uplands. In Maryland, soils are unconsolidated sands of the Patuxent Formation and are extremely acidic with exceedingly low base cation and base saturation levels, indicating extreme infertility.

### Vegetation Description:

Current examples of this community vary from woodlands to open forests. The overstory consists of *Pinus rigida* (pitch pine) mixed with tree oaks, most frequently *Quercus falcata* (southern red oak) and *Quercus coccinea* (scarlet oak). Other associated oaks include *Quercus velutina* (black oak) and *Quercus alba* (white oak). *Pinus virginiana* (Virginia pine) sometimes occurs, and in New Jersey, *Pinus*



Photo by Linda Kelly

*echinata* (short-leaf pine) may be an associate. Maryland occurrences may also include *Myssa sylvatica* (black gum) and *Liquidambar styraciflua* (sweet gum) in the canopy. The tall-shrub layer is characterized by *Ilex opaca* (American holly), *Sassafras albidum* (sassafras), and occasionally *Kalmia latifolia* (mountain laurel). A short-shrub layer is dominated by *Gaylussacia frondosa* (blue huckleberry), *Gaylussacia baccata* (black huckleberry), and *Vaccinium pallidum* (Blue Ridge blueberry). The herbaceous or field layer is usually sparse and may include *Smilax glauca* (cat greenbrier), *Chimaphila maculata* (striped prince's pine), *Gaultheria procumbens* (eastern teaberry), *Carex pensylvanica* (Pennsylvania sedge), and *Cypripedium acaule* (pink lady's slipper).

**Characteristic Species:** *Pinus rigida* (pitch pine), *Quercus falcata* (southern red oak), *Quercus coccinea* (scarlet oak), *Pinus echinata* (short-leaf pine), *Ilex opaca* (American holly), *Gaylussacia frondosa* (blue huckleberry)

**Reference Sites:** Cape May NWR NJ

**Global and State Conservation Ranks and Reasons:** G2G3 (18-Jan-2006). NJ:SNR.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.687022](http://vegbank.org/natureserve/element_global.2.687022)

**References:** Eastern Ecology Working Group n.d., NatureServe 2005, Windisch 1995b

| MOST ABUNDANT SPECIES        |                              |  |
|------------------------------|------------------------------|--|
| STRATUM                      | LIFEFORM                     | SPECIES  |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Quercus falcata</i> (southern red oak)      |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Quercus coccinea</i> (scarlet oak).         |
| Tree canopy                  | Needle-leaved evergreen tree | <i>Pinus rigida</i> (pitch pine)               |
| Tree canopy                  | Needle-leaved evergreen tree | <i>Pinus echinata</i> (short-leaf pine)        |
| Tree subcanopy               | Broad-leaved evergreen tree  | <i>Ilex opaca</i> (American holly)             |
| Shrub/sapling (tall & short) | Broad-leaved deciduous shrub | <i>Gaylussacia frondosa</i> (blue huckleberry) |

## SHORTLEAF PINE / (SOUTHERN RED OAK, WATER OAK) / HILLSIDE BLUEBERRY FOREST

*Pinus echinata* / *Quercus (falcata, nigra)* / *Vaccinium pallidum* Forest

**Range:** This community has only been documented from the Coastal Plain of Maryland, Delaware, and New Jersey with a limited number of occurrences.

**Environmental Description:** This community occurs on dry, sandy inland dunes and ridges of the Parsonsburg Sand Formation on the Delmarva Peninsula. Inland dunes are best developed on the east sides of rivers and characterized by low-relief and a parabolic shape suggesting formation by northwest winds (Denny and Owens 1979). Habitats are very dry and support pyrophytic mixed woodlands of pine, oak, ericaceous shrubs, and light-demanding xerophytes.

### Vegetation Description:

These woodlands are often codominated by *Pinus echinata* (shortleaf pine) (10-25% cover), *Pinus taeda* (loblolly pine) (5-10%), *Quercus falcata* (southern red oak) (10-25%), and *Quercus nigra* (water oak) (5-10%) in the canopy. Also characteristic but less frequent are trees of *Carya pallida* (sand hickory), *Quercus velutina* (black oak), *Diospyros virginiana* (common persimmon), and *Quercus stellata* (post oak). A relatively open tall-shrub stratum is characterized by *Ilex opaca*



Photograph by Linda Kelly

(American holly) at low cover. The short-shrub stratum is patchy, variable and best characterized by *Vaccinium pallidum* (Blue Ridge blueberry) (10-25%). Although slightly less abundant, other ericaceous shrubs that may occupy this stratum include *Gaylussacia baccata* (black huckleberry), *Gaylussacia frondosa* (blue huckleberry), and *Vaccinium stamineum* (deerberry). Vines are sparse but typically include *Smilax glauca* (cat greenbrier) and *Smilax rotundifolia* (roundleaf greenbrier). Herbs are very sparse, often comprising less than 2-5% total cover. Taxa reported from stands include *Baptisia tinctoria* (horseflyweed), *Cypripedium acaule* (moccasin flower), *Carex tonsa* var.

*tonsa* (shaved sedge), *Carex nigromarginata* (black edge sedge), *Carex albicans* (whitetinge sedge), *Chimaphila maculata* (striped prince's pine), *Chimaphila umbellata* (pipsissewa), *Clitoria mariana* (Atlantic pigeonwings), *Dichanthelium commutatum* (variable panicgrass), *Euphorbia ipecacuanhae* (American ipecac), *Melampyrum lineare* (narrowleaf cowwheat), *Mitchella repens* (partridgeberry), and *Pteridium aquilinum* (western brackenfern). Lichens of the genus *Cladonia* (cup lichen) (including *Cladina* (reindeer lichen)) and bryophytes such as *Leucobryum albidum* (leucobryum moss) and *Polytrichum commune* (polytrichum moss) are almost always a component of the ground layer.

**Characteristic Species:** *Pinus echinata* (shortleaf pine), *Quercus falcata* (southern red oak), *Carya pallida* (sand hickory), *Diospyros virginiana* (common persimmon), *Quercus stellata* (post oak), *Ilex opaca* (American holly), *Vaccinium pallidum* (Blue Ridge blueberry)

**Dynamics/Successional Trajectory:** Periodic fire is presumably an important natural disturbance in this type that encourages oak regeneration. Many Virginia stands of this type now have poor oak recruitment and understories dominated by young *Acer rubrum* (red maple) and/or *Fagus grandifolia* (American beech), presumably because of fire exclusion. The relative cover of *Pinus taeda* (loblolly pine) is likely related to disturbance history, with higher pine cover suggesting more recent disturbance.

**Management Concerns:** Mature examples are uncommon, and all stands are vulnerable to logging disturbances and fire suppression.

**Reference Sites:** Tantrough Branch, Mispillion Watershed, DE, Milford Neck, DE; Prime Hook, DE; Maurice River and Manumuskin River, NJ

**Global and State Conservation Ranks and Reasons:** G3 (8-Nov-2007)

**Reasons:** This community has only been documented from the Coastal Plain of Maryland, Delaware, and New Jersey with a limited number of occurrences.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.807522](http://vegbank.org/natureserve/element_global.2.807522)

**References:** Denny and Owens 1979, Eastern Ecology Working Group n.d., Harrison 2007, Shreve et al. 1910, Tatnall 1946

| MOST ABUNDANT SPECIES |                              |   |
|-----------------------|------------------------------|---|
| STRATUM               | LIFEFORM                     | SPECIES   |
| Tree canopy           | Needle-leaved evergreen tree | <i>Pinus echinata</i> (short-leaf pine)             |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Quercus falcata</i> (southern red oak)           |
| Short shrub/sapling   | Broad-leaved deciduous shrub | <i>Vaccinium pallidum</i><br>(Blue Ridge blueberry) |





---

## ***ECOLOGICAL SYSTEM: NORTHERN ATLANTIC COASTAL PLAIN MARITIME FOREST***

---

**Summary:** This system encompasses a range of woody vegetation present on barrier islands and near-coastal strands, from Virginia Beach, the northern range limit of *Quercus virginiana* (live oak), northward to the extent of the Atlantic Coastal Plain. It includes forests and shrublands whose structure and composition are influenced by proximity to marine environments, including both upland and wetlands. These areas are subject to salt spray, high winds, dune deposition, sand shifting and blasting, and occasional overwash during extreme disturbance events. Vegetation includes narrow bands of forests with often stunted trees with contorted branches and wilted leaves and dense vine layers (Edinger et al. 2002). A range of trees may be present depending upon actual location and degree of protection from most extreme maritime influences.

**Range:** This system ranges from Virginia Beach northward to the extent of the Atlantic Coastal Plain. United States: DE, MA, MD, NJ, NY, VA

**Addendum Comment:** The list of component associations for the Northern Atlantic Coastal Plain Maritime Forest ecological system has been updated since the *Guide* was published.

### **Delaware Estuary Addendum Associations:**

- Mid-Atlantic Coastal Maritime Forest
- Loblolly Pine – Wax Myrtle – Saltmeadow Cordgrass Tidal Woodland
- Coastal Loblolly Pine Wetland Forest
- North Atlantic Coast Maritime Post Oak Forest
- Maritime Holly Forest
- Maritime Red Cedar Woodland
- Successional Maritime Forest
- Chesapeake Bay Tall Maritime Shrubland
- Northern Tall Maritime Shrubland

### **Similar Ecological Systems in the Delaware Estuary:**

- Northern Atlantic Coastal Plain Dune and Maritime Grassland

#### **CLASSIFIERS FOR NORTHERN ATLANTIC COASTAL PLAIN MARITIME FOREST**

**Primary Division:** 203

**Land Cover Class:** Forest and Woodland

**Spatial Scale & Pattern:** Large patch

**Required Classifiers:** Natural/Semi-natural; Vegetated (>10% vasc.); Upland; Wetland

**Diagnostic Classifiers:** Forest and Woodland (Treed); Coast

---

## MID-ATLANTIC COASTAL MARITIME FOREST

*Pinus taeda* - *Quercus (falcata, nigra)* / *Morella cerifera* / *Vitis rotundifolia* Forest

---

**Range:** This association occurs along the mid-Atlantic coast from Delaware to North Carolina.

**Environmental Description:** This community occurs on the outer coastal plain and on barrier islands in sheltered backdunes protected from salt spray and overwash. Sites are generally restricted to relict dunes within a few hundred meters of ocean or bay beaches. The substrate is rapidly drained sands or sandy loams which are nutrient poor.

### Vegetation Description:

This community is a mid-Atlantic coastal upland loblolly pine forest dominated by *Pinus taeda* (loblolly pine). Canopy composition varies from nearly pure *Pinus taeda* (loblolly pine) to mixed stands of *Pinus taeda* (loblolly pine), *Quercus falcata* (southern red oak), *Prunus serotina* (black cherry), and *Sassafras albidum* (sassafras), and less frequently *Quercus nigra* (water oak). *Ilex opaca* var. *opaca* (American holly) and *Diospyros virginiana*



Photo by Robert Coxe, Delaware Natural Heritage Program

(persimmon) are frequent understory trees. The tall shrub layer, when present, is comprised of *Morella cerifera* (= *Myrica cerifera*) (wax myrtle) and *Vaccinium corymbosum* (highbush blueberry). Vines and lianas are nearly always present in abundance; *Vitis rotundifolia* (muscadine grape) is most commonly present, but *Toxicodendron radicans* (eastern poison ivy), *Smilax rotundifolia* (muscadine), *Smilax glauca* (whiteleaf greenbrier), and *Parthenocissus quinquefolia* (Virginia creeper) are usually present in abundance as well. The herbaceous layer is typically sparse, particularly if shrubs and vines are dense, but *Chasmanthium laxum* (slender spikegrass) may be fairly abundant in this community. Other herbs include *Mitchella repens* (partridgeberry), *Pityopsis graminifolia* var. *latifolia* (narrowleaf silkgrass), *Dichantheium ovale* (Addison's rosette grass), *Panicum amarum* (bitter panicgrass), *Eupatorium hyssopifolium* (hyssopleaf thoroughwort), and *Elephantopus nudatus* (smooth elephant's-foot). In southern Virginia and North Carolina, *Quercus virginiana* (live oak) and *Gelsemium sempervirens* (Carolina jessamine) may also be present, but *Quercus virginiana* (live oak) is never abundant and when present is usually restricted to the understory. Stands on sheltered flats that have been subject to frequent fires at Chincoteague National Wildlife Refuge and False Cape State Park in Virginia are rather open, with sparse cover of shrubs and vines and moderately high cover of *Chasmanthium laxum* (slender spikegrass) in the herb layer.

**Characteristic Species:** *Pinus taeda* (loblolly pine), *Morella cerifera* (wax-myrtle), *Vitis rotundifolia* (muscadine grape)

**Dynamics/Successional Trajectory:** Some of the pure pine-dominated variants of this association are probably successional, while others are related to environmental stressors that exclude hardwoods. Logging of predominantly live oak maritime forests in North Carolina is suspected to have caused expansion of forests dominated by *Pinus taeda* (Bratton and Davison 1987; Schafale and Weakley 1990), and logging likely impacted the maritime forests of Assateague Island as well (Higgins et al. 1971). However, disturbance brought on by high winds and coastal storms has always been a part of coastal systems, and natural coastal and maritime forests dominated by *Pinus taeda* or mixtures of *Pinus taeda* and hardwoods are likely to have always occurred.

**Reference Sites:** Mispillion Watershed, DE

**Global and State Conservation Ranks and Reasons:** G2 (10-Nov-2008). DE:S2, NJ:SNR. This coastal forest is limited to the immediate vicinity of the coast in southern New Jersey, Delaware, Maryland, and Virginia. EO Rank Estimator v.6.03 was used to assess the global rank. This community has a relatively small geographic range, very narrow environmental specificity, and a substantial overall threat factor from widespread coastal development. Moreover, many existing occurrences have been disturbed by cutting and grazing, and there are relatively few large, protected occurrences.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.685335](http://vegbank.org/natureserve/element_global.2.685335)

**References:** Bartgis 1986, Bratton and Davison 1987, Breden et al. 2001, Clampitt 1991, Clancy 1993a, Clancy 1993b, Clancy 1996, Eastern Ecology Working Group n.d., Fleming 1978, Fleming 1998, Fleming et al. 2001, Harrison 2004, Harvill 1967, Higgins et al. 1971, Hill 1986, J. Harrison pers. comm., Klotz 1986, Schafale and Weakley 1990, Stalter 1990, Stalter and Lamont 1990

| MOST ABUNDANT SPECIES        |                              |   |
|------------------------------|------------------------------|---|
| STRATUM                      | LIFEFORM                     | SPECIES   |
| Tree canopy                  | Evergreen tree               | <i>Pinus taeda</i> (loblolly pine)                    |
| Shrub/sapling (tall & short) | Broad leaved evergreen shrub | <i>Morella cerifera</i> (wax myrtle)                  |
| Shrub/sapling (tall & short) | Vine/Liana                   | <i>Vitis rotundifolia</i> (muscadine grape)           |
| Shrub/sapling (tall & short) | Vine/Liana                   | <i>Smilax rotundifolia</i> (roundleaf greenbrier)     |
| Shrub/sapling (tall & short) | Vine/Liana                   | <i>Toxicodendron radicans</i><br>(eastern poison ivy) |

---

## LOBLOLLY PINE / WAX-MYRTLE / SALTMEADOW CORDGRASS TIDAL WOODLAND

*Pinus taeda* / *Morella cerifera* / *Spartina patens* Tidal Woodland

---

**Range:** This community occurs within mesohaline systems along the shoreline of Maryland's Coastal Plain and Delaware.

**Environmental Description:** These are fringing tidal woodlands characteristic of diurnal to irregularly flooded mesohaline (5.0-18.0 ppt) systems. This community occurs along tidal rivers and creeks but can also occupy narrow ecotones between "high salt marshes" and adjacent uplands and islands in brackish nonriverine habitats. Soils consist of a mixture of silt, fine sands and decomposed organic peat underlain by dark gray, black or greenish-gray silty clayey fine sands and carbonaceous clays.

**Vegetation Description:**

These tidal woodlands are species-poor, structurally open and dominated by *Pinus taeda* (loblolly pine) in the canopy and subcanopy. Occasionally, *Juniperus virginiana* (eastern red cedar), *Acer rubrum* (red maple), *Diospyros virginiana* (common persimmon), *Quercus phellos* (willow oak), and/or *Liquidambar styraciflua* (sweetgum) may occur in the subcanopy. Scattered patches of *Morella cerifera* (wax myrtle) dominate the shrub stratum, along with occasional individuals of *Iva frutescens*



Photo by Robert Coxe, Delaware Natural Heritage Program

(maritime marsh-elder), *Baccharis halimifolia* (groundsel-tree), *Ilex opaca* (American holly), *Prunus serotina* (black cherry), *Acer rubrum* (red maple), and *Juniperus virginiana* (eastern red cedar). *Toxicodendron radicans* (eastern poison ivy) is the predominant vine in these woodlands. The herbaceous community is low in species diversity and primarily comprised of *Spartina patens* (saltmeadow cordgrass), *Panicum virgatum* (switchgrass), and *Distichlis spicata* (saltgrass). *Phragmites australis* (common reed) can be abundant in some stands.

**Characteristic Species:** *Pinus taeda* (loblolly pine), *Morella cerifera* (wax myrtle), *Spartina patens* (saltmeadow cordgrass)

**Dynamics:** This type is the result of the tidally influenced conversion of an upland pine community to a marshland. Stands experience variable levels of flooding, often less than daily, due to fluctuations in groundwater levels and landscape position. It is a short-lived community that is an artifact of sea level rise and marsh subsidence (or lack of vertical accretion) which subsequently allows for a higher frequency of tidal encroachment to the exposed, surrounding upland pine-

dominated communities. Increased frequency and duration of tidal flooding can stunt the growth of the pines, thin crowns, and/or induce mortality.

**Management Concerns:** As a community in large part restricted to barrier islands, it is faced with threats to barrier islands in general: intense development pressures where it remains unprotected. *Phragmites australis* occasionally occurs in this community. Sea level rise may increase the occurrences of this community. A threat to this community is development pressures where it remains unprotected.

**Reference Sites:** Mispillion Watershed, DE

**Global Conservation Rank and Reasons:** This community has not been ranked.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.787718](http://vegbank.org/natureserve/element_global.2.787718)

**References:** Harrison 2004, Schafale 2000

| MOST ABUNDANT SPECIES |                              |  |
|-----------------------|------------------------------|--|
| STRATUM               | LIFEFORM                     | SPECIES  |
| Tree canopy           | Needle-leaved tree           | <i>Pinus taeda</i> (loblolly pine)             |
| Tall shrub/sapling    | Broad-leaved evergreen shrub | <i>Morella cerifera</i> (wax-myrtle)           |
| Tall shrub/sapling    | Liana/Vine                   | <i>Toxicodendron radicans</i> (poison ivy)     |
| Herb (field)          | Graminoid                    | <i>Spartina patens</i> (salt meadow cordgrass) |

---

## COASTAL LOBLOLLY PINE WETLAND FOREST

*Pinus taeda* / *Morella cerifera* / *Osmunda regalis* var. *spectabilis* Forest

---

**Range:** This community ranges from the coast of Delaware and New Jersey to North Carolina.

**Environmental Description:** This maritime/coastal wetland forest occurs in backdune depressions with high water and as an estuarine fringe along bays and sounds. Tree diameters range from 12-36 cm dbh. This community occurs primarily on the bay side of islands, barrier spits and on mainlands adjacent to salt marsh. Soils are characterized by moderately shallow muck (15 cm) overlying organic matter-stained sands. This vegetation occurs adjacent to salt marshes, sometimes even forming small "islands" within high salt marsh. In North Carolina, it may extend well inland fringing bays and sounds on wet saturated flats that are flooded by storm tides. Trees tend to occur on slightly elevated hummocks, with standing water evident in hollows.

**Vegetation Description:** Examples are characterized by a closed to partially open canopy dominated by *Pinus taeda* (loblolly pine). Other canopy associates may be absent or may include *Acer rubrum* (red maple), *Persea palustris* (swampbay), or *Liquidambar styraciflua* (sweetgum). The understory is made up of vines, strongly dominated by *Smilax rotundifolia* (roundleaf greenbrier), with lesser amounts of *Toxicodendron radicans* (eastern poison-ivy) and *Parthenocissus quinquefolia* (Virginia creeper). In addition to comprising the majority of the ground layer of these forests, these vines are relatively large-stemmed lianas that contribute significant cover to the canopy by covering the lower branches of trees. *Morella cerifera* (wax-myrtle) is a typical shrub of this community. The herbaceous layer is usually relatively sparse, characterized most frequently by ferns such as *Woodwardia areolata* (netted chainfern), *Osmunda regalis* var. *spectabilis* (royal fern), or *Osmunda cinnamomea* (cinnamon fern), and farther south (in North Carolina) by *Chasmanthium laxum* (slender spikegrass). *Polygonum pennsylvanicum* (Pennsylvania

smartweed) may also occur. On Assateague Island National Seashore, *Pinus taeda* (loblolly pine) dominates the canopy, with occasional *Acer rubrum* (red maple). *Smilax rotundifolia* (roundleaf greenbrier) is the strongly dominant vine of the understory, with lesser amounts of *Toxicodendron radicans* (eastern poison-ivy) and *Parthenocissus quinquefolia* (Virginia creeper). *Morella cerifera* (wax-myrtle) is also a minor component of this vegetation. *Phragmites australis* (common reed), *Rubus argutus* (southern blackberry), *Panicum virgatum* (switchgrass), and *Polygonum pennsylvanicum* (Pennsylvania smartweed) also occur within this community on Assateague Island National Seashore.

**Characteristic Species:** *Morella cerifera* (wax-myrtle)

**Management Concerns:** As a community in large part restricted to barrier islands, it is faced with threats to barrier islands in general: intense development pressures where it remains unprotected. *Phragmites australis* (common reed) occasionally occurs in this community.

**Reference Sites:** Prime Hook, DE; Dias Creek NWR, NJ; Mad Horse Creek WMA, NJ; Timber Creek, NJ

**Global and State Conservation Ranks and Reasons:** G3 (31-Jan-2005). DE: SNR, NJ: S1?. This community is restricted to barrier islands and coastal areas of the mainland that are directly influenced by the maritime climate. The range is restricted and includes coastal areas from Cape May, New Jersey, to northern North Carolina.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.684829](http://vegbank.org/natureserve/element_global.2.684829)

**References:** Bartgis 1986, Bratton and Davison 1987, Breden et al. 2001, Brush et al. 1980, Eastern Ecology Working Group n.d., Eyre 1980, Fleming et al. 2001, Harrison 2004, Higgins et al. 1971, Hill 1986, Schafale 2000, Schafale and Weakley 1990, Shreve et al. 1910

| MOST ABUNDANT SPECIES |                              |  |
|-----------------------|------------------------------|--|
| STRATUM               | LIFEFORM                     | SPECIES  |
| Tree canopy           | Needle-leaved tree           | <i>Pinus taeda</i> (loblolly pine)                 |
| Tall shrub/sapling    | Broad-leaved evergreen shrub | <i>Morella cerifera</i> (wax-myrtle)               |
| Herb (field)          | Vine/Liana                   | <i>Smilax glauca</i> (whiteleaf greenbrier)        |
| Herb (field)          | Vine/Liana                   | <i>Smilax rotundifolia</i> (roundleaf greenbrier)  |
| Herb (field)          | Vine/Liana                   | <i>Toxicodendron radicans</i> (eastern poison-ivy) |
| Herb (field)          | Fern or fern ally            | <i>Osmunda cinnamomea</i> (cinnamon fern)          |
| Herb (field)          | Fern or fern ally            | <i>Osmunda regalis</i> (royal fern)                |

---

## NORTH ATLANTIC COAST MARITIME POST OAK FOREST

*Quercus stellata* - *Quercus velutina* / *Morella pennsylvanica* / *Deschampsia flexuosa* Forest

---

**Range:** Currently described from Long Island, New York, and Connecticut. It possibly occurs in New Jersey and Delaware.

**Environmental Description:** This vegetation occurs on bluffs, sand spits, and salt marsh borders within 200 m of the seacoast.

**Vegetation Description:** This maritime oak forest is dominated by stunted, wind- and salt-pruned *Quercus stellata* (post oak), *Quercus velutina* (black oak), *Quercus coccinea* (scarlet oak), and

*Quercus alba* (white oak). *Juniperus virginiana* (eastern redcedar) may contribute minor cover to the canopy. A dense shrub layer is made up of *Morella pensylvanica* (northern bayberry), *Gaylussacia baccata* (black huckleberry), and *Prunus serotina* (black cherry) with a heavy component of vines such as *Smilax rotundifolia* (roundleaf greenbrier), *Toxicodendron radicans* (eastern poison ivy), *Parthenocissus quinquefolia* (Virginia creeper), and *Vitis aestivalis* (summer grape). Herbaceous species are sparse and include *Deschampsia flexuosa* (wavy hairgrass).

**Characteristic Species:** *Quercus stellata* (post oak), *Quercus velutina* (black oak), *Quercus coccinea* (scarlet oak), and *Quercus alba* (white oak).

**Dynamics/Successional Trajectory:** Vegetation varies to a degree along topo-edaphic gradients: a post oak-catbrier forest is the typical variety; a post oak-basswood variant occurs on dune sands atop morainal bluffs; and a post oak-blackjack oak variant occurs on reddish sandy clay loam ridges of Staten Island (Reschke et al. 2002).

**Management Concerns:** Northeastern coastal areas in general are under significant threat from housing development.

**Reference Sites:** None identified

**Global and State Conservation Ranks and Reasons:** Rank: GNR (1-Dec-1997).

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.683167](http://vegbank.org/natureserve/element_global.2.683167)

**References:** Breden 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Greller 1977, Hunt 1997a, Metzler and Barrett 2001, Rawinski 1984, Reschke pers. comm., Swain and Kearsley 2001

| MOST ABUNDANT SPECIES        |                              |   |
|------------------------------|------------------------------|---|
| STRATUM                      | LIFEFORM                     | SPECIES   |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Quercus stellata</i> (post oak)                    |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Quercus alba</i> (white oak)                       |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Quercus coccinea</i> (scarlet oak)                 |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Quercus velutina</i> (black oak)                   |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Sassafras albidum</i> (sassafras)                  |
| Shrub/sapling (tall & short) | Broad-leaved deciduous shrub | <i>Morella pensylvanica</i><br>(northern bayberry)    |
| Shrub/sapling (tall & short) | Vine/Liana                   | <i>Smilax rotundifolia</i> (roundleaf greenbrier)     |
| Shrub/sapling (tall & short) | Vine/Liana                   | <i>Toxicodendron radicans</i><br>(eastern poison ivy) |

---

## MARITIME HOLLY FOREST

*Ilex opaca* / *Morella pensylvanica* Forest

---

**Range:** This association is currently only known from New Jersey and Long Island, New York.

**Environmental Description:** This sunken forest occurs in hollows leeward of maritime backdunes where they are protected from tidal overwash and salt spray except during severe storms and hurricanes. Substrate is generally sandy loam over coarse sand with local pockets of peat. This forest also occurs in Cape May County, New Jersey, on the sheltered Delaware Bayshore where many of the tree canopy species are old-growth.

**Vegetation Description:** The dominant tree is *Ilex opaca* (American holly); stems can be 300 years old. Other canopy associates include *Amelanchier canadensis* (Canada serviceberry), *Sassafras albidum* (sassafras), *Quercus stellata* (post oak), *Quercus velutina* (black oak).

Characteristic shrubs include *Morella pensylvanica* (northern bayberry), *Gaylussacia baccata* (black huckleberry), and *Vaccinium corymbosum* (highbush blueberry).

*Sambucus canadensis* (American elder), *Viburnum dentatum* (southern

arrow-wood), and *Toxicodendron vernix* (poison-sumac) can occur infrequently. Vines are particularly abundant and include *Toxicodendron radicans* (eastern poison-ivy), *Smilax rotundifolia* (roundleaf greenbrier), *Parthenocissus quinquefolia* (Virginia creeper), and *Vitis* (grape) spp. The herbaceous layer is sparsely to moderately developed and includes *Aralia nudicaulis* (wild sarsaparilla), *Maianthemum stellatum* (starflower false Solomon's-seal), and *Maianthemum canadense* (Canada mayflower). In locally wetter, boggy areas within the forest *Nyssa sylvatica* (blackgum), *Rhododendron viscosum* (swamp azalea), *Vaccinium corymbosum* (highbush blueberry), *Photinia melanocarpa* (black chokeberry), *Osmunda cinnamomea* (cinnamon fern), *Osmunda regalis* (royal fern), and *Thelypteris palustris* (eastern marsh fern) occur abundantly.

**Characteristic Species:** *Gaylussacia baccata* (black huckleberry), *Ilex opaca* (American holly), *Morella pensylvanica* (northern bayberry), *Vaccinium corymbosum* (highbush blueberry)

**Dynamics/Successional Trajectory:** This is a late-successional expression of wet-mesic forest that develops behind protected maritime dunes. Reproduction is vegetative, not via seeds (Art 1976). On Sandy Hook, in New Jersey, the holly forest occurs just inland from a salt marsh.



Photo by Kathleen Strakosch Walz, New Jersey Natural Heritage Program



**Management Concerns:** Deer browsing affects the shrub and herb layers of sunken forests more than canopy composition decreasing overall species diversity (Art 1992).

**Reference Sites:** Cape May Point, NJ; Higbee Beach, NJ

**Global and State Conservation Ranks and Reasons:** G1 (1-Mar-2002). NJ: S1.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.687104](http://vegbank.org/natureserve/element_global.2.687104)

**References:** Art 1976, Art 1987, Art 1992, Breden et al. 2001, Chrysler 1930, Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Greller 1977, Reschke 1990, Sirkin 1972, Sneddon and Lundgren 2001, Stalter 1979

| MOST ABUNDANT SPECIES        |                              |  |
|------------------------------|------------------------------|--|
| STRATUM                      | LIFEFORM                     | SPECIES  |
| Tree canopy                  | Broad-leaved evergreen tree  | <i>Ilex opaca</i> (American holly)                 |
| Shrub/sapling (tall & short) | Vine/Liana                   | <i>Toxicodendron radicans</i> (eastern poison-ivy) |
| Short shrub/sapling          | Broad-leaved deciduous shrub | <i>Gaylussacia baccata</i> (black huckleberry)     |
| Short shrub/sapling          | Broad-leaved evergreen shrub | <i>Morella pensylvanica</i> (northern bayberry)    |
| Herb (field)                 | Forb                         | <i>Aralia nudicaulis</i> (wild sarsaparilla)       |

---

## MARITIME RED-CEDAR WOODLAND

*Juniperus virginiana* var. *virginiana* / *Morella pensylvanica* Woodland

---

**Range:** This association occurs along the North Atlantic coast from Delaware to Massachusetts.

**Environmental Description:** This maritime woodland community occurs on sand dunes, the upper edges of salt marshes, and less commonly on rocky headlands. It also occurs on islands in salt marshes (relict of post-glacial forest before sea level rise). It is influenced by onshore winds and salt spray, plus infrequent sand deposition and tidal overwash from severe storms.

### Vegetation Description:

*Juniperus virginiana* (eastern red-cedar) may form pure stands but more often grows in association with *Pinus rigida* (pitch pine), *Quercus stellata* (post oak), *Prunus serotina* (black cherry), *Amelanchier canadensis* (Canada serviceberry), *Ilex opaca* (American holly), or *Quercus velutina* (black oak), which tend to have low percent cover. In the southern portion of the range, *Pinus taeda* (loblolly pine), *Quercus falcata* (southern



Photo by Robert Coxe, Delaware Natural Heritage Program

red oak), *Diospyros virginiana* (eastern persimmon), and *Quercus phellos* (willow oak) can be infrequent canopy associates. A shrub layer may be well-developed where the canopy is more open and include *Morella pensylvanica* (northern bayberry), *Morella cerifera* (wax-myrtle) (at the southern end of the range), *Baccharis halimifolia* (groundsel-tree), *Iva frutescens* (maritime marsh-elder), or *Vaccinium corymbosum* (highbush blueberry). Vines can be dense in the shrub layer and extend into the canopy; species include *Toxicodendron radicans* (eastern poison-ivy), *Smilax rotundifolia* (roundleaf greenbrier), *Smilax glauca* (whiteleaf greenbrier), and *Parthenocissus quinquefolia* (Virginia creeper). Herbs are usually patchily distributed in openings and include many species from the surrounding dune associations, among others. They include *Opuntia humifusa* (eastern prickly-pear), *Dichanthelium ovale* (eggleaf rosette grass), *Schizachyrium scoparium* (little bluestem), *Deschampsia flexuosa* (wavy hairgrass), *Cyperus grayi* (Gray's flatsedge), *Polygonella articulata* (coastal jointweed), *Hieracium gronovii* (queendevil), *Panicum amarum* var. *amarulum* (coastal panicgrass), *Solidago sempervirens* (seaside goldenrod), *Panicum virgatum* (switchgrass), *Spartina patens* (saltmeadow cordgrass), and *Lechea intermedia* (round-fruit pinweed).

**Noteworthy Associated Plant and/or Animal Species:** *Ruellia caroliniensis* (Carolina wild petunia)

**Characteristic Species:** *Juniperus virginiana* var. *virginiana* (eastern red-cedar)

**Dynamics/Successional Trajectory:** The physiognomy of this association is variable, ranging from dense tall-shrub thickets to open woodlands; trees are generally shorter than 4 m. Canopy trees are stunted and salt-pruned.

**Management Concerns:** The habitat is threatened by many of the same threats common to coastal dune systems: dune stabilization, commercial and residential development. This community is further threatened even on "protected" lands in some cases by a lack of recognition that this vegetation is a unique community.

**Reference Sites:** Broadkill Beach, Sussex County, DE; Fowlers Beach south to Lewes, Sussex County, DE; Fortesque NWR, NJ; Mad Horse Creek WMA, NJ; Dias Creek NWR, NJ; Higbee Beach, NJ; Cape May, NJ

**Global and State Conservation Ranks and Reasons:** G2 (18-Nov-1997). DE: S1, NJ: S1. This maritime woodland community is naturally restricted to major coastal dune systems. An estimated maximum of 30 occurrences exist, ranging in size from less than an acre up to a maximum of 100, with an average size of less than 10 acres.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.689256](http://vegbank.org/natureserve/element_global.2.689256)

**References:** Bowman 2000, Breden 1989, Breden et al. 2001, Clancy 1996, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fleming et al. 2001, Greller 1977, Harrison 2004, Lundgren 2000, Martin 1959b, Rawinski 1984, Reschke 1990, Swain and Kearsley 2001

| MOST ABUNDANT SPECIES        |                              |   |
|------------------------------|------------------------------|---|
| STRATUM                      | LIFEFORM                     | SPECIES   |
| Tree canopy                  | Needle-leaved tree           | <i>Juniperus virginiana</i> var. <i>virginiana</i><br>(eastern red-cedar) |
| Shrub/sapling (tall & short) | Broad-leaved evergreen shrub | <i>Morella pensylvanica</i> (northern bayberry)                           |
| Shrub/sapling (tall & short) | Vine/Liana                   | <i>Toxicodendron radicans</i> (eastern<br>poison-ivy)                     |
| Herb (field<br>bluestem)     | Graminoid                    | <i>Schizachyrium scoparium</i> (little)                                   |

---

### SUCCESSIONAL MARITIME FOREST

*Prunus serotina* - *Sassafras albidum* - *Amelanchier canadensis* - *Quercus velutina* / *Smilax rotundifolia* Forest

---

**Range:** The range of this community is from southern New Hampshire to New Jersey, but it is restricted to the New Jersey and possibly the Delaware coasts in the Delaware Estuary.

**Environmental Description:** This association occurs most often on stabilized backdunes, generally leeward of secondary dunes or in protected hollows. It also occurs on bluffs or in more interior coastal areas. It is subject to varying degrees of wind and salt spray. Soils are coarse, well-drained sand subject to considerable shifting during coastal storms, or till and sand deposits of terminal moraines.

**Vegetation Description:** This association is generally a maritime forest or scrub forest, although physiognomy can vary considerably. Trees found in this community are usually stunted and flat-topped; the canopy may be only 3-7 m tall. Dominant trees vary locally but often include *Prunus serotina* (black cherry), *Sassafras albidum* (sassafras), and *Amelanchier canadensis* (Canada serviceberry), with admixtures of *Pinus rigida* (pitch pine), *Juniperus virginiana* (eastern red-cedar), *Acer rubrum* (red maple), *Amelanchier stolonifera* (running serviceberry), and in southern occurrences *Quercus coccinea* (scarlet oak), *Quercus falcata* (southern red oak), and/or *Ilex opaca* (American holly). Additional shrub species may also contribute substantially to the canopy and include *Vaccinium corymbosum* (highbush blueberry), *Morella pensylvanica* (northern bayberry), *Gaylussacia baccata* (black huckleberry), *Viburnum recognitum* (northern arrow-wood), *Viburnum dentatum* (southern arrow-wood), and *Rosa virginiana* (Virginia rose). A true shrub layer is generally not present. Lianas are common and can be dense in the canopy or in the ground layer; species include *Parthenocissus quinquefolia* (Virginia creeper), *Toxicodendron radicans* (eastern poison-ivy), *Smilax rotundifolia* (roundleaf greenbrier), and *Smilax glauca* (whiteleaf greenbrier). The understory is generally sparse with tree or vine seedlings plus herbaceous species including *Aralia nudicaulis* (wild sarsaparilla), *Moehringia lateriflora* (grove sandwort), *Maianthemum stellatum* (starflower false Solomon's-seal) and *Maianthemum canadense* (Canada mayflower).

**Characteristic Species:** *Amelanchier canadensis* (Canada serviceberry), *Prunus serotina* (black cherry), *Sassafras albidum* (sassafras), *Smilax rotundifolia* (roundleaf greenbrier)

**Dynamics/Successional Trajectory:** This association occupies a transitional zone between dune grasslands or low dune shrublands and maritime forest. Physiognomy is highly variable depending

on degree of exposure to wind and salt spray and depending on the overall height of the surrounding dunes.

**Management Concerns:** Several invasive species can be prevalent in this association, including *Lonicera morrowii* (Morrow's honeysuckle), *Lonicera japonica* (Japanese honeysuckle), *Ligustrum vulgare* (European privet), *Berberis vulgaris* (European barberry), and *Celastrus orbiculatus* (Asian bittersweet). Northeastern coastal areas in general are under significant threat from housing development.

**Reference Sites:** Cape May Point, NJ

**Global and State Conservation Ranks and Reasons:** G2G3 (22-Oct-1997). DE?: SNA, NJ: S1S2. This maritime forest community is restricted in range to the coastal areas of six northeastern states. Average occurrence size is estimated to be 20-100 acres, but many are substantially below this in size. The potential habitat of this community is naturally restricted to areas directly affected by maritime processes, e.g. salt spray and winds.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.684643](http://vegbank.org/natureserve/element_global.2.684643)

**References:** Art 1987, Bellis 1992, Breden 1989, Breden et al. 2001, Burk 1968, Dowhan and Rozsa 1989, Dunlop and Crow 1985, Eastern Ecology Working Group n.d., Edinger et al. 2002, Greller 1977, Martin 1959b, McDonnell 1979, Metzler and Barrett 2001, Rawinski 1984, Reschke 1990, Sperduto 1997b, Stalter 1979, Svenson 1970, Swain and Kearsley 2001

| MOST ABUNDANT SPECIES        |                             |   |
|------------------------------|-----------------------------|---|
| STRATUM                      | LIFEFORM                    | SPECIES   |
| Tree canopy serviceberry)    | Broad-leaved deciduous tree | <i>Amelanchier canadensis</i> (Canada)                |
| Tree canopy                  | Broad-leaved deciduous tree | <i>Prunus serotina</i> (black cherry)                 |
| Tree canopy                  | Broad-leaved deciduous tree | <i>Quercus velutina</i> (black oak)                   |
| Tree canopy                  | Broad-leaved deciduous tree | <i>Sassafras albidum</i> (sassafras)                  |
| Shrub/sapling (tall & short) | Vine/Liana                  | <i>Parthenocissus quinquefolia</i> (Virginia creeper) |
| Shrub/sapling (tall & short) | Vine/Liana                  | <i>Smilax rotundifolia</i> (roundleaf greenbrier)     |
| Shrub/sapling (tall & short) | Vine/Liana                  | <i>Toxicodendron radicans</i> (eastern poison-ivy)    |

---

### CHESAPEAKE BAY TALL MARITIME SHRUBLAND

*Prunus serotina* / *Morella cerifera* / *Smilax rotundifolia* Scrub Forest

---

**Range:** This association occurs along the mid-Atlantic coast from Virginia north to Cape May, New Jersey.

**Environmental Description:** This association occurs on stabilized dunes, generally occurring leeward of secondary dunes. The substrate varies from pure sand directly adjacent to the ocean to loamy sands in more sheltered areas of the coast.

**Vegetation Description:** The vegetation is dominated by *Prunus serotina* (black cherry), *Amelanchier canadensis* (Canadian serviceberry), *Sassafras albidum* (sassafras), *Photinia pyrifolia*

(= *Aronia arbutifolia*) (red chokeberry), and *Diospyros virginiana* (common persimmon) in varying proportions. *Pinus taeda* (loblolly pine) is a common associate in examples of this community south of New Jersey. *Morella cerifera* (= *Myrica cerifera*) (wax myrtle) and *Vaccinium corymbosum* (highbush blueberry) may form a subcanopy, but if the community is particularly stunted, this species may contribute substantially to the canopy. Lianas are abundant in the canopy or over the ground layer, and species include *Smilax rotundifolia* (roundleaf greenbrier), *Smilax glauca* (cat greenbrier), *Parthenocissus quinquefolia* (Virginia creeper), and *Toxicodendron radicans* (eastern poison ivy). Herbs are generally scarce to lacking entirely, and when present are generally made up of tree and vine seedlings.

**Dynamics/Successional Trajectory:** This is a tall, deciduous shrubland or scrub forest, although physiognomy can vary dramatically, ranging from open woodland to stunted forest to dense nearly impenetrable thicket. Individual trees tend to be wind-pruned and multi-stemmed. It is subject to wind and salt spray to varying degrees. This association occupies a transitional zone between maritime forest and low maritime shrubland or dune associations.

**Management Concerns:** Potential or historic habitat has been reduced by extensive human development such as residential or commercial building, recreation, or road expansion.

**Reference Sites:** Cape Henlopen, DE; Higbee Beach, Cape May County, NJ

**Global Conservation Rank and Reasons:** G1G2 (18-Nov-1997). This maritime shrubland community is restricted to a narrow range on coastal dunes of barrier islands on the mid-Atlantic coast. It does not occur north of southern New Jersey or south of Virginia. Occurrences are naturally small (a few acres), confined to the oceanward portion of barrier islands. Potential or historic habitat has been reduced by extensive human development such as residential or commercial building, recreation, or road expansion.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.684064](http://vegbank.org/natureserve/element_global.2.684064)

**References:** Bartgis 1986, Bellis 1992, Berdine 1998, Boule 1979, Bowman 2000, Breden 1989, Breden et al. 2001, Dunlop and Crow 1985, Eastern Ecology Working Group n.d., Fleming et al. 2001, Harrison 2004, Higgins et al. 1971, Hill 1986, Klotz 1986, Rawinski 1992, Sneddon et al. 1994, Stalter 1979

| MOST ABUNDANT SPECIES        |                              |   |
|------------------------------|------------------------------|---|
| STRATUM                      | LIFEFORM                     | SPECIES   |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Amelanchier canadensis</i> (Canada serviceberry)   |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Prunus serotina</i> (black cherry)                 |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Sassafras albidum</i> (sassafras)                  |
| Shrub/sapling (tall & short) | Vine/Liana                   | <i>Parthenocissus quinquefolia</i> (Virginia creeper) |
| Shrub/sapling (tall & short) | Vine/Liana                   | <i>Smilax rotundifolia</i> (roundleaf greenbrier)     |
| Shrub/sapling (tall & short) | Vine/Liana                   | <i>Toxicodendron radicans</i> (eastern poison-ivy)    |
| Tall shrub/sapling           | Broad-leaved evergreen shrub | <i>Morella cerifera</i> (wax-myrtle)                  |

---

## NORTHERN TALL MARITIME SHRUBLAND

*Amelanchier canadensis* - *Viburnum* spp. - *Morella pensylvanica* Scrub Forest

---

**Range:** This association occurs in the New Jersey portion of the Delaware Estuary.

**Environmental Description:** This tall maritime shrubland or scrub forest community characteristically replaces maritime forests that have been cleared. It occurs at former agricultural sites on sandy loam soils. These shrublands are usually very dense and often maintained in their current state by constant winds and salt spray.

**Vegetation Description:** This tall shrubland community is variable in composition and generally includes *Amelanchier canadensis* (Canadian serviceberry), *Prunus serotina* (black cherry), *Sassafras albidum* (sassafras), *Nyssa sylvatica* (black gum), *Acer rubrum* (red maple), and *Juniperus virginiana* (eastern red-cedar) in the canopy. The oaks *Quercus velutina* (black oak), *Quercus stellata* (post oak), and *Quercus alba* (white oak) may or may not be present. The shrubs *Morella pensylvanica* (eastern bayberry), *Photinia* spp. (chokeberry), *Viburnum* spp. (Viburnum), and *Gaylussacia baccata* (black huckleberry) may form an understory or contribute substantial cover to the canopy. Vines are often prevalent, including *Smilax* spp.



Photo by Linda Kelly

(greenbrier), *Vitis* spp. (grape), *Toxicodendron radicans* (eastern poison ivy), and *Parthenocissus quinquefolia* (Virginia creeper). The herbaceous layer is generally sparse.

**Dynamics/Successional Trajectory:** This tall maritime shrubland community characteristically replaces maritime forests that have been cleared. Successional relationships with maritime forest associations need to be determined.

**Management Concerns:** Potential or historic habitat has been reduced by extensive human development such as residential or commercial building, recreation, or road expansion.

**Reference Sites:** Cape May County, NJ

**Global Conservation Rank and Reasons:** GNR (1-Dec-1997).

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.684064](http://vegbank.org/natureserve/element_global.2.684064)

**References:** Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d.\*, Edinger et al. 2002., Metzler and Barrett 2001, NRCS 2001b, Rawinski 1984, Reschke 1990, Swain and Kearsley 2001

| MOST ABUNDANT SPECIES        |                              |   |
|------------------------------|------------------------------|---|
| STRATUM                      | LIFEFORM                     | SPECIES   |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Amelanchier canadensis</i> (Canada serviceberry)   |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Prunus serotina</i> (black cherry)                 |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Sassafras albidum</i> (sassafras)                  |
| Shrub/sapling (tall & short) | Vine/Liana                   | <i>Parthenocissus quinquefolia</i> (Virginia creeper) |
| Shrub/sapling (tall & short) | Vine/Liana                   | <i>Smilax rotundifolia</i> (roundleaf greenbrier)     |
| Shrub/sapling (tall & short) | Vine/Liana                   | <i>Toxicodendron radicans</i> (eastern poison-ivy)    |
| Tall shrub/sapling           | Broad-leaved evergreen shrub | <i>Morella pensylvanica</i> (eastern bayberry)        |
| Short shrub/sapling          | Broad-leaved deciduous shrub | <i>Gaylussacia baccata</i> (black huckleberry)        |





---

**ECOLOGICAL SYSTEM: NORTHERN ATLANTIC COASTAL PLAIN BASIN SWAMP & WET  
HARDWOOD FOREST**

---

**Summary:** This system is comprised of non-riverine hardwood swamps of seasonally flooded habitats, including relatively shallow groundwater-influenced depressions and other topographic depressions. It ranges from Long Island, New York, south to Virginia. Although supporting some seepage indicators, it is also affected by overland flow. The substrate is mineral soil overlain by a variable organic but non-peaty layer. Characteristic tree species include *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), *Nyssa sylvatica* (blackgum), *Quercus phellos* (willow oak), and *Fraxinus pennsylvanica* (green ash). *Pinus taeda* (loblolly pine) is not uncommon south of Delaware Bay.

**High-ranked Species:** *Carex schweinitzii* (G3G4, Schweinitz's sedge), *Helonias bullata* (G3, swamppink), *Hydrochus spangleri* (G1, seth forest water scavenger beetle), *Juncus caesariensis* (G2, New Jersey rush), *Nartheccium americanum* (G2, yellow asphodel), *Scirpus longii* (G2G3, Long's bulrush), *Trillium pusillum* var. *virginianum* (G3T2, Virginia wakerobin)

**Range:** It ranges from Long Island, New York, south to Virginia. United States: DE, MD, NJ, NY, VA

**Delaware Estuary Addendum Associations:**

- Red Maple - Sweetgum Swamp
- Central Coastal Plain Basin Swamp
- Pond Pine Woodland
- Swamp Cottonwood Coastal Plain Pond

**CLASSIFIERS FOR NORTHERN ATLANTIC COASTAL PLAIN BASIN SWAMP AND WET  
HARDWOOD FOREST**

**Primary Division:** 203

**Land Cover Class:** Woody Wetland

**Spatial Scale & Pattern:** Large patch

**Required Classifiers:** Natural/Semi-natural; Vegetated (>10% vasc.); Wetland

**Diagnostic Classifiers:** Forest and Woodland (Treed); Seepage-Fed Sloping; North Atlantic Coastal Plain

**Non-diagnostic Classifiers:** Isolated Wetland [Partially Isolated]

---

## RED MAPLE - SWEETGUM SWAMP

*Liquidambar styraciflua* - *Acer rubrum* - *Quercus phellos* / *Leucothoe racemosa* Forest

---

**Range:** This association is a seasonally flooded forest of shallow basins and other depressions of the Coastal Plain of the Chesapeake Bay region, Delaware, New Jersey and Pennsylvania..

**Environmental Description:** This type occurs in seasonally flooded shallow basins or depressions. Substrates are acidic, gleyed to mottled, sandy or clay loams. The water table may be perched.

### Vegetation Description:

Characteristic tree species include *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), and *Nyssa sylvatica* (blackgum), which are nearly constant in the canopy. Associates include *Ilex opaca* (American holly), *Magnolia virginiana* (sweetbay), *Nyssa biflora* (swamp tupelo), *Sassafras albidum* (sassafras), *Quercus palustris* (pin oak), *Pinus taeda* (loblolly pine), and *Quercus phellos* (willow oak), and occasionally *Quercus falcata* (southern red oak), *Quercus lyrata* (overcup oak), or *Betula nigra* (river birch). The shrub layer is characterized by *Leucothoe*



Photo by Robert Coxe, Delaware Natural Heritage Program

*racemosa* (swamp doghobble), *Vaccinium corymbosum* (highbush blueberry), *Clethra alnifolia* (coastal sweetpepperbush), *Lindera benzoin* (northern spicebush), *Ilex verticillata* (common winterberry), and *Rhododendron viscosum* (swamp azalea). *Smilax rotundifolia* (roundleaf greenbrier) is a particularly characteristic vine. The herbaceous layer is generally sparse but may include *Mitchella repens* (partridgeberry), *Osmunda cinnamomea* (cinnamon fern), *Woodwardia areolata* (netted chainfern), *Onoclea sensibilis* (sensitive fern), *Osmunda regalis* (royal fern), *Carex albolutescens* (greenwhite sedge), *Scirpus cyperinus* (woolgrass), *Juncus effusus* (common rush), and *Polygonum* (knotweed) spp.

**Characteristic Species:** *Leucothoe racemosa* (swamp doghobble), *Quercus phellos* (willow oak), *Smilax rotundifolia* (roundleaf greenbrier)

**Reference Sites:** Northern portion of Mispillion Watershed, DE, Brendan Byrne State Forest, NJ; Fort Dix, Inner Coastal Plain, NJ; Delhaas Woods, and Black Ditch County Park, Bucks County, PA

**Global and State Conservation Ranks and Reasons:** G4G5 (31-Jan-2007). DE:SNR, NJ:S3, PA:SNR.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.687145](http://vegbank.org/natureserve/element_global.2.687145)

**References:** Bowman 2000, Breden 1989, Breden et al. 2001, Brush et al. 1980, Clancy 1996, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fleming et al. 2001, Harrison 2004, Harrison and Stango 2003, Hunt 1998, Sneddon and Anderson 1994, Sneddon et al. 1996, Thomson et al. 1999, Tyndall et al. 1990, VDNH 2003

| MOST ABUNDANT SPECIES |                              |  |
|-----------------------|------------------------------|--|
| STRATUM               | LIFEFORM                     | SPECIES                                    |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Acer rubrum</i> (red maple)             |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Liquidambar styraciflua</i> (sweetgum)  |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Nyssa sylvatica</i> (blackgum)          |
| Shrub/sapling         | Broad-leaved deciduous shrub | <i>Leucothoe racemosa</i> (swampdoghobble) |

---

### CENTRAL COASTAL PLAIN BASIN SWAMP

*Liquidambar styraciflua* - *Acer rubrum* - *Nyssa biflora* / *Carex jorii* Forest

---

**Range:** This community is limited to small seasonally flooded depressions of the Coastal Plain of Maryland, Virginia and Delaware.

**Environmental Description:** This seasonally flooded hardwood forest community occurs in seasonally flooded groundwater basins on the coastal plain.

**Vegetation Description:** The canopy of stands of this type is of variable closure and is dominated by *Liquidambar styraciflua* (sweetgum), *Acer rubrum* (red maple), and *Nyssa biflora* (swamp tupelo). Associated canopy species include *Quercus lyrata* (overcup oak), *Quercus laurifolia* (laurel oak) and *Diospyros virginiana* (common persimmon). The shrub layer is comprised of *Leucothoe racemosa* (swamp doghobble) and scattered *Cephalanthus occidentalis* (common buttonbush). The herbaceous layer is characterized by *Carex jorii* (cypress swamp sedge), *Carex striata* (Walter's sedge), *Panicum verrucosum* (warty panicgrass), *Fimbristylis autumnalis* (slender fimbry), and others.

**Characteristic Species:** *Nyssa biflora* (swamp tupelo), *Carex jorii* (cypress swamp sedge),

**Reference Sites:** Milford Neck, TNC preserve, Kent County, DE

**Global and State Conservation Ranks and Reasons:** G1G2 (20-Nov-1997). DE:SNR. This community is limited to small seasonally flooded depressions of the coastal plain of Maryland, Virginia, and Delaware. The community is naturally small in size, reaching no more than 25 acres and on average is less than this size. The greatest threat to this community is incompatible human use of surrounding lands, generally agriculture with insufficient buffers to protect from pesticide and fertilizer use. Since this community depends on intact hydrology, another major threat is altered hydrology from ditching or over-pumping of groundwater.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.687976](http://vegbank.org/natureserve/element_global.2.687976)

**References:** Eastern Ecology Working Group n.d., Fleming et al. 2001, Harrison 2004, J. Harrison pers. comm., Rawinski 1997, Sneddon et al. 1996

| MOST ABUNDANT SPECIES |                              |   |
|-----------------------|------------------------------|---|
| STRATUM               | LIFEFORM                     | SPECIES                                     |
| Tree canopy           | Needle-leaved evergreen tree | <i>Liquidambar styraciflua</i> (sweetgum)   |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Acer rubrum</i> (red maple)              |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Nyssa biflora</i> (swamp tupelo)         |
| Shrub/sapling         | Broad-leaved deciduous shrub | <i>Leucothoe racemosa</i> (swamp doghobble) |
| Herb                  | Graminoid                    | <i>Carex jorii</i> (cypress swamp sedge)    |

---

## POND PINE WOODLAND

*Pinus serotina* / *Magnolia virginiana* / *Vaccinium corymbosum* / *Carex atlantica* Woodland

---

**Range:** This community is described from Prime Hook National Wildlife Refuge on the western shore of Delaware Bay.

**Environmental Description:** This community is located around Flaxhole Pond in Prime Hook National Wildlife Refuge. Although *Pinus serotina* (pond pine) can be found in other locations in Delaware, this is the only location in the state where there is a well-developed community of *Pinus serotina* (pond pine). The pond pine woodland is located on the edge of a red maple - seaside alder woodland adjacent to the pond. It is very similar in structure to this woodland with the exception of the pond pine towering over the red maple.

**Vegetation Description:** This is a community that is open and dominated by *Pinus serotina* (pond pine) in the canopy. *Acer rubrum* (red maple) and *Liquidambar styraciflua* (sweetgum) are associates and much less common. The understory is composed of *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), and *Magnolia virginiana* (sweetbay). The shrub layer is dense and composed of *Vaccinium corymbosum* (highbush blueberry), *Photinia pyrifolia* (red chokeberry), *Leucothoe racemosa* (swamp doghobble), and *Itea virginica* (Virginia sweetspire).



Photo by Robert Coxe, Delaware Natural Heritage Program

*Clethra alnifolia* (coastal sweetpepperbush) may also be present. *Smilax walteri* (coral greenbrier) occupies the vine layer along with occasional *Smilax laurifolia* (laurel greenbrier). Common herbs include *Carex atlantica* (prickly bog sedge), *Carex lurida* (shallow sedge), *Woodwardia virginica* (Virginia chainfern), *Carex bromoides* (bromelike sedge), *Osmunda regalis* (royal fern), and *Sagittaria latifolia* (broadleaf arrowhead).

**Characteristic Species:** *Pinus serotina* (pond pine)

**Reference Sites:** Prime Hook, DE

**Global and State Conservation Ranks and Reasons:** GNR (11-Dec-2006). DE:SNR, NJ?:SNA. There are not enough data on this community to determine a global rank.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.797107](http://vegbank.org/natureserve/element_global.2.797107)

**References:** Eastern Ecology Working Group n.d.

| MOST ABUNDANT SPECIES |                              |   |
|-----------------------|------------------------------|---|
| STRATUM               | LIFEFORM                     | SPECIES   |
| Tree canopy           | Needle-leaved evergreen tree | <i>Pinus serotina</i> (pond pine)                   |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Acer rubrum</i> (red maple)                      |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Liquidambar styraciflua</i> (sweetgum)           |
| Tree subcanopy        | Broad-leaved deciduous tree  | <i>Magnolia virginiana</i> (sweetbay)               |
| Shrub/sapling         | Broad-leaved deciduous shrub | <i>Vaccinium corymbosum</i><br>(highbush blueberry) |
| Herb                  | Graminoid                    | <i>Carex atlantica</i> (prickly bog sedge)          |

### SWAMP COTTONWOOD COASTAL PLAIN POND

*Populus heterophylla* - *Acer rubrum* - *Quercus palustris* - *Liquidambar styraciflua* Forest

**Range:** This community occurs on the western shore of Delaware Bay at Prime Hook National Wildlife Refuge and Blackbird State Forest and possibly on Long Island, New York.

**Environmental Description:** This association includes small, isolated, *Populus heterophylla* (swamp cottonwood)-dominated seasonally flooded ponds in the Coastal Plain of Delaware. This community occupies shallow depressions that fill with water in the late fall and winter and then dry in the summer. Topography is typically that of a Coastal Plain pond. In Prime Hook National Wildlife Refuge, one example of this community is located in a pond just south of Prime Hook Beach Road that is impacted by beavers and similar to a Carolina bay. More of these ponds are known from Delmarva bays in southern New Castle and northern Kent counties, Delaware.

**Vegetation Description:** This seasonally flooded pond community is codominated by *Populus heterophylla* (swamp cottonwood), *Acer rubrum* (red maple), *Quercus palustris* (pin oak), *Nyssa sylvatica* (blackgum), and *Liquidambar styraciflua* (sweetgum) in the canopy. There are few species in the understory; some understory associates can include *Acer rubrum* (red maple), *Fraxinus pennsylvanica* (green ash), and *Clethra alnifolia* (coastal sweetpepperbush). The herbaceous layer is dominated by *Microstegium vimineum* (Nepalese browntop), *Osmunda regalis* (royal fern) and



Photo by Robert Coxe, Delaware Natural Heritage Program

*Polygonum hydropiperoides* (swamp smartweed) are also present in the herbaceous layer, and *Smilax laurifolia* (laurel greenbrier) is present as a vine.

**Characteristic Species:** *Populus heterophylla* (swamp cottonwood)

**Reference Sites:** Prime Hook, DE

**Global and State Conservation Ranks and Reasons:** GNR (11-Dec-2006). DE:SNR. There are not enough data on this community to determine a rank.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.797103](http://vegbank.org/natureserve/element_global.2.797103)

**References:** Eastern Ecology Working Group n.d.

| MOST ABUNDANT SPECIES |                              |   |
|-----------------------|------------------------------|---|
| STRATUM               | LIFEFORM                     | SPECIES   |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Populus heterophylla</i><br>(swamp cottonwood)     |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Acer rubrum</i> (red maple)                        |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Liquidambar styraciflua</i> (sweetgum)             |
| Shrub/sapling         | Broad-leaved deciduous shrub | <i>Clethra alnifolia</i> (coastal<br>sweetpepperbush) |
| Herb                  | Graminoid                    | <i>Microstegium vimineum</i><br>(Japanese stiltgrass) |





---

**ECOLOGICAL SYSTEM: NORTHERN ATLANTIC COASTAL PLAIN BASIN PEAT SWAMP**

---

**Summary:** This system is comprised of acidic peat swamps formed in basins of various sizes, predominantly Atlantic white-cedar swamps, occurring on the northern portion of the Atlantic Coastal Plain from Massachusetts south to Virginia. The hydrology is saturated, as evidenced by *Sphagnum*-dominated hummock-and-hollow microtopography. *Chamaecyparis thyoides* (Atlantic white cedar) is characteristic and often dominant. *Acer rubrum* (red maple) may also be an important species, especially after logging.

**High-ranked Species:** *Callophrys hesseli* (G3G4, Hessel's hairstreak), *Gentiana autumnalis* (G3, pine barrens gentian), *Helonias bullata* (G3, swamppink), *Nartheccium americanum* (G2, yellow asphodel), *Scirpus longii* (G2G3, Long's bulrush)

**Range:** This system occurs on the northern portion of the Atlantic Coastal Plain from Massachusetts south to Virginia.

**Delaware Estuary Addendum Associations:**

- Twig-rush Peat Mat

|   |
|---|
| <p><b>CLASSIFIERS FOR NORTHERN ATLANTIC COASTAL PLAIN BASIN PEAT SWAMP</b><br/><b>Primary Division:</b> 203<br/><b>Land Cover Class:</b> Woody Wetland<br/><b>Spatial Scale &amp; Pattern:</b> Large patch<br/><b>Required Classifiers:</b> Natural/Semi-natural; Vegetated (&gt;10% vasc.); Wetland<br/><b>Diagnostic Classifiers:</b> none identified<br/><b>Non Diagnostic Classifiers:</b> Forest and Woodland (Treed); Depressional [Peaty]; Isolated Wetland [Partially Isolated]</p> |
|---|

---

## TWIG-RUSH PEAT MAT

*Cladium mariscoides* - *Eriocaulon decangulare* - *Eriophorum virginicum* Herbaceous Vegetation

---

**Range:** This community occurs in isolated patches on the western shore of Delaware Bay.

**Environmental Description:** This highly distinctive community occurs on deep, mucky peat that forms in open-water depressions, impoundments, and seeps within a shrub-dominated swamp matrix. These sites are floristically diverse and support many state (Delaware) and globally rare plant species and have the look and feel of true "quaking bogs" with a thick *Sphagnum* (sphagnum) mat.

**Vegetation Description:** *Cladium mariscoides* (smooth sawgrass) is the dominant herb. Associate herbaceous plant species include *Eriocaulon decangulare* (tenangle pipewort), *Andropogon glomeratus* var. *hirsutior* (bushy bluestem), *Eriophorum virginicum* (tawny cottongrass), *Bidens coronata* (crowned beggarticks), *Sagittaria engelmanniana*, *Sagittaria latifolia* (broadleaf arrowhead), *Fuirena squarrosa* (hairy umbrella-sedge), *Rhynchospora alba* (white beaksedge), *Spiranthes cernua* (nodding ladies'-tresses), *Eleocharis robbinsii* (Robbins' spikerush), *Dulichium arundinaceum* (threeway sedge), *Lycopus amplexans*



Photo by Robert Coxe, Delaware Natural Heritage Program

(clasping water horehound), *Bartonia paniculata* (twining screwstem), *Woodwardia areolata* (netted chainfern), *Bidens mitis* (smallfruit beggarticks), *Juncus pelocarpus* (brownfruit rush), and *Pogonia ophioglossoides* (snakemouth orchid). Several insectivorous plants are also present within this community: *Sarracenia purpurea* (purple pitcherplant), *Drosera rotundifolia* (roundleaf sundew), *Drosera intermedia* (spoonleaf sundew), *Utricularia striata* (= *Utricularia fibrosa*), and *Utricularia juncea* (southern bladderwort). Scattered shrubs, including *Smilax walteri* (coral greenbrier), *Smilax laurifolia* (laurel greenbrier), *Clethra alnifolia* (coastal sweetpepperbush), *Alnus maritima* (seaside alder), and *Vaccinium corymbosum* (highbush blueberry), are present along the edges of the peat mat community along with occasional *Acer rubrum* (red maple) seedlings and saplings.

**Characteristic Species:** *Cladium mariscoides* (smooth sawgrass), *Eriocaulon decangulare* (tenangle pipewort), *Andropogon glomeratus* var. *hirsutior* (bushy bluestem), *Eriophorum virginicum* (tawny cottongrass), *Sarracenia purpurea* (purple pitcherplant), *Sphagnum* (sphagnum)

**Noteworthy Species:** *Alnus maritima* (seaside alder), G3; one site supports 19 state (DE)-rare plant species.

**Reference Sites:** Prime Hook, DE

**Global and State Conservation Ranks and Reasons:** GNR (11-Dec-2006); Not enough sites have been inventoried to develop a global rank for this community

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.797099](http://vegbank.org/natureserve/element_global.2.797099)

**References:** Eastern Ecology Working Group n.d., Coxe 2007

| MOST ABUNDANT SPECIES  |                              |   |
|------------------------|------------------------------|---|
| STRATUM                | LIFEFORM                     | SPECIES   |
| Shrub (tall and short) | Broad leaved deciduous shrub | <i>Clethra alnifolia</i><br>(coastal sweetpepperbush) |
| Shrub (tall and short) | Broad leaved deciduous shrub | <i>Vaccinium corymbosum</i><br>(highbush blueberry)   |
| Herb (field)           | Graminoid                    | <i>Cladium mariscoides</i> (smooth sawgrass)          |
| Nonvascular            | Moss                         | <i>Sphagnum</i> spp. (sphagnum moss)                  |



---

## **ECOLOGICAL SYSTEM: NORTHERN ATLANTIC COASTAL PLAIN PITCH PINE BARRENS**

---

**Summary:** This system is comprised of a group of dry pitch pine woodlands and forests of deep sandy soils ranging from Cape Cod, Massachusetts; Long Island, New York; and the New Jersey Coastal Plain. The vegetation is characterized by a tree canopy of *Pinus rigida* (pitch pine) with a tall-shrub layer dominated by *Quercus ilicifolia* (bear oak) and a low-shrub layer characterized by *Vaccinium pallidum* (hillside blueberry) or *Vaccinium angustifolium* (northern lowbush blueberry). The system is heavily influenced by fire, the composition and structure of its components varying with fire frequency. In general, tree oaks are more prevalent in those stands having a longer fire-return interval, while at the other extreme, fire frequencies of eight to ten years foster the growth of "pine plains," i.e., dwarf pine stands of 1 meter in height. The pine cones of pine plains have a very high incidence of serotiny as compared to the other associations of this system. Dwarf-shrubs such as *Arctostaphylos uva-ursi* (bearberry) and *Hudsonia ericoides* (pine barren golden-heather) typify the field layer of pine plains.

Scrub oak stands may occur without pine cover, particularly in low-lying areas that do not intersect the water table, where cold-air drainage inhibits pine growth.

North of the glacial boundary, heathlands characterized by *Arctostaphylos uva-ursi* (bearberry), *Corema conradii* (broom crowberry), and *Morella pensylvanica* (northern bayberry) and grasslands characterized by *Schizachyrium littorale* (seaside bluestem) and *Danthonia spicata* (poverty oatgrass) occur as small patches. The Pine Barrens of New Jersey are very similar in structure and composition to those north of the glacial boundary but are characterized by additional species such as *Quercus marilandica* (blackjack oak), *Pyxidantha barbulate* (pyxie-moss), *Leiophyllum buxifolium* (sand-myrtle), and others. Where the water table is close to the surface, pitch pine lowland vegetation (described as a separate system) occurs.

**Range:** Found in the Coastal Plain from Delaware Bay northward, ranging from Cape Cod, Massachusetts; Long Island, New York; and the New Jersey Coastal Plain. United States: DE, MA, NJ, NY

### **Delaware Estuary Addendum Associations:**

- Pine Barrens Pine - Oak Woodland

#### **CLASSIFIERS FOR NORTHERN ATLANTIC COASTAL PLAIN PITCH PINE BARRENS**

**Primary Division:** 203

**Land Cover Class:** Forest and Woodland

**Spatial Scale & Pattern:** Large patch

**Required Classifiers:** Natural/Semi-natural; Vegetated (>10% vasc.); Upland

**Diagnostic Classifiers:** Forest and Woodland (Treed); Xeric; F-Patch/High Intensity; Needle-Leaved Tree

---

## PINE BARRENS PINE – OAK WOODLAND

*Pinus rigida* - *Quercus coccinea* - *Quercus falcata* / (*Quercus marilandica*) / *Gaylussacia frondosa*  
Woodland

---

**Range:** This association occurs on the Coastal Plain of New Jersey and Maryland.

**Environmental Description:** This community is associated with xeric, sublevel, sandy uplands. In Maryland, soils are unconsolidated sands of the Patuxent Formation and are extremely acidic with exceedingly low base cation and base saturation levels, indicating extreme infertility.

### Vegetation Description:

Current examples of this community vary from woodlands to open forests. The overstory consists of *Pinus rigida* (pitch pine) mixed with tree oaks, most frequently *Quercus falcata* (southern red oak) and *Quercus coccinea* (scarlet oak). Other associated oaks include *Quercus velutina* (black oak) and *Quercus alba* (white oak). *Pinus virginiana* (Virginia pine) sometimes occurs, and in New Jersey, *Pinus echinata* (short-leaf



Photograph by Linda Kelly

pine) may be an associate. Maryland occurrences may also include *Nyssa sylvatica* (black gum) and *Liquidambar styraciflua* (sweet gum) in the canopy. The tall-shrub layer is characterized by *Ilex opaca* (American holly), *Sassafras albidum* (sassafras), and occasionally *Kalmia latifolia* (mountain laurel). A short-shrub layer is dominated by *Gaylussacia frondosa* (blue huckleberry), *Gaylussacia baccata* (black huckleberry), and *Vaccinium pallidum* (Blue Ridge blueberry). The herbaceous or field layer is usually sparse and may include *Smilax glauca* (cat greenbrier), *Chimaphila maculata* (striped prince's pine), *Gaultheria procumbens* (eastern teaberry), *Carex pensylvanica* (Pennsylvania sedge), and *Cypripedium acaule* (pink lady's slipper).

**Characteristic Species:** *Pinus rigida* (pitch pine), *Quercus falcata* (southern red oak), *Quercus coccinea* (scarlet oak), *Pinus echinata* (short-leaf pine), *Ilex opaca* (American holly), *Gaylussacia frondosa* (blue huckleberry)

**Reference Sites:** Cape May NWR NJ

**Global and State Conservation Ranks and Reasons:** G2G3 (18-Jan-2006). NJ:SNR.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.687022](http://vegbank.org/natureserve/element_global.2.687022)

**References:** Eastern Ecology Working Group n.d., NatureServe 2005, Windisch 1995b

| MOST ABUNDANT SPECIES        |                              |  |
|------------------------------|------------------------------|--|
| STRATUM                      | LIFEFORM                     | SPECIES  |
| Tree canopy                  | Needle-leaved evergreen tree | <i>Pinus rigida</i> (pitch pine)               |
| Tree canopy                  | Needle-leaved evergreen tree | <i>Pinus echinata</i> (short-leaf pine)        |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Quercus falcata</i> (southern red oak)      |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Quercus coccinea</i> (scarlet oak).         |
| Tree subcanopy               | Broad-leaved evergreen tree  | <i>Ilex opaca</i> (American holly)             |
| Shrub/sapling (tall & short) | Broad-leaved deciduous shrub | <i>Gaylussacia frondosa</i> (blue huckleberry) |





---

## **ECOLOGICAL SYSTEM: NORTHERN ATLANTIC COASTAL PLAIN PITCH PINE LOWLAND**

---

**Summary:** This system is comprised of wetland pine barrens vegetation, best developed in the New Jersey Pine Barrens. Although this system can be extensive, components of this system often co-occur as a mosaic with upland pine barrens vegetation as well. The vegetation is characterized by associations having variable hydroperiods, occurring on a range of substrates from saturated deep peats to seasonally saturated mineral soils. Physiognomy of the component associations is similarly widely variable, ranging from wet grasslands dominated by *Calamovilfa brevipilis* to seasonally saturated pine forests characterized by mesic species. Fire frequency, as well as hydrology, has a profound influence on the vegetation. Where fire frequency is high, woody vegetation is impeded, favoring the development of large wet grasslands.

**Range:** This system ranges along the northern Atlantic Coastal Plain from the vicinity of the James River in Virginia north into New Jersey. United States: DE, MD, NJ, VA

**High Ranked Species:** *Cirsium virginianum* (G3, Virginia thistle), *Coreopsis rosea* (G3, pink tickseed), *Eupatorium resinosum* (G3, pine barren thoroughwort), *Gentiana autumnalis* (G3, pine barren gentian), *Juncus caesariensis* (G2, New Jersey rush), *Muhlenbergia torreyana* (G3, New Jersey muhly), *Narthecium americanum* (G2, bog asphodel), *Platanthera integra* (G3G4, yellow fringeless orchid), *Rhexia aristosa* (G3, awned meadowbeauty), *Rhynchospora knieskernii* (G2, knieskern's beakrush), *Rhynchospora pallida* (G3, pale beakrush), *Rubus hypolasius* (G1?Q, pineland dewberry), *Scirpus longii* (G2G3, Long's bulrush)

### **Delaware Estuary Addendum Associations:**

- Pine Barrens Lowland Forest

|   |
|---|
| <p><b>CLASSIFIERS FOR NORTHERN ATLANTIC COASTAL PLAIN STREAM AND RIVER</b><br/><b>Primary Division:</b> 203<br/><b>Land Cover Class:</b> Mixed Upland and Wetland<br/><b>Spatial Scale &amp; Pattern:</b> Linear<br/><b>Required Classifiers:</b> Natural/Semi-natural; Vegetated (&gt;10% vasc.); Upland; Wetland<br/><b>Diagnostic Classifiers:</b> Riverine / Alluvial<br/><b>Non-diagnostic Classifiers:</b> Forest and Woodland (Treed); Stream terrace (undifferentiated)</p> |
|---|

---

## PINE BARRENS LOWLAND FOREST

*Pinus rigida* - *Nyssa sylvatica* / *Clethra alnifolia* - *Leucothoe racemosa* Forest

---

**Range:** This community is limited in range to the Pine Barrens of New Jersey and the Inner Coastal Plain of Maryland.

**Environmental Description:** This association is restricted to groundwater seepage areas associated with sandy uplands of the Pine Barrens of New Jersey and the inner Coastal Plain of Maryland.

**Vegetation Description:** The canopy is a mixture of *Pinus rigida* (pitch pine), *Acer rubrum* (red maple), *Nyssa sylvatica* (blackgum), with *Liquidambar styraciflua* (sweetgum) in New Jersey. The canopy ranges from mixed deciduous-evergreen to deciduous. The subcanopy is characterized by *Magnolia virginiana* (sweetbay), with occasional *Ilex opaca* (American holly). Typical shrubs include *Clethra alnifolia* (coastal sweetpepperbush), *Leucothoe racemosa* (swamp doghobble), *Gaylussacia frondosa* (blue huckleberry), and *Vaccinium corymbosum* (highbush blueberry). There is often significant cover of *Smilax rotundifolia* (roundleaf greenbrier) vines. The herbaceous stratum includes *Osmunda cinnamomea* (cinnamon fern) and *Gaultheria procumbens* (eastern teaberry). Other species of the herbaceous layer may include *Woodwardia areolata* (netted chainfern), *Chasmanthium laxum* (slender woodoats), *Carex folliculata* (northern long sedge), *Bartonia paniculata* (twining screwstem), *Carex atlantica* (prickly bog sedge), *Carex seorsa* (weak stellate sedge), *Glyceria striata* (fowl mannagrass), and *Lycopus virginicus* (Virginia water horehound).

**Characteristic Species:** *Pinus rigida* (pitch pine), *Acer rubrum* (red maple), *Nyssa sylvatica* (blackgum), with *Liquidambar styraciflua* (sweetgum), *Leucothoe racemosa* (swamp doghobble), *Clethra alnifolia* (coastal sweetpepperbush), *Osmunda cinnamomea* (cinnamon fern)

**Reference Sites:** Manumuskin Preserve, NJ; Cape May NWR NJ

**Global and State Conservation Ranks and Reasons:** G2 (18-Jan-2006). NJ:SNR.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.687022](http://vegbank.org/natureserve/element_global.2.687022)

**References:** Eastern Ecology Working Group n.d., NatureServe 2005

| MOST ABUNDANT SPECIES        |                              |  |
|------------------------------|------------------------------|--|
| STRATUM                      | LIFEFORM                     | SPECIES  |
| Tree canopy                  | Needle-leaved evergreen tree | <i>Pinus rigida</i> (pitch pine)                   |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Acer rubrum</i> (red maple)                     |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Nyssa sylvatica</i> (blackgum)                  |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Liquidambar styraciflua</i> (sweetgum)          |
| Tree subcanopy               | Broad-leaved deciduous tree  | <i>Magnolia virginiana</i> (sweetbay)              |
| Shrub/sapling (tall & short) | Broad-leaved deciduous shrub | <i>Clethra alnifolia</i> (coastal sweetpepperbush) |
| Shrub/sapling (tall & short) | Vine/Liana                   | <i>Smilax rotundifolia</i> (roundleaf greenbrier)  |

---

## **ECOLOGICAL SYSTEM: NORTHERN ATLANTIC COASTAL PLAIN STREAM AND RIVER**

---

**Summary:** This system is found throughout the northern Atlantic Coastal Plain, ranging from Virginia to Delaware. Examples occur along low-gradient small streams and rivers. There may be little to moderate floodplain development. This system is influenced by overbank flooding, groundwater seepage and occasional beaver impoundments. The vegetation is a mosaic of forests, woodlands, shrublands, and herbaceous communities. Canopy composition and cover can vary within examples of this system, but typical tree species may include *Quercus palustris* (pin oak), *Quercus phellos* (willow oak), *Chamaecyparis thyoides* (Atlantic white cedar), *Acer rubrum* (red maple), *Fraxinus pennsylvanica* (green ash), *Nyssa sylvatica* (blackgum), *Betula nigra* (river birch), *Liquidambar styraciflua* (sweetgum), and *Platanus occidentalis* (American sycamore). Shrubs and herbaceous layers can vary in richness and cover. Some characteristic shrubs may include *Alnus maritima* (seaside alder), *Carpinus caroliniana* (American hornbeam), *Lindera benzoin* (northern spicebush), and *Viburnum nudum* (possumhaw). Seepage forests dominated by *Acer rubrum* (red maple) and *Magnolia virginiana* (sweetbay) can often be found within this system, especially at the headwaters and terraces of streams.

**Range:** This system ranges along the northern Atlantic Coastal Plain from the vicinity of the James River in Virginia north into Delaware. United States: DE, MD, VA

**Addendum Comments:** This ecological system replaces Atlantic Coastal Plain Blackwater Stream Floodplain Forest and Atlantic Coastal Plain Brownwater Stream Floodplain Forest ecological systems described in the *Guide*. All vegetation communities previously listed under these floodplain forest ecological systems are now listed in the North Atlantic Coastal Plain Stream and River ecological system.

### **Delaware Estuary Addendum Associations:**

- Chesapeake/ Piedmont Red Maple / Lizard's-tail Swamp
- Coastal Plain Atlantic White-cedar - Red Maple Swamp
- Atlantic White-cedar / Seaside Alder Swamp
- Southern Red Maple - Blackgum Swamp Forest
- Red Maple – Sweet Gum Swamp
- Swamp Loosestrife Shrub Swamp

### **CLASSIFIERS FOR NORTHERN ATLANTIC COASTAL PLAIN STREAM AND RIVER**

**Primary Division:** 203

**Land Cover Class:** Mixed Upland and Wetland

**Spatial Scale & Pattern:** Linear

**Required Classifiers:** Natural/Semi-natural; Vegetated (>10% vasc.); Upland; Wetland

**Diagnostic Classifiers:** Riverine / Alluvial

**Non-diagnostic Classifiers:** Forest and Woodland (Treed); Stream terrace (undifferentiated)

---

## CHESAPEAKE/PIEDMONT RED MAPLE / LIZARD'S-TAIL SWAMP

*Acer rubrum* - *Fraxinus pennsylvanica* / *Saururus cernuus* Forest

---

**Range:** This red maple swamp community occurs in the Coastal Plain of the Chesapeake Bay region, Delaware and in New Jersey.

**Environmental Description:** This red maple swamp community of the Coastal Plain of the Chesapeake Bay region occurs on poorly drained to very poorly drained, base-rich alluvial soils that are seasonally to semipermanently flooded. A thin organic horizon overlies sandy or silt clay loam soils. This swamp has pronounced hummock-and-hollow microtopography.

**Vegetation Description:** The tree canopy is closed to partially open and dominated by *Acer rubrum* (red maple), *Fraxinus pennsylvanica* (green ash), and *Quercus lyrata* (overcup oak). Associated canopy species may include *Nyssa sylvatica* (blackgum), *Quercus phellos* (willow oak), and *Populus heterophylla* (swamp cottonwood). The shrub layer includes *Lindera benzoin* (northern spicebush), *Leucothoe racemosa* (swamp doghobble), *Ilex verticillata* (common winterberry), *Viburnum* (viburnum) spp., and *Fraxinus pennsylvanica* (green ash) saplings.



Photo by Robert Coxe, Delaware Natural Heritage Program

The herbaceous layer is characterized by *Saururus cernuus* (lizard's tail), *Peltandra virginica* (green arrow arum), *Boehmeria cylindrica* (smallspike false nettle), *Triadenum walteri* (greater marsh St. Johnswort), *Cinna arundinacea* (sweet woodreed), *Pilea pumila* (Canadian clearweed), *Impatiens capensis* (jewelweed), *Osmunda cinnamomea* (cinnamon fern), *Osmunda regalis* (royal fern), *Leersia oryzoides* (rice cutgrass), *Leersia virginica* (whitegrass), *Glyceria striata* (fowl mannagrass), *Commelina virginica* (Virginia dayflower), *Rumex verticillatus* (swamp dock), *Carex* (sedge) spp., and *Polygonum arifolium* (halberdleaf tearthumb).

**Characteristic Species:** *Saururus cernuus* (lizard's tail)

**Reference Sites:** Tantrogh Branch and Tubbs Mill Pond, Mispillion Watershed, DE; Lizard Tail Swamp and Supawna National Wildlife Refuge, NJ

**Global and State Conservation Ranks and Reasons:** GNR (21-Mar-2000). DE:SNR, NJ:SNR. This association requires global ranking.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.685450](http://vegbank.org/natureserve/element_global.2.685450)

References: Bowman 2000, Breden et al. 2001, Eastern Ecology Working Group n.d., Fleming 2001, Harrison 2004, Harrison and Stango 2003, Meininger 1998, Thomson et al. 1999, VDNH 2003

| MOST ABUNDANT SPECIES |                              |   |
|-----------------------|------------------------------|---|
| STRATUM               | LIFEFORM                     | SPECIES                                     |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Acer rubrum</i> (red maple)              |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Fraxinus pennsylvanica</i> (green ash)   |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Quercus lyrata</i> (overcup oak)         |
| Tall shrub/sapling    | Broad-leaved deciduous shrub | <i>Lindera benzoin</i> (northern spicebush) |
| Herb (field)          | Forb                         | <i>Saururus cernuus</i> (lizard's tail)     |

### COASTAL PLAIN ATLANTIC WHITE-CEDAR - RED MAPLE SWAMP

*Chamaecyparis thyoides* - *Acer rubrum* - *Magnolia virginiana* Forest

**Range:** This association is found in New Jersey, Delaware, and Maryland.

**Environmental Description:** This is a mixed Atlantic white-cedar - red maple swamp of New Jersey, Delaware and Maryland.

**Vegetation Description:** In addition to *Chamaecyparis thyoides* (Atlantic white cedar) and *Acer rubrum* (red maple), other canopy associates include *Magnolia virginiana* (sweetbay), *Nyssa sylvatica* (blackgum), and *Pinus rigida* (pitch pine). *Ilex opaca* (American holly) occasionally occurs in the subcanopy. The shrub layer is characterized by *Vaccinium corymbosum* (highbush blueberry), *Clethra alnifolia* (coastal sweetpepperbush), *Ilex glabra* (inkberry), *Gaylussacia frondosa* (blue huckleberry), *Rhododendron viscosum* (swamp azalea), *Smilax rotundifolia* (roundleaf greenbrier), and *Smilax laurifolia* (laurel greenbrier). The herbaceous layer may have sparse to moderate cover and includes species such as *Osmunda cinnamomea* (cinnamon fern), *Mitchella repens* (partridgeberry), *Woodwardia virginica* (Virginia chainfern), *Sarracenia purpurea* (purple pitcherplant), *Triadenum virginicum* (Virginia marsh St. Johnswort), *Pogonia ophioglossoides*



Photo by Robert Coxe, Delaware Natural Heritage

(snakemouth orchid), *Boehmeria cylindrica* (smallspike false nettle), *Carex collinsii* (Collins' sedge), and *Carex folliculata* (northern long sedge). In canopy openings, *Orontium aquaticum* (goldenclub) and *Iris versicolor* (harlequin blueflag) may also occur. Sphagnum mosses form a moderately dense to dense bryophyte layer; species include *Sphagnum magellanicum* (Magellan's sphagnum), *Sphagnum cuspidatum* (toothed sphagnum), *Sphagnum pulchrum* (sphagnum), *Sphagnum flavicomans* (sphagnum), *Sphagnum recurvum* (recurved sphagnum), and *Sphagnum fallax* (sphagnum).

**Characteristic Species:** *Chamaecyparis thyoides* (Atlantic white cedar), *Magnolia virginiana* (sweetbay)

**Reference Sites:** Mispillion Watershed, DE, Brendan Byrne State Forest and Cape May National Wildlife Refuge, NJ

**Global and State Conservation Ranks and Reasons:** GNR (1-Dec-1997). DE:SNR, NJ:S4.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.683516](http://vegbank.org/natureserve/element_global.2.683516)

**References:** Breden 1989, Breden et al. 2001, Clancy 1996, Eastern Ecology Working Group n.d., Harrison 2004, Harrison et al. 2004, Karlin 1988, Olsson 1979

| MOST ABUNDANT SPECIES |                              |   |
|-----------------------|------------------------------|---|
| STRATUM               | LIFEFORM                     | SPECIES   |
| Tree canopy           | Needle-leaved tree           | <i>Chamaecyparis thyoides</i><br>(Atlantic white cedar) |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Acer rubrum</i> (red maple)                          |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Magnolia virginiana</i> (sweetbay)                   |
| Tall shrub/sapling    | Broad-leaved deciduous shrub | <i>Vaccinium corymbosum</i><br>(highbush blueberry)     |
| Herb (field)          | Fern or fern ally            | <i>Osmunda cinnamomea</i> (cinnamon fern)               |

---

## ATLANTIC WHITE-CEDAR / SEASIDE ALDER SWAMP

*Chamaecyparis thyoides* / *Alnus maritima* Woodland

---

**Range:** This swamp type occurs along streams of the Delmarva peninsula in Delaware and Maryland.

**Environmental Description:** This open-canopy Atlantic white-cedar swamp occurs along streams of the Delmarva peninsula. It is also found in artificial mill ponds. The substrate is peat and muck characterized by hummock-and-hollow microtopography.

**Vegetation Description:** The tree canopy is characterized by low-statured *Chamaecyparis thyoides* (Atlantic white cedar) in association with *Pinus taeda* (loblolly pine). Other woody associates include *Alnus maritima* (seaside alder), *Morella cerifera* (wax myrtle), *Ilex glabra* (inkberry), and *Clethra alnifolia* (coastal sweetpepperbush). The herbaceous layer is comprised of *Decodon verticillatus* (swamp loosestrife), *Peltandra virginica* (green arrow arum), *Nymphaea odorata* (American white waterlily), *Carex exilis* (coastal sedge), *Dichanthelium dichotomum* (cypress panicgrass), *Oxypolis rigidior* (stiff cowbane), *Triadenum virginicum* (Virginia marsh St. Johnswort), *Dulichium arundinaceum* (threeway sedge), *Glyceria obtusa* (Atlantic mannagrass), *Rhynchospora alba* (white beaksedge), *Carex atlantica* (prickly bog sedge), *Selaginella apoda* (meadow spikemoss), *Drosera rotundifolia* (roundleaf sundew), *Juncus militaris* (bayonet rush), *Vaccinium macrocarpon* (cranberry), *Calopogon tuberosus* (tuberous grasspink), and *Eriocaulon decangulare* (tenangle pipewort). Floating mats within mill ponds have a unique species assemblage including *Xyris difformis* (bog yelloweyed grass), *Fuirena* (umbrella-sedge) spp., *Hypericum mutilum* (dwarf St. Johnswort), *Juncus pelocarpus* (brownfruit rush), *Juncus canadensis*

(Canadian rush), *Fimbristylis (fimbry) sp.*, and *Rhynchospora macrostachya* (tall horned beaksedge).

**Characteristic Species:** *Chamaecyparis thyoides* (Atlantic white cedar), *Alnus maritima* (seaside alder)

**Noteworthy Plants:** *Alnus maritima* (seaside alder), G3

**Reference Sites:** Cedar Creek Watershed, DE

**Global and State Conservation Ranks and Reasons:** Rank: GNR (17-Apr-2000). This association may be of artificial origin, as a result of damming. More information is needed.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.685928](http://vegbank.org/natureserve/element_global.2.685928)

**References:** Eastern Ecology Working Group n.d., Harrison 2004, Coxe 2007

| MOST ABUNDANT SPECIES        |                              |   |
|------------------------------|------------------------------|---|
| STRATUM                      | LIFEFORM                     | SPECIES   |
| Tree canopy                  | Needle-leaved tree           | <i>Chamaecyparis thyoides</i><br>(Atlantic white cedar) |
| Tree canopy                  | Needle-leaved tree           | <i>Pinus taeda</i> (loblolly pine)                      |
| Shrub/sapling (tall & short) | Broad-leaved deciduous shrub | <i>Alnus maritima</i> (seaside alder)                   |
| Herb (field)                 | Forb                         | <i>Decodon verticillatus</i> (swamp loosestrife)        |

---

### SOUTHERN RED MAPLE - BLACKGUM SWAMP FOREST

*Acer rubrum* - *Nyssa sylvatica* - *Magnolia virginiana* / *Viburnum nudum* var. *nudum* / *Osmunda cinnamomea* - *Woodwardia areolata* Forest

---

**Range:** This community ranges from southeastern New York and New Jersey to southeastern Virginia on the Coastal Plain. In Virginia, it extends into the extreme eastern portion of the Piedmont.

**Environmental Description:** This association is generally restricted to groundwater-saturated stream bottoms, seeping toeslopes, and poorly drained depressions with seasonally perched water tables. Sites typically have hummock-and-hollow microtopography with braided channels, *Sphagnum* (sphagnum)-covered hummocks, mucky depressions, and areas of exposed sand and gravel.



Photo by NatureServe

Soils are extremely acidic and very low in base status.

**Vegetation Description:** Canopy closure ranges from closed to quite open. Plot data from 20 Virginia and Maryland stands indicate that *Acer rubrum* (red maple) and *Nyssa sylvatica* (blackgum) are consistently dominant overstory species. *Magnolia virginiana* (sweetbay) is a frequent overstory associate and usually dominant in the subcanopy layer, or codominant with *Ilex opaca* (American holly). *Liriodendron tulipifera* (tuliptree) is a frequent but minor overstory associate. Shrub layers tend to be dense and diverse, characteristically containing *Viburnum nudum* var. *nudum* (possumhaw), *Vaccinium corymbosum* (highbush blueberry), *Smilax rotundifolia* (roundleaf greenbrier), *Ilex verticillata* (common winterberry), and *Lindera benzoin* (northern spicebush). In parts of the range, *Clethra alnifolia* (coastal sweetpepperbush) is a dominant shrub, while in New Jersey, *Chamaedaphne calyculata* (leatherleaf) and *Gaylussacia frondosa* (blue huckleberry) are present. Additional, less constant shrub associates are *Rhododendron viscosum* (swamp azalea), *Leucothoe racemosa* (swamp doghobble), *Chionanthus virginicus* (white fringetree), *Viburnum dentatum* (southern arrowwood), *Toxicodendron vernix* (poison sumac), and *Carpinus caroliniana* (American hornbeam). The herb layer varies from dense to sparse. *Osmunda cinnamomea* (cinnamon fern) and *Woodwardia areolata* (netted chainfern) are generally the most constant and abundant herbs, but *Symplocarpus foetidus* (skunk cabbage) is a patch-dominant in approximately two-thirds of the Virginia and Maryland stands. Additional characteristic herbs occurring at low cover include *Arisaema triphyllum* ssp. *pusillum* (Jack in the pulpit), *Carex folliculata* (northern long sedge), *Carex seorsa* (weak stellate sedge), *Chelone glabra* (white turtlehead), *Impatiens capensis* (jewelweed), *Lycopus virginicus* (Virginia water horehound), *Mitchella repens* (partridgeberry), *Osmunda regalis* var. *spectabilis* (royal fern), *Platanthera clavellata* (small green wood orchid), and *Viola cucullata* (marsh blue violet).

**Noteworthy Associated Plant and/or Animal Species:** *Helonias bullata* (swamppink)

**Characteristic Species:** *Arisaema triphyllum* ssp. *pusillum* (Jack in the pulpit), *Carex folliculata* (northern long sedge), *Carex seorsa* (weak stellate sedge), *Chelone glabra* (white turtlehead), *Ilex verticillata* (common winterberry), *Impatiens capensis* (jewelweed), *Lindera benzoin* (northern spicebush), *Lycopus virginicus* (Virginia water horehound), *Mitchella repens* (partridgeberry), *Osmunda regalis* var. *spectabilis* (royal fern), *Platanthera clavellata* (small green wood orchid), *Smilax rotundifolia* (roundleaf greenbrier), *Vaccinium corymbosum* (highbush blueberry), *Viburnum nudum* var. *nudum* (possumhaw), *Viola cucullata* (marsh blue violet), *Woodwardia areolata* (netted chainfern)

**Dynamics/Successional Trajectory:** Trees tend to be slow-growing and of less than optimal stature in the wet, unstable habitats. Additionally, these swamps tend to border dry, sandy uplands supporting fire-prone oak/heath forests. Occasional fires, burning into the swamps from the uplands during dry periods, may have once influenced the composition and physiognomy of this type. However, fire has now been excluded from almost all areas within the range. An exception is at Fort A.P. Hill Military Reservation, where military training results in frequent incendiary fires in a roughly 5000-ha area. Stands of this community are very susceptible to flooding from beaver activities, which usually results in the destruction or extreme alteration of a stand. In New Jersey, this community is often situated adjacent to *Chamaecyparis thyoides* (Atlantic white cedar)-dominated swamp and may replace it after logging.

**Management Concerns:** This community is vulnerable to alteration or destruction by beavers and various anthropogenic activities, including hydrologic modifications.



**Reference Sites:** Mispillion Watershed, DE, widespread in NJ and DE, including Fort Dix and Cape May National Wildlife Refuge, NJ

**Global and State Conservation Ranks and Reasons:** G3? (30-Mar-2004). DE:SNR, NJ:S4S5, PA:SNR. The type is restricted to an uncommon wetland habitat in a limited region. It is vulnerable to alteration or destruction by beavers and various anthropogenic activities, including hydrologic modifications.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.686944](http://vegbank.org/natureserve/element_global.2.686944)

**References:** Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Ehrenfeld and Gulick 1981, Fike 1999, Fleming et al. 2001, Fleming pers. comm., Golet et al. 1993, Harrison 2004, Harrison and Stango 2003, Harvill 1967, Heckscher 1994, Hill 1986, McCormick 1979, Patterson pers. comm., Robichaud and Buell 1973, Sipple and Klockner 1984, VDNH 2003, Windisch 1995b

| MOST ABUNDANT SPECIES        |                              |   |
|------------------------------|------------------------------|---|
| STRATUM                      | LIFEFORM                     | SPECIES   |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Acer rubrum</i> (red maple)                        |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Liquidambar styraciflua</i> (sweetgum)             |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Nyssa sylvatica</i> (blackgum)                     |
| Shrub/sapling (tall & short) | Broad-leaved deciduous shrub | <i>Clethra alnifolia</i><br>(coastal sweetpepperbush) |
| Shrub/sapling (tall & short) | Broad-leaved deciduous shrub | <i>Vaccinium corymbosum</i><br>(highbush blueberry)   |
| Herb (field)                 | Fern or fern ally            | <i>Osmunda cinnamomea</i> (cinnamon fern)             |
| Herb (field)                 | Fern or fern ally            | <i>Woodwardia areolata</i> (netted chainfern)         |

## RED MAPLE - SWEETGUM SWAMP

*Liquidambar styraciflua* - *Acer rubrum* - *Quercus phellos* / *Leucothoe racemosa* Forest

**Range:** This association is a seasonally flooded forest of shallow basins and other depressions of the Coastal Plain of the Chesapeake Bay region, Delaware, New Jersey and Pennsylvania..

**Environmental Description:** This type occurs in seasonally flooded shallow basins or depressions. Substrates are acidic, gleyed to mottled, sandy or clay loams. The water table may be perched.

**Vegetation Description:** Characteristic tree species



Photo by Robert Cox, Delaware Natural Heritage Program

include *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), and *Nyssa sylvatica* (blackgum), which are nearly constant in the canopy. Associates include *Ilex opaca* (American holly), *Magnolia virginiana* (sweetbay), *Nyssa biflora* (swamp tupelo), *Sassafras albidum* (sassafras), *Quercus palustris* (pin oak), *Pinus taeda* (loblolly pine), and *Quercus phellos* (willow oak), and occasionally *Quercus falcata* (southern red oak), *Quercus lyrata* (overcup oak), or *Betula nigra* (river birch). The shrub layer is characterized by *Leucothoe racemosa* (swamp doghobble), *Vaccinium corymbosum* (highbush blueberry), *Clethra alnifolia* (coastal sweetpepperbush), *Lindera benzoin* (northern spicebush), *Ilex verticillata* (common winterberry), and *Rhododendron viscosum* (swamp azalea). *Smilax rotundifolia* (roundleaf greenbrier) is a particularly characteristic vine. The herbaceous layer is generally sparse but may include *Mitchella repens* (partridgeberry), *Osmunda cinnamomea* (cinnamon fern), *Woodwardia areolata* (netted chainfern), *Onoclea sensibilis* (sensitive fern), *Osmunda regalis* (royal fern), *Carex albolutescens* (greenwhite sedge), *Scirpus cyperinus* (woolgrass), *Juncus effusus* (common rush), and *Polygonum* (knotweed) spp.

**Characteristic Species:** *Leucothoe racemosa* (swamp doghobble), *Quercus phellos* (willow oak), *Smilax rotundifolia* (roundleaf greenbrier)

**Reference Sites:** Northern portion of Mispillion Watershed, DE, Brendan Byrne State Forest, NJ; Cape May NWR, Supawna NWR, NJ; Fort Dix, Inner Coastal Plain, NJ; Delhaas Woods, and Black Ditch County Park, Bucks County, PA

**Global and State Conservation Ranks and Reasons:** G4G5 (31-Jan-2007). DE:SNR, NJ:S3, PA:SNR.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.687145](http://vegbank.org/natureserve/element_global.2.687145)

**References:** Bowman 2000, Breden 1989, Breden et al. 2001, Brush et al. 1980, Clancy 1996, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fleming et al. 2001, Harrison 2004, Harrison and Stango 2003, Hunt 1998, Sneddon and Anderson 1994, Sneddon et al. 1996, Thomson et al. 1999, Tyndall et al. 1990, VDNH 2003

| MOST ABUNDANT SPECIES |                              |  |
|-----------------------|------------------------------|--|
| STRATUM               | LIFEFORM                     | SPECIES                                    |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Acer rubrum</i> (red maple)             |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Liquidambar styraciflua</i> (sweetgum)  |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Nyssa sylvatica</i> (blackgum)          |
| Shrub/sapling         | Broad-leaved deciduous shrub | <i>Leucothoe racemosa</i> (swampdoghobble) |

---

## SWAMP-LOOSESTRIFE SHRUB SWAMP

*Decodon verticillatus* Semipermanently Flooded Shrubland

---

**Range:** This community occurs in the New Jersey and Delaware portions of the Delaware Estuary.

**Environmental Description:** This shrubland forms as a fringe along aquatic edges of lakes, streams, and impoundments.

**Vegetation Description:** *Decodon verticillatus* (swamp loosestrife) forms a dense, often monotypic tangle. *Cephalanthus occidentalis* (common buttonbush) can occur but with less abundance than *Decodon verticillatus* (swamp loosestrife). Herbaceous species vary widely but may include *Nuphar lutea* ssp. *variegata* (variegated yellow pond-lily), *Nymphaea odorata* (American white waterlily), *Peltandra virginica* (green arrow arum), *Pontederia cordata* (pickerelweed), *Utricularia* (bladderwort) spp., and *Potamogeton* (pondweed) spp.



Photo by Robert Coxe, Delaware Natural Heritage Program

**Characteristic Species:** *Decodon verticillatus* (swamp loosestrife)

**Reference Sites:** Tantrough Branch, Mispillion Watershed, DE; Cape May NWR, NJ

**Global and State Conservation Ranks and Reasons:** GNR (15-Dec-1994). DE:SNR, NJ:SNR, PA:SNR.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.685207](http://vegbank.org/natureserve/element_global.2.685207)

**References:** Bowman 2000, Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Harrison 2004, Metzler and Barrett 2001, Swain and Kearsley 2001

| MOST ABUNDANT SPECIES |                              |  |
|-----------------------|------------------------------|--|
| STRATUM               | LIFEFORM                     | SPECIES  |
| Short shrub/sapling   | Broad-leaved deciduous shrub | <i>Decodon verticillatus</i> (swamp loosestrife) |



---

## ECOLOGICAL SYSTEM: NORTHERN ATLANTIC COASTAL PLAIN POND

---

**Summary:** This system includes vegetation of groundwater-flooded depressions characterized by a flora generally restricted to the Coastal Plain from the southern portion of the Delmarva peninsula to Cape Cod, Massachusetts. Ponds may contain permanent water, such as the deep glacial kettleholes of Cape Cod and Long Island, New York, or may be shallow basins where groundwater drops below the surface late in the growing season. This system occurs on sandy deposits such as outwash plains of the glaciated region (Long Island and Cape Cod), on the deep sands of the New Jersey Pine Barrens, or on finer sediments of the Coastal Plain of Cape May, New Jersey, the Delmarva peninsula, and the Chesapeake Bay region. The vegetation of steeper-sided basins (generally those containing permanent water) are characterized by strong zonation, with a border of tall shrubs, such as *Vaccinium corymbosum* (highbush blueberry), and several essentially concentric bands or zones dominated by different associations, depending on geography. Characteristic species in Massachusetts and Long Island include *Rhexia virginica* (handsome Harry), *Cyperus dentatus* (toothed flatsedge), *Gratiola aurea* (golden hedgehyssop), *Panicum verrucosum* (warty panicgrass), *Euthamia caroliniana* (slender goldentop), *Carex striata* (Walter's sedge), *Juncus pelocarpus* (brownfruit rush), *Rhynchospora capillacea* (needle beaksedge), *Rhynchospora macrostachya* (tall horned beaksedge), *Xyris difformis* (bog yelloweyed grass), *Fimbristylis autumnalis* (slender fimbry), *Scleria reticularis* (netted nutrush), *Sabatia kennedyana* (Plymouth rose gentian), *Drosera filiformis* (threadleaf sundew), *Juncus militaris* (bayonet rush), and many others.

Ponds of the New Jersey Pine Barrens share many of these species, with others including *Juncus repens* (lesser creeping rush), *Muhlenbergia torreyi* (ring muhly), *Rhynchospora oligantha* (featherbristle beaksedge), *Rhynchospora cephalantha* (bunched beaksedge), *Rhynchospora chalarocephala* (loosehead beaksedge), and many others. In shallow basins, such strong zonation is generally lacking but still remains evident in some cases. On Cape Cod, Long Island, and New Jersey, this system most often occurs within the pitch pine barrens.

From Cape May and south, the system occurs within an upland matrix of mixed hardwood forests and generally supports a seasonally flooded swamp forest characterized by *Liquidambar styraciflua* (sweetgum), *Acer rubrum* (red maple), wetland oaks such as *Quercus phellos* (willow oak), and in Virginia and scattered locations on the Inner Coastal Plain of Maryland *Nyssa biflora* (swamp tupelo). The vegetation is characterized by many of the species from New England, New York and New Jersey and also includes *Juncus repens* (lesser creeping rush), *Boltonia asteroides* (white doll's daisy), *Fimbristylis perpusilla* (Harper's fimbry), *Coelorachis rugosa* (wrinkled jointtail grass), *Dichantherium spretum* (Eaton's rosette grass), *Saccharum giganteum* (sugarcane plume grass), *Eleocharis quadrangulata* (squarestem spikerush), and others. *Cephalanthus occidentalis* (common buttonbush) often occurs as scattered individuals or as a shrub swamp with less diversity and cover of Coastal Plain flora.

**High-ranked Species:** *Clonophis kirtlandii* (G2, kirtland's snake), *Coreopsis rosea* (G3, pink tickseed), *Dichantherium hirstii* (G1, Hirst's panicgrass), *Eulimnadia agassizii* (G1G2, agassiz clam shrimp), *Eupatorium leucolepis* var. *novae-angliae* (G5T1, justiceweed), *Eupatorium resinosum* (G3, Pine Barren thoroughwort), *Euthamia galetorum* (G3, narrowleaf fragrant goldenrod), *Fimbristylis perpusilla* (G2, Harper's fimbry), *Helenium virginicum* (G3, Virginia sneezeweed), *Hypericum adpressum* (G3, creeping St. Johnswort), *Lobelia boykinii* (G2G3, Boykin's lobelia),

*Lycopodiella margueritiae* (G2, Marguerite's clubmoss), *Lycopodiella subappressa* (G2, northern bog clubmoss), *Oxypolis canbyi* (G2, Canby's cowbane), *Papaipema sulphurata* (G2, decodon stem borer moth), *Rhexia aristosa* (G3, awnpetal meadowbeauty), *Sabatia kennedyana* (G3, Plymouth rose gentian), *Sagittaria teres* (G3, slender arrowhead), *Schoenoplectus etuberculatus* (G3G4, Canby's bulrush), *Scirpus ancistrochaetus* (G3, barbedbristle bulrush)

**Range:** This system ranges from the southern portion of the Delmarva peninsula to Cape Cod, Massachusetts, and also in limited, highly disjunct occurrences on sand lakeplain near southern Lake Michigan and in southeastern Vermont. United States: DE, MA, MD, MI, NJ, NY, VA, VT, WI

**Delaware Estuary Addendum Associations:**

- Smartweed - Cutgrass Beaver Pond
- Swamp Cottonwood Coastal Plain Pond
- Chainfern Small Depression Pond

**CLASSIFIERS FOR NORTHERN ATLANTIC COASTAL PLAIN POND SHORE**

**Primary Division:** 203

**Land Cover Class:** Herbaceous Wetland

**Spatial Scale & Pattern:** Small patch

**Required Classifiers:** Natural/Semi-natural; Vegetated (>10% vasc.); Wetland

**Diagnostic Classifiers:** None identified

**Non-diagnostic Classifiers:** Herbaceous; Depressional; Isolated Wetland [Partially Isolated]

---

**SMARTWEED - CUTGRASS BEAVER POND**

*Polygonum (hydropiperoides, punctatum) - Leersia* spp. Herbaceous Vegetation

---

**Range:** This association is found in the Atlantic Coastal Plain. An example occurs in the Supawna Meadows National Wildlife Refuge in New Jersey.

**Environmental Description:** This association incorporates vegetation of beaver ponds and other semipermanent impoundments.

**Vegetation Description:** Stands of this vegetation are dominated by some combination of *Polygonum punctatum* (dotted smartweed), *Polygonum hydropiperoides* (swamp smartweed), *Leersia lenticularis* (catchfly grass), *Leersia oryzoides* (rice cutgrass), and/or *Leersia virginica* (whitegrass). Other herbaceous species which may be present include *Polygonum densiflorum* (denseflower knotweed), *Saururus cernuus* (lizard's tail), *Proserpinaca* (mermaidweed) sp., *Sparganium americanum* (American bur-reed), *Typha latifolia* (broadleaf cattail), *Scirpus cyperinus* (woolgrass), *Lobelia cardinalis* (cardinalflower), *Onoclea sensibilis* (sensitive fern), *Penthorum sedoides* (ditch stoneweed), *Boehmeria cylindrica* (smallspike false nettle), *Sambucus canadensis* (common elderberry), *Bidens aristosa* (bearded beggarticks), and *Xanthium strumarium* (rough cocklebur). Scattered individuals of *Cephalanthus occidentalis* (common buttonbush) and *Acer saccharinum* (silver maple) or other woody plants may be present. Examples which have become dried-out (through drought and/or beaver dam failure) may exhibit greater dominance by *Leersia* (cutgrass) rather than *Polygonum* (knotweed). The combination of *Polygonum punctatum* - *Leersia virginica* was first noted, but the combination of *Polygonum hydropiperoides* (swamp smartweed) and *Leersia lenticularis* (catchfly grass) has also been observed in the Oconee National Forest.

**Characteristic Species:** *Leersia lenticularis* (catchfly grass), *Leersia virginica* (whitegrass), *Polygonum hydropiperoides* (swamp smartweed), *Polygonum punctatum* (dotted smartweed)

**Global and State Conservation Ranks and Reasons:** G4? (21-Dec-2000). This association is found in the Coastal Plain and Interior from Tennessee and Alabama to the Carolinas and Mid Atlantic. The full extent of its distribution is not known. This is not a rare community type, but it is threatened by filling of wetlands.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.688722](http://vegbank.org/natureserve/element_global.2.688722)

**References:** Aulbach-Smith pers. comm., Ehrenfeld 1977, Gallyoun et al. 1996, NatureServe Ecology - Southeastern U.S. unpubl. data, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data

| MOST ABUNDANT SPECIES |           |   |
|-----------------------|-----------|---|
| STRATUM               | LIFEFORM  | SPECIES   |
| Herb (Field)          | Forb      | <i>Polygonum hydropiperoides</i><br>(swamp smartweed) |
| Herb (Field)          | Forb      | <i>Polygonum punctatum</i> (dotted smartweed)         |
| Herb (field)          | Graminoid | <i>Leersia</i> spp. (whitegrass)                      |

## SWAMP COTTONWOOD COASTAL PLAIN POND

*Populus heterophylla* - *Acer rubrum* - *Quercus palustris* - *Liquidambar styraciflua* Forest

**Range:** This community occurs on the western shore of Delaware Bay at Prime Hook National Wildlife Refuge and Blackbird State Forest and possibly on Long Island, New York.

**Environmental Description:** This association includes small, isolated, *Populus heterophylla* (swamp cottonwood)-dominated seasonally flooded ponds in the Coastal Plain of Delaware. This community occupies shallow depressions that fill with water in the late fall and winter and then dry in the summer. Topography is typically that of a Coastal Plain pond. In Prime Hook National Wildlife Refuge, one example of this community is located in a pond just south of Prime Hook Beach Road that is impacted by beavers and similar to a Carolina bay. More of these ponds are known from Delmarva bays in southern New Castle and northern Kent counties, Delaware.

### Vegetation Description:

This seasonally flooded pond community is codominated by *Populus heterophylla* (swamp cottonwood), *Acer rubrum* (red maple), *Quercus palustris* (pin oak), *Nyssa sylvatica* (blackgum), and *Liquidambar styraciflua* (sweetgum) in the canopy. There are few species in the understory; some understory associates can include *Acer rubrum* (red maple),



Photo by Robert Coxe, Delaware Natural Heritage Program

*Fraxinus pennsylvanica* (green ash), and *Clethra alnifolia* (coastal sweetpepperbush).

The herbaceous layer is dominated by *Microstegium vimineum* (Nepalese browntop). *Osmunda regalis* (royal fern) and *Polygonum hydropiperoides* (swamp smartweed) are also present in the herbaceous layer, and *Smilax laurifolia* (laurel greenbrier) is present as a vine.

**Characteristic Species:** *Populus heterophylla* (swamp cottonwood)

**Reference Sites:** Prime Hook, DE

**Global and State Conservation Ranks and Reasons:** GNR (11-Dec-2006). DE: SNR. There is not enough data on this community to determine a global rank.



VegBank Link for Plot Data: [http://vegbank.org/natureserve/element\\_global.2.797103](http://vegbank.org/natureserve/element_global.2.797103)

References: Eastern Ecology Working Group n.d.

| MOST ABUNDANT SPECIES |                              |  |
|-----------------------|------------------------------|--|
| STRATUM               | LIFEFORM                     | SPECIES  |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Populus heterophylla</i><br>(swamp cottonwood)      |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Acer rubrum</i> (red maple)                         |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Liquidambar styraciflua</i> (sweetgum)              |
| Shrub/sapling         | Broad-leaved deciduous shrub | <i>Clethra alnifolia</i> (coastal<br>sweet pepperbush) |
| Herb                  | Graminoid                    | <i>Microstegium vimineum</i><br>(Japanese stiltgrass)  |

### CHAINFERN SMALL DEPRESSION POND

*Woodwardia virginica* / *Sphagnum cuspidatum* Herbaceous Vegetation

**Range:** This association is attributed to various states in the Atlantic Coastal Plain from New Jersey and Delaware to Florida.

**Environmental Description:** Stands of this generally defined association are seasonally flooded wetland depressions or ponds which occur in acidic sands of the Coastal Plain.

**Vegetation Description:** Stands of this generally defined association are often strongly dominated by *Woodwardia virginica* (Virginia chainfern). The vegetation may be tall, reaching up to 1.5 m in height.

Additional associates include *Triadenum virginicum* (Virginia marsh St. Johnswort), *Carex striata* (Walter's sedge), *Hypericum mutilum* (dwarf St. Johnswort), and *Decodon verticillatus* (swamp loosestrife).

Woody associates typically occur at the periphery of the pond or depression and may include scattered and stunted individuals of

*Acer rubrum* (red maple), *Pinus taeda* (loblolly pine), *Liquidambar styraciflua* (Sweetgum), *Clethra alnifolia* (sweet pepperbush), *Rhododendron viscosum* (swamp azalea), or *Vaccinium corymbosum* (highbush blueberry). In addition, *Sphagnum* mosses (e.g., *Sphagnum cuspidatum*, *Sphagnum palustre*) are also typical components. More information is needed on this vegetation type.



Photo by Linda Kelly

**Characteristic Species:** *Woodwardia virginica* (Virginia chainfern)

Reference Sites: Cape May NWR, NJ

Global and State Conservation Ranks and Reasons: G2? 1-Dec-1997.

References: Bartgis 1986, Berdine and Gould 1999, Clancy 1996, Glitzenstein and Streng 2004, Harrison 2004, Laessle 1942, Schafale 2000, Schafale and Weakley 1990, Southeastern Ecology Working Group n.d.\*

| MOST ABUNDANT SPECIES |                              |   |
|-----------------------|------------------------------|---|
| STRATUM               | LIFEFORM                     | SPECIES   |
| Shrub/sapling         | Broad-leaved deciduous shrub | <i>Decodon verticillatus</i> (swamp loosestrife)    |
| Herb                  | Fern                         | <i>Woodwardia virginica</i><br>(Virginia chainfern) |

---

**ECOLOGICAL SYSTEM: NORTHERN ATLANTIC COASTAL PLAIN FRESH AND OLIGOHALINE TIDAL MARSH**

---

**Summary:** This system includes freshwater tidal vegetation occurring on the upper reaches of large rivers influenced by tidal flooding, but beyond the reach of the salt wedge. The system is best developed on the Chesapeake and Delaware Bay drainages, including the rivers of southern New Jersey. The system extends northeast and includes inland portions of the Hudson River, Connecticut River, and the Merrimac River and their tributaries. The vegetation includes tall marshes dominated by tall grasses such as *Zizania aquatica* (annual wildrice), marshes of lower stature dominated by forbs such as *Amaranthus cannabinus* (tidal marsh amaranth), *Hibiscus moscheutos* (crimson-eyed rose mallow) and others, and vegetation characterized by short-statured and rosette-forming forbs such as *Eriocaulon parkeri* (estuary pipewort) and *Isoetes riparia* (shore quillwort). Associations are distributed by proximity to tidal waters and thus duration and force of flooding. Sediments of more protected and isolated vegetation is comprised of finer-grained materials that are poorly drained, or of well-consolidated peat deposits. Vegetation exposed to greater flooding force and scouring action is supported by mineral substrates such as sand and gravel.

**Range:** Best developed on the Chesapeake and Delaware Bay drainages, including the rivers of southern New Jersey, but extends northeast and includes inland portions of the Hudson River, Connecticut River, and the Merrimac River and their tributaries. United States: DE, MD, VA

**Delaware Estuary Addendum Associations:**

- Oligohaline Mixed Forbs Tidal Marsh

**CLASSIFIERS FOR NORTHERN ATLANTIC COASTAL PLAIN FRESH AND OLIGOHALINE TIDAL MARSH**

**Primary Division:** 203

**Land Cover Class:** Herbaceous Wetland

**Spatial Scale & Pattern:** Large patch

**Required Classifiers:** Natural/Semi-natural; Vegetated (>10% vasc.); Wetland

**Diagnostic Classifiers:** Tidal / Estuarine; Graminoid

**Non-diagnostic Classifiers:** Herbaceous

---

**BRACKISH TIDAL CREEK SHRUBLAND**

*Morella cerifera* - *Baccharis halimifolia* / *Eleocharis fallax* Shrubland

---

**Range:** This vegetation occurs on tidal rivers of the central and mid-Atlantic coast.

**Environmental Description:** This is an oligohaline tidal shrubland of brackish tidal waters in Maryland and Delaware on firm, partially decomposed peat lacking pronounced hummock-and-hollow microtopography. This vegetation forms linear stands along tidal channels between freshwater tidal marshes and adjacent swamp forests.

**Vegetation Description:** The shrub canopy is relatively open to moderately dense and is dominated by *Morella cerifera* (wax myrtle). *Baccharis halimifolia* (eastern baccharis) is a common associate; others include *Acer rubrum* (red maple) and *Toxicodendron radicans* (eastern poison ivy). The herbaceous layer is relatively diverse and characterized by *Eleocharis fallax* (creeping spikerush), *Kosteletzkya virginica* (Virginia saltmarsh mallow), *Hibiscus moscheutos* (crimson-eyed rosemallow), *Typha angustifolia* (narrowleaf cattail), *Polygonum punctatum* (dotted smartweed), *Cyperus filicinus* (fern flatsedge), *Panicum virgatum* (switchgrass), *Schoenoplectus americanus* (chairmaker's bulrush), *Amaranthus cannabinus* (tidalmarsh amaranth), *Hydrocotyle verticillata* (whorled marshpennywort), *Pluchea odorata* (sweetscent), *Spartina alterniflora* (smooth cordgrass), *Lythrum lineare* (wand lythrum), *Asclepias incarnata* (swamp milkweed), *Ptilimnium capillaceum* (herbwilliam), and *Carex hormathodes* (marsh straw sedge).

**Characteristic Species:** *Morella cerifera* (wax myrtle), *Eleocharis fallax* (creeping spikerush)

**Reference Sites:** Prime Hook, DE; Cape May NWR, NJ

**Global Conservation Rank and Reasons:** GNR (21-Apr-2004).

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.721904](http://vegbank.org/natureserve/element_global.2.721904)

**References:** Coulling unpubl. data 2007, Eastern Ecology Working Group n.d., Harrison 2004, Harrison and Stango 2003

| MOST ABUNDANT SPECIES |                              |  |
|-----------------------|------------------------------|--|
| STRATUM               | LIFEFORM                     | SPECIES  |
| Tall and Short shrub  | Broad leaved deciduous shrub | <i>Morella cerifera</i> (wax myrtle)                   |
| Tall and Short shrub  | Broad leaved deciduous shrub | <i>Baccharis halimifolia</i> (eastern baccharis)       |
| Tall and Short shrub  | Broad leaved deciduous shrub | <i>Hibiscus moscheutos</i><br>(Halberd-leaf tearthumb) |
| Herb(field)           | Forb                         | <i>Polygonum punctatum</i><br>(dotted smartweed)       |
| Herb (field)          | Graminoid                    | <i>Eleocharis fallax</i> (creeping spikerush)          |

---

## OLIGOHALINE MIXED FORBS TIDAL MARSH

*Hibiscus moscheutos* - *Polygonum punctatum* - *Peltandra virginica* Tidal Herbaceous Vegetation

---

**Range:** This community occurs in the New Jersey and Delaware portions of the Delaware Estuary.

**Environmental Description:** Most stands are located near the edge of an extensive marsh but set by the main river channel and often bordered by scattered clumps of shrubs. There is often hummock-and-hollow microtopography.

**Vegetation Description:** These are diverse oligohaline marshes characterized by variable dominance patterns but generally containing *Polygonum arifolium* (Halberd-leaf tearthumb), *Hibiscus moscheutos* ssp. *moscheutos* (swamp rosemallow), *Polygonum punctatum* (dotted smartweed), *Peltandra virginica* (green arrow-arum), *Leersia oryzoides* (rice cutgrass), *Polygonum sagittatum* (rice cutgrass), *Mikania scandens* (climbing hempweed), and *Toxicodendron radicans* (eastern poison-ivy). *Bidens laevis* (smooth bur-marigold), *Cicuta maculata* (spotted water-hemlock), *Cuscuta* sp. (dodder), *Impatiens capensis* (orange jewelweed), *Lycopus americanus* (American bugleweed), and *Sagittaria latifolia* (broadleaf arrowhead), and graminoids such as *Typha latifolia* (broadleaf cattail) and *Schoenoplectus fluviatilis* (= *Bulboschoenus fluviatilis*) (river bulrush) may also be present at variable cover. *Typha angustifolia* (narrowleaf cattail) and *Spartina cynosuroides* (salt reedgrass) may form extensive dominance patches. All of these species are able to tolerate a broad range of halinity, and the high mean species richness of this type suggests that it is generally restricted to only slightly oligohaline habitats. Infrequently present are several species that are more specific to oligohaline conditions, including *Echinochloa walteri* (Walter's barnyard grass), *Kosteletzkya virginica* (Virginia sea-shore mallow), *Pluchea odorata* (shrubby camphorweed), *Rumex verticillatus* (swamp dock), *Sagittaria lancifolia* (bull-tongue arrowhead), and *Teucrium canadense* (American germander). *Spartina cynosuroides* (salt reedgrass) occurs in approximately two-thirds of the representative vegetation sample plots and at times codominates. The colonial sedge *Carex stricta* (tussock sedge) often forms local dominance patches, characteristically on hummocks raised 20-25 cm above the primary marsh surface. Such stands also characteristically contain scattered individuals of *Rosa palustris* (swamp rose) or *Cephalanthus occidentalis* (common buttonbush).

**Characteristic Species:** *Hibiscus moscheutos* ssp. *moscheutos* (swamp rosemallow), *Polygonum punctatum* (dotted smartweed), *Peltandra virginica* (green arrow-arum), *Leersia oryzoides* (rice cutgrass)

**Reference Sites:** Mispillion Watershed, DE, Trenton Marsh, Mercer County, NJ; Taylor's Preserve, Riverton, Burlington County, NJ; Mannington Creek, NJ; Pedricktown Marsh, NJ, Supawna Meadows, NJ

**Dynamics/Successional Trajectory:** This association forms in oligohaline marshes on the Coastal Plain where gradual elevation gradients allow exaggeration of salinity gradients.

**Global Conservation Rank and Reasons:** GNR (12-May-2002).

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.685367](http://vegbank.org/natureserve/element_global.2.685367)

**References:** Bartgis 1986, Coulling 2002, Eastern Ecology Working Group n.d., Fleming et al. 2004, Harrison 2004, Harrison pers. comm.

| MOST ABUNDANT SPECIES |            |   |
|-----------------------|------------|---|
| STRATUM               | LIFEFORM   | SPECIES   |
| Short shrub/sapling   | Semi-shrub | <i>Hibiscus moscheutos</i> ssp. <i>moscheutos</i><br>(eastern rosemallow) |
| Herb (field)          | Forb       | <i>Peltandra virginica</i> (green arrow-arum)                             |
| Herb (field)          | Forb       | <i>Polygonum arifolium</i><br>(Halberd-leaf tearthumb)                    |
| Herb(field)           | Forb       | <i>Polygonum punctatum</i><br>(dotted smartweed)                          |
| Herb (field)          | Graminoid  | <i>Typha angustifolia</i> (narrow leaved cattail)                         |

---

## **ECOLOGICAL SYSTEM: NORTHERN ATLANTIC COASTAL PLAIN TIDAL SALT MARSH**

---

**Summary:** This system encompasses the mesohaline to saline intertidal marshes of the North Atlantic Coastal Plain, ranging from Chesapeake Bay north to Cape Cod, Massachusetts, and sporadically to the southern Maine coast. It includes a number of different broad vegetation types including salt pannes, salt marshes, and salt shrublands. This system occurs on the bay side of barrier beaches and the outer mouth of tidal rivers where salinity is not much diluted by freshwater input. The typical salt marsh profile, from sea to land, can be summarized as follows: a low regularly flooded marsh strongly dominated by *Spartina alterniflora* (smooth cordgrass); a higher irregularly flooded marsh dominated by *Spartina patens* (saltmeadow cordgrass) and *Distichlis spicata* (inland saltgrass); low hypersaline pannes characterized by *Salicornia* (pickleweed) spp.; and a salt scrub ecotone characterized by *Iva frutescens* (Jesuit's bark), *Baccharis halimifolia* (eastern baccharis), and *Panicum virgatum* (switchgrass). Salt marsh "islands" of slightly higher elevation also support *Juniperus virginiana* (eastern redcedar). This system also includes the rare sea-level fen vegetation, which occurs at the upper reaches of the salt marsh where groundwater seepage creates a freshwater fen.

**Range:** This system is found from the southern Maine coast south to the Chesapeake Bay. United States: CT, DE, MA, MD, ME, NH, NJ, NY, RI, VA

### **Delaware Estuary Addendum Associations:**

- Loblolly Pine / Wax-myrtle / Saltmeadow Cordgrass Tidal Woodland
- Eastern Tidal Salt Shrub
- Atlantic Coast Interdune Swale

### **CLASSIFIERS FOR NORTHERN ATLANTIC COASTAL PLAIN TIDAL SALT MARSH**

**Primary Division:** 203

**Land Cover Class:** Herbaceous Wetland

**Spatial Scale & Pattern:** Large patch

**Required Classifiers:** Natural/Semi-natural; Vegetated (>10% vasc.); Wetland

**Diagnostic Classifiers:** Tidal / Estuarine; Graminoid; North Atlantic Coastal Plain

**Non-diagnostic Classifiers:** Herbaceous

---

## LOBLOLLY PINE / WAX-MYRTLE / SALTMEADOW CORDGRASS TIDAL WOODLAND

*Pinus taeda* / *Morella cerifera* / *Spartina patens* Tidal Woodland

---

**Range:** This community occurs within mesohaline systems along the shoreline of Maryland's Coastal Plain and Delaware.

**Environmental Description:** These are fringing tidal woodlands characteristic of diurnal to irregularly flooded mesohaline (5.0-18.0 ppt) systems. This community occurs along tidal rivers and creeks but can also occupy narrow ecotones between "high salt marshes" and adjacent uplands and islands in brackish nonriverine habitats. Soils consist of a mixture of silt, fine sands and decomposed organic peat underlain by dark gray, black or greenish-gray silty clayey fine sands and carbonaceous clays.

**Vegetation Description:**

These tidal woodlands are species-poor, structurally open and dominated by *Pinus taeda* (loblolly pine) in the canopy and subcanopy. Occasionally, *Juniperus virginiana* (eastern red cedar), *Acer rubrum* (red maple), *Diospyros virginiana* (common persimmon), *Quercus phellos* (willow oak), and/or *Liquidambar styraciflua* (sweetgum) may occur in the subcanopy.



Photo by Robert Coxe, Delaware Natural Heritage Program

Scattered patches of *Morella cerifera* (wax myrtle) dominate the shrub stratum, along with occasional individuals of *Iva frutescens* (maritime marsh-elder), *Baccharis halimifolia* (groundsel-tree), *Ilex opaca* (American holly), *Prunus serotina* (black cherry), *Acer rubrum* (red maple), and *Juniperus virginiana* (eastern red cedar).

*Toxicodendron radicans* (eastern poison ivy) is the predominant vine in these woodlands. The herbaceous community is low in species diversity and primarily comprised of *Spartina patens* (saltmeadow cordgrass), *Panicum virgatum* (switchgrass), and *Distichlis spicata* (saltgrass). *Phragmites australis* (common reed) can be abundant in some stands.

**Characteristic Species:** *Pinus taeda* (loblolly pine), *Morella cerifera* (wax myrtle), *Spartina patens* (saltmeadow cordgrass)

**Dynamics:** This type is the result of the tidally influenced conversion of an upland pine community to a marshland. Stands experience variable levels of flooding, often less than daily, due to fluctuations in groundwater levels and landscape position. It is a short-lived community that is an artifact of sea level rise and marsh subsidence (or lack of vertical accretion) which subsequently allows for a higher frequency of tidal encroachment to the exposed, surrounding upland pine-



dominated communities. Increased frequency and duration of tidal flooding can stunt the growth of the pines, thin crowns, and/or induce mortality.

**Management Concerns:** As a community in large part restricted to barrier islands, it is faced with threats to barrier islands in general: intense development pressures where it remains unprotected. *Phragmites australis* occasionally occurs in this community. Sea level rise may increase the occurrences of this community. A threat to this community is development pressures where it remains unprotected.

**Reference Sites:** Mispillion Watershed, DE

**Global Conservation Rank and Reasons:** This community has not been ranked.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.787718](http://vegbank.org/natureserve/element_global.2.787718)

**References:** Harrison 2004, Schafale 2000

| MOST ABUNDANT SPECIES |                              |  |
|-----------------------|------------------------------|--|
| STRATUM               | LIFEFORM                     | SPECIES  |
| Tree canopy           | Needle-leaved tree           | <i>Pinus taeda</i> (loblolly pine)             |
| Tall shrub/sapling    | Broad-leaved evergreen shrub | <i>Morella cerifera</i> (wax-myrtle)           |
| Tall shrub/sapling    | Liana/Vine                   | <i>Toxicodendron radicans</i> (poison ivy)     |
| Herb (field)          | Graminoid                    | <i>Spartina patens</i> (salt meadow cordgrass) |

---

## EASTERN TIDAL SALT SHRUB

*Iva frutescens* / *Spartina patens* Shrubland

---

**Range:** This association ranges from Massachusetts to South Carolina. It occurs in Delaware and New Jersey in the Delaware Estuary.

**Environmental Description:** This maritime and estuarine shrubland of the eastern Atlantic states occurs in association with salt marshes. It forms an ecotone between the high salt marsh and adjacent upland vegetation. It also occurs in patches on areas of slightly higher elevation within the salt marsh or on spoil mounds adjacent to ditches.



Photo by Robert Coxe, Delaware Natural Heritage Program

This shrubland occurs above mean high tide but can be flooded by storm tides. Substrate is organic peat over glacial till, sand, or sandy loam.

**Vegetation Description:** *Iva frutescens* (maritime marsh-elder) is the most characteristic and dominant shrub species. *Spartina patens* (saltmeadow cordgrass) is a characteristic and usually abundant grass, often occurring as a monoculture beneath the shrub canopy. Other common herbaceous associates include *Distichlis spicata* (saltgrass) and *Spartina alterniflora* (smooth cordgrass); *Juncus gerardii* (salt meadow rush) may also occur at the northern end of the range. Other less common associates may include *Cuscuta gronovii* (scaldweed), *Limonium carolinianum* (Carolina sealavender), *Lythrum lineare* (wand lythrum), and *Solidago sempervirens* (seaside goldenrod). The vegetation is characterized by an open and relatively evenly spaced shrub stratum of short stature, rarely exceeding one meter in height, with a well-developed herbaceous layer, reflecting an intergrading of this community with the adjacent high salt marsh.

**Characteristic Species:** *Iva frutescens* (maritime marsh-elder), *Spartina patens* (saltmeadow cordgrass)

**Dynamics/Successional Trajectory:** This association can be flooded by storm tides. Heavy salt spray and tidal flooding from severe storms can cause die-back in the shrub layer. Seaward, this association grades into high salt marsh dominated by herbaceous vegetation. Landward, shrub cover becomes more dense.

**Management Concerns:** Sea level rise may influence the dynamics of this community in the future.

**Reference Sites:** Mispillion Watershed, DE, Hansey Creek WMA, NJ; Dias Creek NWR, NJ; Moore's Beach and Thompson Beach, NJ

**Global Conservation Rank and Reasons:** G5 (1-Dec-1997).

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.686210](http://vegbank.org/natureserve/element_global.2.686210)

**References:** Barry 1980, Bartgis 1986, Berdine 1998, Boule 1979, Bowman 2000, Breden 1989, Breden et al. 2001, Clancy 1996, Coulling pers. comm., Daiber et al. 1976, Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Fleming 2001, Fleming et al. 2001, Fleming pers. comm., Good 1965, Harrison 2004, Harrison and Stango 2003, Harrison pers. comm., Higgins et al. 1971, Hill 1986, Klemas et al. 1973, Klotz 1986, Martin 1959b, Metzler and Barrett 2001, Rawinski 1984, Reschke 1990, Schafale 2000, Schafale and Weakley 1990, Sneddon et al. 1995, Swain and Kearsley 2001, TNC 1995c, Tiner 1984, Tiner 1985a, Tiner 1985b, VDNH 2003

| MOST ABUNDANT SPECIES |            |   |
|-----------------------|------------|---|
| STRATUM               | LIFEFORM   | SPECIES                                       |
| Short shrub/sapling   | Semi-shrub | <i>Iva frutescens</i> (maritime marsh-elder)  |
| Herb (field)          | Graminoid  | <i>Spartina patens</i> (saltmeadow cordgrass) |

---

## WAX MYRTLE SWALE

*Morella cerifera* / *Spartina patens* Shrubland

---

**Range:** This type occurs along the Atlantic Coast from New Jersey south to Florida.

**Environmental Description:** This association occurs as a shrub swamp within salt marshes and on maritime barrier islands and spits, usually on more protected backdunes, barrier flats, wetland flats, and/or interdunal swales. The substrate may be sand or loamy sand, sometimes with a thin layer of organic matter. The water table is often less than half a meter below the surface.

**Vegetation Description:** This vegetation is characterized by a moderately open to densely closed canopy of *Morella cerifera* (= *Myrica cerifera*) (wax myrtle). Other canopy associates include *Baccharis halimifolia* (eastern baccharis), *Morella pensylvanica* (northern bayberry) (from northern NC northward), *Juniperus virginiana* var. *sillicicola* (southern redcedar) (from NC and possibly southern VA southward), and *Rhus copallinum* (flameleaf sumac). The herbaceous layer is characterized by *Spartina patens* (saltmeadow cordgrass). Other ground flora associates include



Photo by NatureServe

*Toxicodendron radicans* (eastern poison ivy), *Phragmites australis* (common reed), *Panicum virgatum* (switchgrass), *Andropogon virginicus* (broomsedge bluestem), *Juncus dichotomus* (forked rush), *Solidago sempervirens* (seaside goldenrod), *Smilax* spp. (greenbrier), *Parthenocissus quinquefolia* (Virginia creeper), *Vitis* spp. (grape), and *Schoenoplectus pungens* (= *Scirpus pungens*) (common threesquare). Small openings may have wetland graminoids, such as *Juncus roemerianus* (needlegrass rush), *Spartina patens* (saltmeadow cordgrass), *Fimbristylis castanea* (marsh fimbry), *Andropogon glomeratus* var. *pumilus* (bushy bluestem), *Muhlenbergia filipes* (gulfhairawn muhly), etc., and forbs, such as *Hydrocotyle bonariensis* (largeleaf pennywort), *Sabatia stellaris* (rose of Plymouth), *Polygonum hydropiperoides* (swamp smartweed), *Eleocharis* spp. (spikerush), etc. In other cases, few herbs are present, because of the dense, thicket-like shrub layer.

**Characteristic Species:** *Morella cerifera* (= *Myrica cerifera*) (wax myrtle), *Spartina patens* (saltmeadow cordgrass)

**Dynamics/Successional Trajectory:** This community can be tidally flooded, but typically occurs beyond the reach of most storm tides. It is impacted by salt spray.

**Management Concerns:** Many occurrences have been destroyed by coastal development, as these soils can be sandy and dry enough that they are often not considered "jurisdictional wetlands" and are therefore destroyed for development. Other wetter occurrences have been left undeveloped but now occur as isolated areas fragmented by development.

**Reference Sites:** Mispillion Watershed, DE, Great Marsh, Sussex County, DE; Prime Hook NWR, DE

**Global Conservation Rank and Reasons:** G3G4 (1-Feb-2005). This association occurs in as swamp islands within saltmarshes and along interdune flats on barrier islands and barrier spits from New Jersey south to Florida. Many occurrences have been destroyed by coastal development, as these soils can be sandy and dry enough in some settings that they are often not considered "jurisdictional wetlands" and are therefore destroyed for development. Other, wetter occurrences have been left undeveloped but now occur as isolated areas fragmented by development. Fairly extensive occurrences are protected on Cape Hatteras National Seashore and Cape Lookout National Seashore, North Carolina.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.685109](http://vegbank.org/natureserve/element_global.2.685109)

**References:** Ambrose 1990a, Berdine 1998, Boule 1979, Bowman 2000, Breden et al. 2001, FNAI 1992a, Fleming 2001, Harrison 2004, Higgins et al. 1971, Hill 1986, Klotz 1986, Martin 1959b, Schafale and Weakley 1990, Southeastern Ecology Working Group n.d.

| MOST ABUNDANT SPECIES |                              |   |
|-----------------------|------------------------------|---|
| STRATUM               | LIFEFORM                     | SPECIES                                       |
| Tall shrub/sapling    | Broad-leaved deciduous shrub | <i>Morella cerifera</i> (wax-myrtle)          |
| Herb (field)          | Graminoid                    | <i>Spartina patens</i> (saltmeadow cordgrass) |

---

## **ECOLOGICAL SYSTEM: NORTHERN ATLANTIC COASTAL PLAIN DUNE AND SWALE**

---

**Summary:** This system consists of vegetation of barrier islands and other coastal areas, ranging from northernmost North Carolina northward to southern Maine (where extensive sandy coastlines are replaced by rocky coasts). A range of plant communities may be present, but natural vegetation is predominately herbaceous, with *Ammophila breviligulata* (American beachgrass) diagnostic. Shrublands resulting from succession from grasslands may occur in limited areas. Both dune uplands and non-flooded wetland vegetation of interdunal swales are included in this system. Small patches of natural woodland may also be present in limited areas, especially in the northern range of this system. Dominant ecological processes are those associated with the maritime environment, including frequent salt spray, saltwater overwash, and sand movement.

**Range:** This system ranges from northernmost North Carolina (EPA ecoregion 63d) and southeastern Virginia to southern Maine. The southern portion is a transition zone from around Kitty Hawk, North Carolina, to the Virginia-North Carolina border. The northern limit is Merrymeeting Bay, Maine.

**High-ranked species:** *Schizaea pusilla* (little curly grass fern)(G3G4)

**Dynamics:** The environment of this system is one of the most dynamic in existence for terrestrial vegetation. Reworking of sand by storms or by slower eolian processes may completely change the local environment in a short time, changing one association to another. Many of these sites are fairly early in the process of primary succession on recent surfaces. Chronic salt spray is an ongoing stress. Overwash and extreme salt spray in storms are frequent disturbances. Vegetation interacts strongly with geologic processes; the presence of grass is an important factor in the development of new dunes. Alteration of dynamic processes, such as artificial enhancement of dunes by planting or sand fencing, can have drastic effects on this system, causing large areas to succeed to woody vegetation. Fire is probably not a major natural factor in this system, but may have been important locally. Most vegetation is too sparse to carry fire well.

### **Delaware Estuary Addendum Associations:**

- Mid-Atlantic Coast Backdune Grassland

|   |
|---|
| <p><b>CLASSIFIERS FOR NORTHERN ATLANTIC COASTAL PLAIN TIDAL SALT MARSH</b><br/><b>Primary Division:</b> 203<br/><b>Land Cover Class:</b> Mixed Upland and Wetland<br/><b>Spatial Scale &amp; Pattern:</b> Large patch, Linear<br/><b>Required Classifiers:</b> Natural/Semi-natural; Vegetated (&gt;10% vasc.); Upland; Wetland<br/><b>Diagnostic Classifiers:</b> Coast; Beach (Substrate); Graminoid; North Atlantic Coastal Plain<br/><b>Non-diagnostic Classifiers:</b> Herbaceous; Depressional; Isolated Wetland [Partially Isolated]</p> |
|---|

---

## MID-ATLANTIC COAST BACKDUNE GRASSLAND

*Morella (pennsylvanica, cerifera) / Schizachyrium littorale - Eupatorium hyssopifolium* Shrub  
Herbaceous Vegetation

---

**Range:** This community ranges from New Jersey to Virginia and possibly North Carolina on coastal dunes.

**Environmental Description:** This community occurs on deep well-drained sands of old leveled interdunes and backdunes. It usually occurs within the influence of offshore winds and salt spray.

**Vegetation Description:** Although highly variable in species composition, the typical expression of this community is characterized by a predominance (25-50% cover) of bunch grasses including *Schizachyrium littorale* (= *Schizachyrium scoparium* ssp. *littorale*) (shore little bluestem), *Andropogon virginicus* (broomsedge bluestem), *Panicum amarum* (bitter panicgrass), *Ammophila breviligulata* (American beachgrass), *Dichanthelium scoparium* (velvet panicum) and *Dichanthelium acuminatum* (tapered rosette grass). Generally one or two of these species is dominant while the others occur as more infrequent, scattered clumps. Occasionally *Spartina patens* (saltmeadow cordgrass) forms the dominant graminoid cover. Shrubs of *Morella pennsylvanica* (= *Myrica pennsylvanica*) (northern bayberry) are sparse and stunted *Baccharis halimifolia* (eastern baccharis), *Prunus maritima* (beach plum), and *Diospyros virginiana* (common persimmon) are even less frequent. Dense tangles of *Toxicodendron radicans* (eastern poison ivy) are very characteristic of this association as they sprawl over the bare ground and sparse vegetation. *Rubus argutus* (sawtooth blackberry) and *Rhus copallinum* (winged sumac) are also scattered throughout. Much of the remaining dry sands are exposed with sparsely distributed herbs. Characteristic herb species include *Cirsium horridulum* (yellow thistle), *Solidago sempervirens* (seaside goldenrod), *Pseudognaphalium obtusifolium* (= *Gnaphalium obtusifolium*) (cudweed), *Nuttallanthus canadensis* (= *Linaria canadensis*) (blue toadflax), *Euthamia caroliniana* (= *Euthamia tenuifolia*) (slender goldentop), *Oenothera humifusa* (seabeach evening primrose), *Pityopsis falcata* (sickleleaf silkgrass), *Opuntia humifusa* (devil's tongue), and *Diodia teres* (poorjoe).

**Characteristic Species:** *Schizachyrium littorale* (= *Schizachyrium scoparium* ssp. *littorale*) (shore little bluestem), *Andropogon virginicus* (broomsedge bluestem), *Panicum amarum* (bitter panicgrass), *Toxicodendron radicans* (eastern poison ivy), *Morella pennsylvanica* (= *Myrica pennsylvanica*) (northern bayberry) are sparse and stunted *Baccharis halimifolia* (eastern baccharis)

**Reference Sites:** Cape May NWR, NJ

**Global Conservation Rank and Reasons:** G2 (2-Dec-1998). This grassland community is confined to barrier islands ranging from New Jersey to Virginia. It occurs on dune flats protected from overwash, and is generally small in size with occurrences ranging from less than an acre to approximately 20 acres. Approximately 100-120 occurrences are thought to occur rangewide, covering a total of less than 1000 acres. The major threats to this community are human development (commercial and residential building), as well as dune stabilization activities.

**References:** Bartgis 1986, Berdine 1998, Blizzard 1931, Breden et al. 2001, Eastern Ecology Working Group n.d.\*. Fleming 2001a, Fleming et al. 2001, Harrison 2004, Higgins et al. 1971, Hill 1986, Reschke 1990, Schafale 2000, Sneddon et al. 1996, TNC 1995c

| MOST ABUNDANT SPECIES |                              |   |
|-----------------------|------------------------------|---|
| STRATUM               | LIFEFORM                     | SPECIES   |
| Short shrub/sapling   | Broad-leaved evergreen shrub | <i>Morella pensylvanica</i> (northern bayberry)           |
| Herb (field)          | Graminoid                    | <i>Schizachyrium littorale</i><br>(shore little bluestem) |
| Herb (field)          | Graminoid                    | <i>Andropogon virginicus</i><br>(broomsedge bluestem)     |
| Herb (field)          | Graminoid                    | <i>Panicum amarum</i> (bitter panicgrass)                 |





---

## ECOLOGICAL SYSTEM: NORTHEASTERN INTERIOR DRY-MESIC OAK FOREST

---

**Summary:** These oak-dominated forests are one of the matrix forest systems in the northeastern and north-central U.S. Occurring in dry-mesic settings, they are typically closed-canopy forests, though there may be areas of patchy-canopy woodlands. They cover large expanses at low to mid elevations, where the topography is flat to gently rolling, occasionally steep. Soils are mostly acidic and relatively infertile but not strongly xeric. Local areas of calcareous bedrock, or colluvial pockets, may support forests typical of richer soils. Oak species characteristic of dry-mesic conditions (e.g., *Quercus rubra* (northern red oak), *Quercus alba* (white oak), *Quercus velutina* (black oak), and *Quercus coccinea* (scarlet oak)) and *Carya* (hickory) spp. are dominant in mature stands. *Quercus prinus* (chestnut oak) may be present but is generally less important than the other oak species. *Castanea dentata* (American chestnut) was a prominent tree before chestnut blight eradicated it as a canopy constituent. *Acer rubrum* (red maple), *Betula lenta* (sweet birch), and *Betula alleghaniensis* (yellow birch) may be common associates; *Acer saccharum* (sugar maple) is occasional. With a long history of human habitation, many of the forests are early- to mid-successional, where *Pinus strobus* (eastern white pine), *Pinus virginiana* (Virginia pine), or *Liriodendron tulipifera* (tuliptree) may be dominant or codominant. Within these forests, hillslope pockets with impeded drainage may support small isolated wetlands, including non-forested seeps or forested wetlands with *Acer rubrum* (red maple), *Quercus bicolor* (swamp white oak), or *Nyssa sylvatica* (blackgum) characteristic.

**High-ranked Species:** *Callophrys irus* (G3, frosted elfin), *Canis rufus* (G1Q, red wolf), *Carex communis* var. *amplisquama* (G5T3, Dixie sedge), *Carex polymorpha* (G3, variable sedge), *Coreopsis delphiniifolia* (G3?Q, larkspurleaf tickseed), *Fothergilla major* (G3, mountain witchalder), *Gaylussacia brachycera* (G3, box huckleberry), *Taenidia montana* (G3, mountain pimpernel), *Thermopsis fraxinifolia* (G3?, ashleaf goldenbanner), *Thermopsis mollis* (G3G4, Allegheny Mountain goldenbanner), *Virginia valeriae pulchra* (G5T3T4, mountain earthsnake)

**Range:** This system is found from southern New York west through Ohio and Pennsylvania and south to Virginia. United States: MD, NJ, NY, OH, PA, VA, WV

### Delaware Estuary Addendum Associations:

- Central Appalachian Dry-Mesic Chestnut Oak - Northern Red Oak Forest
- Northern Piedmont Mesic Oak - Beech Forest
- Northeastern Dry Oak - Hickory Forest

### Similar Ecological Systems in the Delaware Estuary:

- Central Appalachian Dry Oak-Pine Forest

#### CLASSIFIERS FOR NORTHEASTERN INTERIOR DRY-MESIC OAK FOREST

Primary Division: 202

Land Cover Class: Forest and Woodland

Spatial Scale & Pattern: Matrix

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland; Wetland

Diagnostic Classifiers: Lowland; Forest and Woodland (Treed); Acidic Soil; Quercus - Carya

Non-diagnostic Classifiers: Sideslope; Toeslope/Valley Bottom; Mineral: W/ A-Horizon >10 cm; Loam Soil Texture; Ustic; F-Patch/Medium Intensity; Broad-Leaved Deciduous Tree

---

## CENTRAL APPALACHIAN DRY-MESIC CHESTNUT OAK - NORTHERN RED OAK FOREST

*Quercus prinus* - *Quercus rubra* / *Hamamelis virginiana* Forest

---

**Range:** This association occurs throughout the central Appalachian region of Virginia, West Virginia, Maryland, Pennsylvania, and possibly farther north. It also occurs in the Piedmont of Delaware.

**Environmental Description:** Sites occupied by this dry-mesic oak forest are mostly protected rocky mountain slopes. In the Central Appalachians of Virginia, West Virginia, Delaware, and Maryland, the type occurs at low and middle elevations, from <300 m (1000 feet) to about 1100 m (3600 feet), reaching optimal development at 610-915 m (2000-3000 feet). Habitats are underlain by a variety of bedrock types, including metabasalt (greenstone), pyroxene-rich granitic rocks, Antietam and Tuscarora quartzites, metasilstone and phyllite, shale, and sedimentary material (interbedded sandstone, siltstone, and shale). Among plot-sampled Mid-Atlantic stands, lower to middle slope topographic positions predominate, along with steep (mean = 27 degrees), usually concave slopes, and relatively high surface cover of outcrops, boulders, and stones. Slope aspect is variable, but the majority of aspects range from north to southeast. Soil samples collected from plots were strongly to very strongly acidic (mean pH = 4.8) but had moderately high levels of calcium (mean = 1019 ppm), reflecting the frequent occurrence of this community on moderately base-rich substrates.

**Vegetation Description:** The vegetation is usually a closed-canopy forest codominated by *Quercus prinus* (chestnut oak) and *Quercus rubra* (northern red oak) in variable proportions. Over the full geographic range, overstory associates are reported to include *Liriodendron tulipifera* (tuliptree), *Fraxinus americana* (white ash), *Tilia americana* (American basswood), *Betula lenta*, *Acer rubrum* (red maple), *Magnolia acuminata* (cucumber-tree), *Nyssa sylvatica* (blackgum), *Robinia pseudoacacia* (black locust), *Carya glabra* (pignut hickory), *Carya ovalis* (red hickory), and *Carya alba* (mockernut hickory). Less frequent, and more local, overstory and understory trees include *Acer saccharum* (sugar maple), *Amelanchier arborea* (Canadian serviceberry), *Asimina triloba* (pawpaw), *Fagus grandifolia* (American beech), *Ostrya virginiana* (hophornbeam), and *Tsuga canadensis* (eastern hemlock). A tall-shrub layer is occasionally absent but usually characterized by *Hamamelis virginiana* (American witchhazel) and, less frequently, by *Cornus florida* (flowering dogwood) and *Acer pensylvanicum* (striped maple), the latter more common at higher elevations. The lower shrub layer contains scrambling or climbing vines of *Parthenocissus quinquefolia* (Virginia creeper), *Vitis aestivalis* (summer grape), and *Toxicodendron radicans* (eastern poison ivy), along with *Viburnum acerifolium* (mapleleaf viburnum), *Hydrangea arborescens* (wild hydrangea), *Vaccinium pallidum* (Blue Ridge blueberry), and *Vaccinium stamineum* (deerberry). In general, ericaceous species are patchy to sparse in this community. The herbaceous layer is usually sparse but may include *Dryopteris marginalis* (marginal woodfern), *Dioscorea quaternata* (fourleaf yam), *Eurybia divaricata* (white wood aster), *Ageratina altissima* (white snakeroot), *Polygonatum biflorum* (smooth Solomon's seal), *Solidago caesia* (wreath goldenrod), *Festuca subverticillata* (nodding fescue), *Thelypteris noveboracensis* (New York fern), *Sanicula trifoliata* (largefruit blacksnakeroot), *Prenanthes altissima* (tall rattlesnakeroot), *Polystichum acrostichoides* (Christmas fern), *Desmodium nudiflorum* (nakedflower ticktrefoil), *Galium latifolium* (purple bedstraw), *Houstonia purpurea* (Venus' pride), and *Maianthemum racemosum* (feathery false lily of the valley). Although not one of the more constant herbs, *Aralia nudicaulis* (wild sarsaparilla) may occasionally dominate the herb layer of this community in large, clonal patches. This association is more or less intermediate in site conditions and composition

between oak / heath forests of exposed, xeric, infertile sites and richer cove or montane oak-hickory forests of sheltered, fertile sites.

**Characteristic Species:** *Acer pensylvanicum* (striped maple), *Acer rubrum* (red maple), *Carya glabra* (pignut hickory), *Cornus florida* (flowering dogwood), *Hamamelis virginiana* (American witchhazel), *Parthenocissus quinquefolia* (Virginia creeper), *Quercus prinus* (chestnut oak), *Quercus rubra* (northern red oak), *Sassafras albidum* (sassafras), *Viburnum acerifolium* (mapleleaf viburnum), *Vitis aestivalis* (summer grape)

**Global and State Conservation Ranks and Reasons:** G5 (1-Oct-2001). DE:SNR, NJ:SNR, PA:SNR. This is a widespread oak forest of the central Appalachian Mountains found on intermediate rocky slopes. It is secure within its range.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.683617](http://vegbank.org/natureserve/element_global.2.683617)

**References:** Breden et al. 2001, CAP pers. comm. 1998, Eastern Ecology Working Group n.d., Ehrenfeld 1977, Eyre 1980, Fike 1999, Fleming and Coulling 2001, Fleming and Moorhead 1996, Fleming and Moorhead 2000, Fleming et al. 2001, Harrison 2004, Lea 2003, Rawinski et al. 1994, Rawinski et al. 1996, Stephenson and Adams 1991, VDNH 2003, Vanderhorst 2000b, Young et al. 2006

| MOST ABUNDANT SPECIES        |                              |  |
|------------------------------|------------------------------|--|
| STRATUM                      | LIFEFORM                     | SPECIES  |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Quercus prinus</i> (chestnut oak)                 |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Quercus rubra</i> (northern red oak)              |
| Shrub/sapling (tall & short) | Broad-leaved deciduous shrub | <i>Hamamelis virginiana</i><br>(American witchhazel) |

---

### NORTHERN PIEDMONT MESIC OAK - BEECH FOREST

*Fagus grandifolia* - *Betula lenta* - *Quercus (alba, rubra)* / *Carpinus caroliniana* Forest

---

**Range:** This vegetation occurs in the mid-Atlantic states.

**Environmental Description:** This association occurs on gently sloping sites, and soils may be rocky.

**Vegetation Description:** These mesic hardwood forests occur north of the Coastal Plain (especially in the northern Piedmont of New Jersey). The canopy is characterized by *Fagus grandifolia* (American beech), *Liriodendron tulipifera* (tuliptree), and *Betula lenta* (sweet birch), with associated species including *Quercus alba* (white oak), *Quercus rubra* (northern red oak), *Nyssa sylvatica*



Photo by Robert Coxe. Delaware Natural Heritage Program

(blackgum), *Fraxinus americana* (white ash), and *Carya* (hickory) spp. The shrub layer is dominated by *Carpinus caroliniana* (American hornbeam), with lesser amounts of *Cornus florida* (flowering dogwood), *Hamamelis virginiana* (American witchhazel), and *Lindera benzoin* (northern spicebush). Other shrub associates include *Viburnum acerifolium* (mapleleaf viburnum), *Vaccinium pallidum* (Blue Ridge blueberry), *Viburnum dentatum* (southern arrowwood), and *Hamamelis virginiana* (American witchhazel). The herbaceous layer is characterized by *Polystichum acrostichoides* (Christmas fern), *Arisaema triphyllum* (Jack in the pulpit), *Thelypteris noveboracensis* (New York fern), *Mitchella repens* (partridgeberry), *Medeola virginiana* (Indian cucumber), *Parthenocissus quinquefolia* (Virginia creeper), *Polygonatum biflorum* (smooth Solomon's seal), *Galium circaezans* (licorice bedstraw), *Botrychium virginianum* (rattlesnake fern), and *Amphicarpaea bracteata* (American hogpeanut).

**Characteristic Species:** *Betula lenta* (sweet birch), *Carpinus caroliniana* (American hornbeam), *Fagus grandifolia* (American beech), *Quercus alba* (white oak), *Quercus rubra* (northern red oak)

**Reference Sites:** Clayton Park, NJ, Green Lane County Park, PA

**Global and State Conservation Ranks and Reasons:** GNR (7-Nov-2000). DE:SNR, NJ:SNR, PA:SNR.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.689321](http://vegbank.org/natureserve/element_global.2.689321)

**References:** Bowman 2000, Eastern Ecology Working Group n.d., Ehrenfeld 1977

| MOST ABUNDANT SPECIES        |                              |   |
|------------------------------|------------------------------|---|
| STRATUM                      | LIFEFORM                     | SPECIES   |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Fagus grandifolia</i> (American beech)             |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Betula lenta</i> (sweet birch)                     |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Liriodendron tulipifera</i> (tuliptree)            |
| Shrub/sapling (tall & short) | Broad-leaved deciduous shrub | <i>Carpinus caroliniana</i><br>(American hornbeam)    |
| Herb (field)                 | Fern                         | <i>Polystichum acrostichoides</i><br>(Christmas fern) |

---

## NORTHEASTERN DRY OAK-HICKORY FOREST

*Quercus (alba, rubra, velutina) / Cornus florida / Viburnum acerifolium* Forest

---

**Range:** This association occurs from Maine to Virginia. This forest type is very common on mid- to upper slopes and dry mesic sites in Pennsylvania. It occurs in all three states of the Delaware Estuary.

**Environmental Description:** This forest type occurs on well-drained loamy sand of midslopes. The sites may be gently to steeply sloping and may contain scattered boulders or large rocks.

**Vegetation Description:** *Quercus rubra* (northern red oak), *Quercus alba* (white oak), and *Quercus velutina* (black oak) are prominent in the canopy. Typical hickory species include *Carya glabra* (pignut hickory), *Carya ovata* (shagbark hickory), *Carya alba* (mockernut hickory), and *Carya ovalis* (red hickory). Other canopy associates may include *Acer rubrum* (red maple), *Sassafras albidum* (sassafras), and *Amelanchier arborea* (common serviceberry). At the northern range limit of this type, *Pinus strobus* (eastern white pine) and *Betula lenta* (sweet birch) also occur

as minor associates. *Cornus florida* (flowering dogwood) is a characteristic understory tree in portions of the range. The shrub layer is characterized by *Viburnum acerifolium* (mapleleaf viburnum), with other frequent associates including *Hamamelis virginiana* (American witch-hazel), *Vaccinium corymbosum* (highbush blueberry), *Corylus cornuta* (beaked hazelnut), and *Corylus americana* (American hazelnut). A dwarf-shrub layer may be common, but generally not abundant, and characterized by *Vaccinium pallidum* (hillside blueberry) and *Gaylussacia baccata* (black huckleberry), with *Vaccinium angustifolium* (northern lowbush blueberry) occurring more frequently to the north. The herbaceous layer is characterized by *Carex pensylvanica* (Pennsylvania sedge), *Maianthemum racemosum* (feathery false lily-of-the-valley), *Aralia nudicaulis* (wild sarsaparilla), *Hieracium venosum*

(rattlesnake-weed), *Solidago bicolor* (white goldenrod), *Desmodium glutinosum* (large tick-trefoil), *Desmodium paniculatum* (narrowleaf tick-trefoil), *Melampyrum lineare* (narrowleaf cow-wheat), *Chimaphila maculata* (striped pipsissewa), *Eurybia divaricata* (white wood-aster), *Danthonia spicata* (poverty oatgrass), *Aureolaria* (yellow false foxglove) spp., and *Helianthemum canadense* (long-branch frostweed).



Photo by Pennsylvania Natural Heritage Program

**Characteristic Species:**

*Carex pensylvanica* (Pennsylvania sedge), *Cornus florida* (flowering dogwood), *Gaylussacia baccata* (black huckleberry), *Vaccinium pallidum* (hillside blueberry), *Viburnum acerifolium* (mapleleaf viburnum)

**Dynamics/Successional Trajectory:** This vegetation is ecologically transitional between dry-rich oak-hickory forests of relatively high diversity and dry, acidic oak-species-poor forests.

**Management Concerns:** Mature stands are uncommon, and most stands are subject to logging disturbances or even complete destruction if located in rapidly developing suburban areas.

**Reference Sites:** East Blackbird Drainage, DE; Rancocas State Park, NJ; Hopewell Furnace National Historic Site, Berks County, PA; Peace Valley County Park, PA

**Global and State Conservation Ranks and Reasons:** G4G5 (24-Jan-2005). DE: S3?, NJ: S4S5, PA: SNR. This type is not naturally rare and has a wide geographic distribution.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.685156](http://vegbank.org/natureserve/element_global.2.685156)

**References:** Bartgis 1986, Berdine 1998, Breden 1989, Breden et al. 2001, Clancy 1996, Damman 1977, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Fike 1999, Fleming et al. 2001, Fleming et al. 2004, Fleming pers. comm., Gawler 2002, Harrison 2004, Hunt 1997a, MENHP 1991, McCoy and Fleming 2000, Metzler and Barrett 2001, Patterson pers. comm.,

Rawinski 1984, Sperduto 1997b, Sperduto and Nichols 2004, Swain and Kearsley 2001, VDNH 2003

| MOST ABUNDANT SPECIES        |                              |  |
|------------------------------|------------------------------|--|
| STRATUM                      | LIFEFORM                     | SPECIES  |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Carya glabra</i> (pignut hickory)             |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Quercus rubra</i> (northern red oak)          |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Quercus velutina</i> (black oak)              |
| Shrub/sapling (tall & short) | Broad-leaved deciduous tree  | <i>Cornus florida</i> (flowering dogwood)        |
| Shrub/sapling (tall & short) | Broad-leaved deciduous shrub | <i>Viburnum acerifolium</i> (mapleleaf viburnum) |
| Short shrub/sapling          | Broad-leaved deciduous shrub | <i>Gaylussacia baccata</i> (black huckleberry)   |
| Herb (field sedge)           | Graminoid                    | <i>Carex pensylvanica</i> (Pennsylvania)         |

---

## ECOLOGICAL SYSTEM: NORTH-CENTRAL APPALACHIAN ACIDIC CLIFF AND TALUS

---

**Summary:** This system comprises sparsely vegetated to partially wooded cliffs and talus slopes in the Central Appalachians and Piedmont, occurring on rocks of acidic lithology and lacking any indicators of enriched conditions. This cliff system occurs at low to mid elevations from central New England south to Virginia. It consists of vertical or near-vertical cliffs and the talus slopes below, formed on hills of granitic, sandstone, or otherwise acidic bedrock. Most of the substrate is dry and exposed, but small (occasionally large) areas of seepage are often present. Vegetation in seepage areas tends to be more well-developed and floristically different from the surrounding dry cliffs. The vegetation is patchy and often sparse, punctuated with patches of small trees that may form woodlands in places. *Juniperus virginiana* (eastern redcedar) is a characteristic tree species, *Toxicodendron radicans* (eastern poison ivy) a characteristic woody vine, and *Polypodium virginianum* (rock polypody) a characteristic fern.

**High-ranked Species:** *Acrobolbus ciliatus* (G3?, a liverwort), *Aneides aeneus* (G3G4, green salamander), *Bryum riparium* (G2G4, streamside bryum moss), *Canis rufus* (G1Q, red wolf), *Carex biltmoreana* (G3, stiff sedge), *Carex misera* (G3, wretched sedge), *Gymnoderma lineare* (G2, rock gnome lichen), *Heuchera alba* (G2Q, white alumroot), *Hymenophyllum tayloriae* (G2, Taylor's filmy fern), *Hypericum buckleyi* (G3, Buckley's St. Johnswort), *Krigia montana* (G3, mountain dwarfdandelion), *Leptohymerium sharpii* (G1, Sharp's leptohymerium moss), *Liatris helleri* (G2, Heller's blazing star), *Liatris microcephala* (G3G4, smallhead blazing star), *Lophocolea appalachiana* (G1G2Q), *Mannia californica* (G3?), *Marsupella emarginata* var. *latiloba* (G5T1T2), *Metzgeria fruticulosa* (G2Q), *Metzgeria furcata* var. *setigera* (G5T1), *Microtus chrotorrhinus carolinensis* (G4T3, southern rock vole), *Nardia lescurii* (G3?), *Neotoma magister* (G3G4, allegheny woodrat), *Plagiochila austinii* (G3, a liverwort), *Plagiochila caduciloba* (G2, gorge leafy liverwort), *Plagiochila eurphyllon* ssp. *echinata* (GNRT2), *Plagiochila sullivantii* var. *spinigera* (G2T1), *Plagiochila sullivantii* var. *sullivantii* (G2T2), *Plagiochila virginica* var. *caroliniana* (G3T2), *Plagiomnium carolinianum* (G3, Carolina plagiomnium moss), *Platyhypnidium pringlei* (G2G3), *Porella japonica* ssp. *appalachiana* (G5?T1), *Radula sullivantii* (G3, a liverwort), *Rhododendron vaseyi* (G3, pinkshell azalea), *Saxifraga careyana* (G3, golden eye saxifrage), *Saxifraga caroliniana* (G3, Carolina saxifrage), *Scutellaria arguta* (G1?Q, Blue Ridge skullcap), *Sedum nevii* (G3, Nevius' stonecrop), *Tetradontium brownianum* (G3G4, Brown's tetradontium moss), *Thelypteris pilosa* var. *alabamensis* (G4T1, Alabama maiden fern), *Tsuga caroliniana* (G3, Carolina hemlock)

**Range:** This system is found from central New England and New York south to Virginia. NJ, PA.

### Delaware Estuary Addendum Associations:

- Eastern Temperate Acidic Cliff

#### CLASSIFIERS FOR NORTH-CENTRAL APPALACHIAN ACIDIC CLIFF AND TALUS

Primary Division: 202

Land Cover Class: Barren

Spatial Scale & Pattern: Small patch

Required Classifiers: Natural/Semi-natural; Unvegetated (<10% vasc.); Upland

Diagnostic Classifiers: Cliff (Substrate); Talus (Substrate); Temperate; Acidic Soil

Non-diagnostic Classifiers: Lowland; Sideslope; Very Shallow Soil; Ustic; Landslide

---

## EASTERN TEMPERATE ACIDIC CLIFF

*Juniperus virginiana* - *Corydalis sempervirens* Cliff Sparse Vegetation

---

**Range:** This type is documented from Massachusetts, New Hampshire, Vermont, New Jersey, and Pennsylvania; southward and westward extent has not been determined.

**Environmental Description:** This community is found on cliff faces developed on resistant acidic bedrock such as granite, quartzite, sandstone, shale or schist, with little or no soil development. The outcrops are typically vertical to near-vertical. Exposure varies, and moisture regime likewise varies from dry on the exposed faces to moist on more protected or seepy areas. These cliffs may contain small areas of seepage vegetation among the generally dry substrate.

**Vegetation Description:** The patchy vegetation is restricted to cracks and crevices and can vary from well-vegetated to barren across the cliff face. The association presents itself as a mixture of open rock, scrubby trees and shrubs, herbaceous plants, and bryoids. Typical tree species include *Juniperus virginiana* (eastern redcedar), *Fraxinus americana* (white ash), *Acer rubrum* (red maple), and *Betula papyrifera* (paper birch); none usually grow very large. Individuals of additional tree species from the surrounding forest may also be present; these include *Tsuga canadensis* (eastern hemlock), *Quercus* (oak) spp., and *Carya* (hickory) spp. *Rubus odoratus* (purpleflowering raspberry), *Rubus allegheniensis* (Allegheny blackberry), and *Rhus copallinum* (flameleaf sumac) are representative shrubs. Woody vines include *Vitis aestivalis* (summer grape) and *Parthenocissus quinquefolia* (Virginia creeper). Herbaceous composition varies; typical species include *Deschampsia flexuosa* (wavy hairgrass), *Danthonia spicata* (poverty oatgrass), *Campanula rotundifolia* (bluebell bellflower), *Aquilegia canadensis* (red columbine), *Corydalis sempervirens* (rock harlequin), *Saxifraga virginiana* (early saxifrage), and *Woodsia ilvensis* (rusty woodsia). *Opuntia humifusa* (devil's-tongue) occurs in some of the most southerly occurrences of this association.

**Characteristic Species:** *Aquilegia canadensis* (red columbine), *Campanula rotundifolia* (bluebell bellflower), *Corydalis sempervirens* (rock harlequin), *Danthonia spicata* (poverty oatgrass), *Deschampsia flexuosa* (wavy hairgrass), *Juniperus virginiana* (eastern redcedar), *Rhus copallinum* (flameleaf sumac), *Rubus odoratus* (purpleflowering raspberry), *Woodsia ilvensis* (rusty woodsia)

**Dynamics:** The setting is dry vertical exposures of resistant acidic bedrock, with little or no soil development. Landslides are common on these sheer faces. Talus can form from freeze/thaw action cracking the bedrock. These cliffs are mostly dry but may contain small areas of seepy conditions, with associated floristic variation. The patchy vegetation is restricted to cracks and crevices and can vary from well-vegetated to barren across the cliff face. In most cases, overall cover averages less than 25%. Vegetative cover is low in stands of this type and is confined to lichens and plants growing on bare rock, and to sparse herbs, shrubs and trees rooted in local pockets of deeper soil. The flora is a mix that usually includes drought-tolerant, shade-intolerant species, species shared with surrounding forests, and sometimes local occurrences of wetland species associated with small seepage zones.

**Reference Sites:** Nockamixon Rocks, Bucks County, PA. The diabase rock in this shale cliff contributes to an interesting flora that is not necessarily characteristic of the true shale cliffs described by this type.



**Global and State Conservation Ranks and Reasons:** G4 (22-Jun-2006). NJ:SNR, PA:S3. This community is considered relatively common in at least two of the states where it occurs (state conservation rank of S4).

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.687085](http://vegbank.org/natureserve/element_global.2.687085)

**References:** Anderson 1996, Collins and Anderson 1994, Eastern Ecology Working Group n.d., Edinger et al. 2002, Metzler and Barrett 2004, Perles et al. 2007, Podniesinski 1999, Podniesinski 2005, Podniesinski and Kunsman 1999, Sneddon and Menard 2002, Sperduto 1992, Sperduto 2000a, Swain and Kearsley 2000, Thompson and Sorenson 2000

| MOST ABUNDANT SPECIES        |                              |  |
|------------------------------|------------------------------|--|
| STRATUM                      | LIFEFORM                     | SPECIES  |
| Tree canopy                  | Needle-leaved evergreen tree | <i>Juniperus virginiana</i> (eastern redcedar)       |
| Tree canopy                  | Broad-leaved deciduous tree  | <i>Betula papyrifera</i> (paper birch)               |
| Shrub/sapling (tall & short) | Broad-leaved deciduous shrub | <i>Rubus odoratus</i><br>(purpleflowering raspberry) |
| Herb (field)                 | Graminoid                    | <i>Deschampsia flexuosa</i> (wavy hairgrass)         |
| Herb (field)                 | Graminoid                    | <i>Danthonia spicata</i> (poverty oatgrass)          |



---

## ECOLOGICAL SYSTEM: CENTRAL APPALACHIAN RIVER FLOODPLAIN

---

**Summary:** This system encompasses floodplains of medium to large rivers from southern New England to Virginia. This system can include a complex of wetland and upland vegetation on deep alluvial deposits and scoured vegetation on depositional bars and on bedrock where rivers cut through resistant geology. This complex includes floodplain forests in which *Acer saccharinum* (silver maple), *Populus deltoides* (eastern cottonwood), and *Platanus occidentalis* (American sycamore) are characteristic, as well as



Photo by Tony Davis, Pennsylvania Natural Heritage Program

herbaceous sloughs, shrub wetlands, riverside prairies and woodlands. Most areas are underwater each spring; microtopography determines how long the various habitats are inundated. Depositional and erosional features may both be present depending on the particular floodplain.

**High-ranked Species:** *Arabis georgiana* (G1, Georgia rockcress), *Aspiromitus appalachianus* (G1), *Canis rufus* (G1Q, red wolf), *Catocala marmorata* (G3G4, marbled underwing), *Cicindela ancocisconensis* (G3, appalachian tiger beetle), *Diervilla rivularis* (G3, mountain bush honeysuckle), *Eurycea junaluska* (G3, junaluska salamander), *Fissidens appalachensis* (G2G3, Appalachian fissidens moss), *Gymnoderma lineare* (G2, rock gnome lichen), *Hygrohypnum closteri* (G3, hygrophypnum moss), *Lejeunea blomquistii* (G1G2, blomquist leafy liverwort), *Lysimachia fraseri* (G3, Fraser's yellow loosestrife), *Marshallia grandiflora* (G2, Monongahela Barbara's buttons), *Myotis austroriparius* (G3G4, southeastern myotis), *Plethodon aureolus* (G2G3, tellico salamander), *Sagittaria secundifolia* (G1, Little River arrowhead), *Sorex palustris punctulatus* (G5T3, southern water shrew), *Spiraea virginiana* (G2, Virginia meadowsweet)

**Range:** Southern New England west to Lake Erie and south to Virginia. The James River in Virginia marks the southern extent of this system. United States: CT, MA, MD, NH, NJ?, NY, OH, PA, VA, VT, WV

### Delaware Estuary Addendum Associations:

- Riverine Floodplain Forest (Early-Successional Type)

### Similar Ecological Systems in the Delaware Estuary:

- Central Appalachian Stream and Riparian

## CLASSIFIERS FOR CENTRAL APPALACHIAN RIVER FLOODPLAIN

**Primary Division:** 202

**Land Cover Class:** Mixed Upland and Wetland

**Spatial Scale & Pattern:** Large patch

**Required Classifiers:** Natural/Semi-natural; Vegetated (>10% vasc.); Upland; Wetland

**Diagnostic Classifiers:** Forest and Woodland (Treed); Toeslope/Valley Bottom; Riverine / Alluvial; Broad-Leaved Deciduous Tree; Intermittent Flooding; Short (<5 yrs) Flooding Interval

**Non-diagnostic Classifiers:** Lowland; Temperate; Eutrophic Soil; Deep Soil; Mineral: W/ A-Horizon >10 cm; Silt Soil Texture; Udic; Ustic; Unconsolidated; Short Disturbance Interval; Flood Scouring; 1-29-day hydroperiod; 30-180-day hydroperiod; Moderate (100-500 yrs) Persistence

---

### RIVERINE FLOODPLAIN FOREST (EARLY-SUCCESSIONAL TYPE)

*Platanus occidentalis* - *Fraxinus pennsylvanica* Forest

---

**Range:** This association ranges from New England south to Pennsylvania.

**Environmental Description:** Early- to-mid successional forest occurs on cobble or sand substrates of floodplain islands or cobble shores of moderate- to high-energy rivers.

**Vegetation Description:** The canopy is closed to somewhat open and usually dominated by *Platanus occidentalis* (American sycamore). *Populus deltoides* (eastern cottonwood), *Acer saccharinum* (silver maple), and *Ulmus americana* (American elm) are usually present but not common; occasional associates include *Acer negundo* (boxelder), *Fraxinus pennsylvanica* (green ash), *Juglans cinerea* (butternut), *Carya cordiformis* (bitternut hickory), *Celtis occidentalis* (common hackberry), *Acer saccharum* (sugar maple), and *Acer rubrum* (red maple). Shrubs or subcanopy are variable depending on geography and can include *Betula nigra* (river birch), *Carpinus caroliniana* (American hornbeam), *Salix nigra* (black willow), *Lindera benzoin* (northern spicebush), or *Alnus serrulata* (hazel alder), plus exotic invasives such as *Rosa multiflora* (multiflora rose), *Berberis thunbergii* (Japanese barberry), and *Lonicera morrowii* (Morrow's honeysuckle). The herbaceous layer tends to be sparse to locally abundant and can include *Matteuccia struthiopteris* (ostrich fern), *Osmunda cinnamomea* (cinnamon fern), *Onoclea sensibilis* (sensitive fern), *Geum canadense* (white avens), *Impatiens pallida* (pale touch-me-not), *Boehmeria cylindrica* (smallspike false nettle), *Urtica dioica* (stinging nettle), *Solidago rugosa* (wrinkleleaf goldenrod), *Hydrophyllum virginianum* (Shawnee salad), *Carex bromoides* (bromelike sedge), *Ageratina altissima* (white snakeroot), plus vine species *Toxicodendron radicans* (eastern poison ivy) and *Parthenocissus quinquefolia* (Virginia creeper). There is typically a very high component of disturbance-tolerant exotic species such as *Lysimachia nummularia* (creeping jenny), *Glechoma hederacea* (ground ivy), *Microstegium vimineum* (Nepalese browntop), *Hesperis matronalis* (dames rocket), *Aegopodium podagraria* (bishop's goutweed), *Polygonum cuspidatum* (Japanese knotweed), and *Alliaria petiolata* (garlic mustard).

**Characteristic Species:** *Acer saccharinum* (silver maple), *Circaea lutetiana* ssp. *canadensis* (broadleaf enchanter's nightshade), *Elymus virginicus* (Virginia wildrye), *Onoclea sensibilis* (sensitive fern), *Osmunda cinnamomea* (cinnamon fern), *Parthenocissus quinquefolia* (Virginia creeper), *Platanus occidentalis* (American sycamore), *Polygonum sagittatum* (arrowleaf tearthumb), *Populus deltoides* (eastern cottonwood), *Ulmus americana* (American elm)

Reference Sites: Brandywine Watershed, DE

**Global and State Conservation Ranks and Reasons:** G4? (20-Jun-2006). DE:S3S4, NJ:SNR, PA:SNR. Total acreage (rangewide) is limited. Good-quality examples are uncommon. Threats include development and filling, alteration in flooding regimes, excessive beaver activity, and encroachment by aggressive non-native plant species. Further data are needed to define the rank.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.686466](http://vegbank.org/natureserve/element_global.2.686466)

**References:** Clancy 1996, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Fike 1999, Frye and Quinn 1979, Kearsley 1999b, Metzler and Barrett 2001, Newbold 1994, Newbold et al. 1988, Nichols et al. 2001, Overlease 1978, Overlease 1987, Russell and Schuyler 1988, Sperduto 2000a, Sperduto 2000b, Swain and Kearsley 2000, Thompson and Sorenson 2000, WPC and TNC 2002, Wistendahl 1958

| MOST ABUNDANT SPECIES |                             |  |
|-----------------------|-----------------------------|--|
| STRATUM               | LIFEFORM                    | SPECIES  |
| Tree canopy           | Broad-leaved deciduous tree | <i>Platanus occidentalis</i><br>(American sycamore)      |
| Herb (field)          | Forb                        | <i>Boehmeria cylindrica</i><br>(smallspike false nettle) |
| Herb (field)          | Fern or fern ally           | <i>Onoclea sensibilis</i> (sensitive fern)               |
| Herb (field)          | Fern or fern ally           | <i>Osmunda cinnamomea</i> (cinnamon fern)                |



---

## ECOLOGICAL SYSTEM: CENTRAL APPALACHIAN STREAM AND RIPARIAN

---

**Summary:** This riparian system ranges from southern New England to Virginia and West Virginia and occurs over a wide range of elevations. It develops on floodplains and shores along river channels that lack a broad flat floodplain due to steeper sideslopes, higher gradient, or both. It may include communities influenced by flooding, erosion, or groundwater seepage. The vegetation is often a mosaic of forest, woodland, shrubland, and herbaceous communities. Common trees include *Betula nigra* (river birch), *Platanus occidentalis* (American sycamore), and *Acer negundo* (boxelder). Open, flood-scoured rivershore prairies feature *Panicum virgatum* (switchgrass) and *Andropogon gerardii* (big bluestem), and *Carex torta* (twisted sedge) is typical of wetter areas near the channel.

**High-ranked Species:** *Bryoerythrophyllum ferruginascens* (G3G4, bryoerythrophyllum moss), *Canis rufus* (G1Q, red wolf), *Catocala marmorata* (G3G4, marbled underwing), *Cicindela ancocisconensis* (G3, appalachian tiger beetle), *Desmognathus aeneus* (G3G4, seepage salamander), *Desmognathus wrightii* (G3G4, pygmy salamander), *Fissidens appalachensis* (G2G3, Appalachian fissidens moss), *Gymnoderma lineare* (G2, rock gnome lichen), *Hexastylis naniflora* (G3, dwarfflower heartleaf), *Hexastylis rhombiformis* (G2, North Fork heartleaf), *Hexastylis shuttleworthii* var. *harperi* (G4T3, largeflower heartleaf), *Isotria medeoloides* (G2, green fiveleaf orchid), *Jamesianthus alabamensis* (G3, Alabama warbonnet), *Lejeunea blomquistii* (G1G2, blomquist leafy liverwort), *Lysimachia fraseri* (G3, Fraser's yellow loosestrife), *Marshallia grandiflora* (G2, Monongahela Barbara's buttons), *Megaceros aenigmaticus* (G2G3), *Myotis austroriparius* (G3G4, southeastern myotis), *Plethodon hubrichti* (G2, peaks of otter salamander), *Plethodon punctatus* (G3, white-spotted salamander), *Sagittaria secundifolia* (G1, Little River arrowhead), *Spiraea virginiana* (G2, Virginia meadowsweet), *Trillium rugelii* (G3, illscented wakerobin), *Waldsteinia lobata* (G2G3, Piedmont barren strawberry)

**Range:** This system ranges from southern New England west to Lake Erie and south to Virginia and West Virginia. The James River in Virginia marks its southern extent. DE, NJ?, PA.

### Delaware Estuary Addendum Associations:

- Central Appalachian / Piedmont Bedrock Floodplain Woodland
- Central Appalachian Basic Seepage Swamp
- Central Appalachian Cutgrass Marsh
- Southern New England Red Maple Seepage Swamp
- Willow River-Bar Shrubland

### Similar Ecological Systems in the Delaware Estuary:

- Central Appalachian River Floodplain

## CLASSIFIERS FOR CENTRAL APPALACHIAN STREAM AND RIPARIAN

**Primary Division:** 202

**Land Cover Class:** Mixed Upland and Wetland

**Spatial Scale & Pattern:** Linear

**Required Classifiers:** Natural/Semi-natural; Vegetated (>10% vasc.); Upland; Wetland

**Diagnostic Classifiers:** Lowland; Riverine / Alluvial; Very Short Disturbance Interval; Flood Scouring; Intermittent Flooding

**Non-diagnostic Classifiers:** Forest and Woodland (Treed); Sideslope; Toeslope/Valley Bottom; Temperate; Mesotrophic Soil; Udic; Ustic; Short (<5 yrs) Flooding Interval; Short (50-100 yrs) Persistence

---

### CENTRAL APPALACHIAN / PIEDMONT BEDROCK FLOODPLAIN WOODLAND

*Platanus occidentalis* - *Acer saccharinum* - *Betula nigra* - *Fraxinus pennsylvanica* / *Boehmeria cylindrica* - *Carex emoryi* Woodland

---

**Range:** The type is known from the higher gradient sections of the Potomac River, with well-documented stands concentrated in the fall-line (Potomac Gorge) and Ridge and Valley provinces. It may occur along the Shenandoah River but is unlikely to occur on the Monocacy River and other smaller tributaries. There is an unverified report of similar vegetation on the Susquehanna River below Conowingo Dam (C. Lea pers. comm.).

**Environmental Description:** This association occurs on scoured shorelines of high-gradient, large-river reaches where there is a combination of control by bedrock and alluvial processes. Stands are usually on the active channel shelf but have some aspects of depositional bars. Sites are flooded annually and inundated from 3 to 7% of the year, mostly during the dormant season, and often but probably irregularly in the early growing season. Surface substrate is variable, averaging >10% cover of bedrock and boulders in 14 plot samples. Two intergrading phases have been recognized and are described according to perceived differences in net rates of sediment erosion/accretion. In the eroding phase, the channel shelf surface is actively eroding along low channels often filled with cobbles and other coarse material, with finer soil being retained around tree bases. In the stable phase, vegetation holds finer sediments in place and provides an equilibrium between erosion and accretion. Soils are sandy loams to sands, with coarser textures prevailing in the eroding phase, which also often has a surface layer of cobbles.

**Vegetation Description:** Physiognomic and floristic expressions of this type are variable, with physiognomy ranging from wooded herbaceous vegetation to nearly closed-canopy forest. In all expressions, some combination of *Platanus occidentalis* (American sycamore), *Acer saccharinum* (silver maple), *Betula nigra* (river birch), and/or *Fraxinus pennsylvanica* (green ash) dominates the uppermost woody layer, which tends to be a woodland to open forest in the eroding phase and woodland or wooded herbaceous vegetation in the stable phase. Less constant species include *Ulmus americana* (American elm), *Diospyros virginiana* (common persimmon), *Juglans nigra* (black walnut), *Quercus bicolor* (swamp white oak), *Populus deltoides* (eastern cottonwood), and *Salix nigra* (black willow). The shrub layer is absent to poorly developed, with battered individuals of *Cornus amomum* (silky dogwood), *Cephalanthus occidentalis* (common buttonbush), and *Salix caroliniana* (coastal plain willow) the most frequent true shrubs. Woody vines, including *Toxicodendron radicans* (eastern poison ivy), *Campsis radicans* (trumpet creeper), and *Vitis riparia* (riverbank grape), are frequent. The herb layer is diverse and variable. Characteristic herbs, in



descending order of constancy in plot samples, include *Verbesina alternifolia* (wingstem), *Boehmeria cylindrica* (smallspike false nettle), *Polygonum punctatum* (dotted smartweed), *Eupatorium serotinum* (lateflowering thoroughwort), *Leersia virginica* (whitegrass), *Dichanthelium clandestinum* (deertongue), *Carex emoryi* (Emory's sedge) (locally abundant in large clones), *Ambrosia artemisiifolia* (annual ragweed), *Polygonum virginianum* (jumpseed), *Teucrium canadense* (Canada germander), *Polygonum pennsylvanicum* (Pennsylvania smartweed), *Symphotrichum lanceolatum* ssp. *lanceolatum* (white panicle aster), *Pilea pumila* (Canadian clearweed), *Chasmanthium latifolium* (Indian woodoats), *Conoclinium coelestinum* (blue mistflower), *Elymus riparius* (riverbank wildrye), *Solidago gigantea* (giant goldenrod), *Eupatorium perfoliatum* var. *perfoliatum*, *Eupatorium fistulosum* (trumpetweed), and *Apocynum cannabinum* (Indianhemp). In drier expressions, *Panicum virgatum* (switchgrass), *Andropogon gerardii* (big bluestem), and other prairie species may be present. In the stable phase, rhizomatous species, primarily *Carex emoryi* (Emory's sedge) but also *Onoclea sensibilis* (sensitive fern), *Boehmeria cylindrica* (smallspike false nettle), *Dichanthelium clandestinum* (deertongue), and inconstantly *Spartina pectinata* (prairie cordgrass), exhibit patch dominance; in the eroding phase these species are less prominent, evidently because of higher rates of substrate disturbance which may select for fast-growing but less strongly rhizomatous species. Species richness is dramatically higher in the eroding phase (mean in 14 plots = 102 taxa vs. 44 taxa). Although relatively well-defined, the two "phases" nevertheless have a high degree of floristic similarity and should be considered variants of a single association. This type is prone to invasion by the exotics *Microstegium vimineum* (Nepalese browntop), *Polygonum cuspidatum* (Japanese knotweed), *Lysimachia nummularia* (creeping jenny), and *Phalaris arundinacea* (reed canarygrass).

In the Delaware variant of this community, *Platanus occidentalis* (American sycamore), *Acer negundo* (boxelder), and *Fraxinus pennsylvanica* (green ash) dominate the low canopy. *Populus deltoides* (eastern cottonwood), *Salix nigra* (black willow), *Betula nigra* (river birch), *Acer saccharinum* (silver maple), and *Cephalanthus occidentalis* (common buttonbush) are found in the lower "understory." *Amorpha fruticosa* (desert false indigo) dominates the shrub layer and is associated by *Sambucus canadensis* (common elderberry) with lesser amounts of *Ilex verticillata* (common winterberry) and *Viburnum prunifolium* (blackhaw). Vines are fairly common and include exotics *Lonicera japonica* (Japanese honeysuckle), *Celastrus orbiculatus* (Asian bittersweet), and *Wisteria sinensis* (Chinese wisteria). Many herbs are present but some of the more common ones are *Dichanthelium clandestinum* (deertongue), *Elymus riparius* (riverbank wildrye), *Elymus virginicus* (Virginia wildrye), *Perilla frutescens* (beefsteakplant), *Rudbeckia laciniata* (cutleaf coneflower), and *Eleocharis erythropoda* (bald spikerush) on rocks.

**Characteristic Species:** *Platanus occidentalis* (American sycamore), *Acer saccharinum* (silver maple), *Betula nigra* (river birch), *Fraxinus pennsylvanica* (green ash)

**Reference Sites:** Brandywine Watershed, DE

**Global and State Conservation Ranks and Reasons:** G2? (5-Oct-2006). DE:SNR. This community is restricted to very specific environmental conditions on high-gradient rivershores with a combination of control by bedrock and alluvial processes. Known examples occur in small patches and are restricted to and scattered along approximately 170 miles of the Potomac River. Although additional occurrences may be found within the Potomac drainage or along other rivers, these are unlikely to dramatically increase the acreage covered by the type.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.795520](http://vegbank.org/natureserve/element_global.2.795520)

References: Eastern Ecology Working Group n.d., Fleming et al. 2004, Lea 2000, Lea 2003

| MOST ABUNDANT SPECIES     |                             |   |
|---------------------------|-----------------------------|---|
| STRATUM                   | LIFEFORM                    | SPECIES   |
| Tree (canopy & subcanopy) | Broad-leaved deciduous tree | <i>Platanus occidentalis</i><br>(American sycamore)       |
| Tree (canopy & subcanopy) | Broad-leaved deciduous tree | <i>Acer saccharinum</i> (silver maple)                    |
| Tree (canopy & subcanopy) | Broad-leaved deciduous tree | <i>Betula nigra</i> (river birch)                         |
| Tree (canopy & subcanopy) | Broad-leaved deciduous tree | <i>Fraxinus pennsylvanica</i> (green ash)                 |
| Herb (field)              | Forb                        | <i>Boehmeria cylindrica</i><br>(small spike false nettle) |

---

### CENTRAL APPALACHIAN BASIC SEEPAGE SWAMP

*Acer rubrum* - *Fraxinus americana* - *Fraxinus nigra* - *Betula alleghaniensis* / *Veratrum viride* - *Carex bromoides* Forest

---

**Range:** The probable range of this community type encompasses the Central Appalachian region of Pennsylvania, Maryland, Virginia, and West Virginia. It is reported in the Brandywine Watershed in the Piedmont of Delaware. The majority of occurrences are on the northern Blue Ridge, but the type is also scattered in suitable habitats of the Ridge and Valley province and western Piedmont.

**Environmental Description:** This community type occupies groundwater-saturated stream headwaters, large spring seeps and runs, and lateral areas in ravine and stream bottoms where groundwater emerges at the base of slopes. Hydrologically, these habitats are classified as "groundwater slope wetlands," where seepage discharged at the ground surface is drained away as streamflow (Golet et al. 1993). Habitats are usually more-or-less narrow and elongate, with considerable exposed bouldery and cobble alluvium. Soils are predominantly mineral, but local areas of organic muck sometimes accumulate in depressions. The ground surface is slightly sloping (mean slope = 3 degrees), and drainage is usually via small, intricately braided channels with intervening hummocks. Moss mats on boulders and cobble deposits commonly provide a rooting medium for herbaceous species, and "sedge tussocks" (especially of *Carex bromoides* (bromelike sedge) and *Carex prasina*) are conspicuous features of these swamps. Soils collected from 25 Virginia and Maryland plot samples ranged from strongly acidic to neutral in pH, with moderately high calcium (mean = 1358 ppm) and magnesium (mean = 211 ppm) levels. This community is most frequent and best developed on Catoclin Formation metabasalt (greenstone) of the northern Blue Ridge. There, it occurs locally in small patches (<12 hectares [30 acres]) at elevations from about 275 to 850 m (900-2800 feet) and occasionally up to 975 m (3200 feet) (Ludwig et al. 1993). It has also been documented in northwestern Virginia in the Massanutten Mountains and western Ridge and Valley region, and in the western Piedmont of both Virginia and Maryland. A somewhat isolated and disjunct occurrence is documented from the Dismal Creek valley in Giles County, in the southwestern Virginia Ridge and Valley. This is probably one of the southernmost occurrences for both the community type and *Fraxinus nigra* (black ash), a tree of pronounced northern distribution. The few known Ridge and Valley occurrences are associated with sites where Devonian or Silurian limestones are interbedded with sandstone and shale. While surficial outcrops of limestone are not evident at these sites, it is clear from both soil samples and floristic evidence that the wetlands are being supplied with calcium by groundwater.

**Vegetation Description:** Overstory composition is mixed, with *Acer rubrum* (red maple), *Fraxinus americana* (white ash), and *Liriodendron tulipifera* (tuliptree) the most abundant species. *Fraxinus nigra* (black ash) is a frequent overstory associate but more abundant and sometimes dominant in the understory, along with young *Acer rubrum* (red maple) and *Fraxinus americana* (white ash). With increasing elevation, *Betula alleghaniensis* (yellow birch) becomes increasingly important, codominating most stands above 760 m (2500 feet) in Virginia and in the Catoctin Mountains of Maryland. Minor tree associates include *Betula lenta* (sweet birch) and *Tilia americana* (American basswood). Almost all trees in plot-sampled stands were <50 cm dbh and most were <40 cm dbh; but scattered *Liriodendron* (tuliptree) specimens >80 cm dbh occur, and in one plot such an individual tree accounts for the high canopy cover of this species. Canopy closure is often incomplete (mean stratum cover = 60-80%), most evidently because of blowdowns. Very wet microhabitats that impede the establishment and firm rooting of trees may also contribute to a somewhat open canopy. Shrub stratum diversity is moderately high; *Lindera benzoin* (northern spicebush) is usually the most abundant species, and considerable stratum cover is contributed by tree saplings. Other frequently occurring true shrubs are *Alnus serrulata* (hazel alder), *Carpinus caroliniana* (American hornbeam), *Hamamelis virginiana* (American witchhazel), *Ilex verticillata* (common winterberry), and *Sambucus canadensis* (common elderberry). Except in local areas where shrubs are dense, herbaceous cover is high (mean stratum cover = 90%). One or both of the early-maturing forbs *Symplocarpus foetidus* (skunk cabbage) (mostly at lower elevations) and *Veratrum viride* (green false hellebore) are usually dominant over substantial areas. Because of microtopographic diversity, herbaceous patch-mosaics are typical in this vegetation. More-or-less constant, sometimes locally abundant species include *Eurybia schreberi* (Schreber's aster), *Caltha palustris* (yellow marsh marigold), *Carex bromoides* (bromelike sedge), *Carex gynandra* (nodding sedge), *Carex prasina* (drooping sedge), *Chelone glabra* (white turtlehead), *Chrysosplenium americanum* (American golden saxifrage), *Cinna arundinacea* (sweet woodreed), *Dryopteris carthusiana* (spinulose woodfern), *Dryopteris goldiana* (Goldie's woodfern), *Glyceria striata* (fowl mannagrass), *Impatiens capensis* (jewelweed), *Osmunda cinnamomea* (cinnamon fern), *Osmunda regalis* var. *spectabilis* (royal fern), *Ranunculus recurvatus* (blisterwort), *Saxifraga pensylvanica* (eastern swamp saxifrage), *Packera aurea* (golden ragwort), *Sphenopholis pensylvanica* (swamp wedgescale), *Thalictrum pubescens* (king of the meadow), and *Viola cucullata* (marsh blue violet). Moss cover is often significant, but only rarely includes *Sphagnum* (sphagnum) spp. (not recorded in Virginia plots). Typical upland mesophytes commonly occur in well-drained hummock microhabitats and contribute to relatively high species richness values for this type of wetland (n = 60 taxa per 400 square meters for 25 plot samples).

**Characteristic Species:** *Acer rubrum* (red maple), *Athyrium filix-femina* ssp. *asplenioides* (asplenium ladyfern), *Caltha palustris* (yellow marsh marigold), *Cardamine pensylvanica* (Pennsylvania bittercress), *Carex bromoides* (bromelike sedge), *Carex gynandra* (nodding sedge), *Carex laevivaginata* (smoothsheath sedge), *Carex prasina* (drooping sedge), *Carex scabrata* (eastern rough sedge), *Carex scoparia* (broom sedge), *Carex seorsa* (weak stellate sedge), *Chelone glabra* (white turtlehead), *Chrysosplenium americanum* (American golden saxifrage), *Cinna arundinacea* (sweet woodreed), *Dryopteris carthusiana* (spinulose woodfern), *Dryopteris cristata* (crested woodfern), *Eurybia schreberi* (Schreber's aster), *Fraxinus americana* (white ash), *Fraxinus nigra* (black ash), *Huperzia lucidula* (shining clubmoss), *Ilex verticillata* (common winterberry), *Impatiens capensis* (jewelweed), *Lindera benzoin* (northern spicebush), *Onoclea sensibilis* (sensitive fern), *Osmunda regalis* var. *spectabilis* (royal fern), *Packera aurea* (golden ragwort), *Poa paludigena* (bog bluegrass), *Ranunculus hispidus* var. *caricetorum* (bristly

buttercup), *Rosa palustris* (swamp rose), *Sambucus canadensis* (common elderberry), *Saxifraga micranthidifolia* (lettuceleaf saxifrage), *Saxifraga pensylvanica* (eastern swamp saxifrage), *Sphenopholis pensylvanica* (swamp wedgescale), *Symplocarpus foetidus* (skunk cabbage), *Thalictrum pubescens* (king of the meadow), *Thelypteris noveboracensis* (New York fern), *Trautvetteria caroliniensis* (Carolina bugbane), *Trillium cernuum* (whip-poor-will flower), *Veratrum viride* (green false hellebore), *Veronica americana* (American speedwell), *Veronica anagallis-aquatica* (water speedwell), *Viola cucullata* (marsh blue violet), *Vitis labrusca* (fox grape)

**Noteworthy Plants:** *Euphorbia purpurea* (Darlington's glade spurge) G3

**Reference Sites:** Brandywine Watershed, DE

**Global and State Conservation Ranks and Reasons:** G3 (17-Apr-2000). DE:SNR, NJ:SNR. This association has a narrow geographic range and is further limited by its small patch sizes and requirement for special, very localized wetlands. The type is confined to groundwater-saturated, base-rich habitats that are large enough to support forest vegetation.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.689612](http://vegbank.org/natureserve/element_global.2.689612)

**References:** Ehrenfeld 1977, Eyre 1980, Fleming 1999, Fleming and Coulling 2001, Fleming and Van Alstine 1999, Fleming et al. 2001, Golet et al. 1993, Gould and Berdine 1998, Harrison 2004, Lea 2003, Ludwig et al. 1993, Southeastern Ecology Working Group n.d., VDNH 2003, VDNH unpubl. data, Young et al. 2006

| MOST ABUNDANT SPECIES        |                             |  |
|------------------------------|-----------------------------|--|
| STRATUM                      | LIFEFORM                    | SPECIES  |
| Tree canopy                  | Broad-leaved deciduous tree | <i>Acer rubrum</i> (red maple)                 |
| Tree canopy                  | Broad-leaved deciduous tree | <i>Fraxinus americana</i> (white ash)          |
| Tree canopy                  | Broad-leaved deciduous tree | <i>Liriodendron tulipifera</i> (tuliptree)     |
| Tree subcanopy               | Broad-leaved deciduous tree | <i>Fraxinus nigra</i> (black ash)              |
| Shrub/sapling (tall & short) | Broad-leaved deciduous tree | <i>Lindera benzoin</i> (northern spicebush)    |
| Herb (field)                 | Forb                        | <i>Symplocarpus foetidus</i> (skunk cabbage)   |
| Herb (field)                 | Forb                        | <i>Veratrum viride</i> (green false hellebore) |

---

## CENTRAL APPALACHIAN CUTGRASS MARSH

*Leersia oryzoides* - *Sagittaria latifolia* Herbaceous Vegetation

---

**Range:** This association is currently documented from several areas in West Virginia; it is likely in other parts of the Central Appalachians from Pennsylvania to Virginia.

**Environmental Description:** This community occupies wet alluvial bottomlands, beaver ponds, and disturbed flats in the Central Appalachians and adjacent ecoregions. Parent materials at documented sites are alluvium derived mainly from acidic sandstones and shales. Surface soils described from sampled plots are somewhat to very poorly drained clay, clay loam, muck, sandy clay, sandy loam, or silty clay. Hydric soil indicators include Histosols, histic epipedon, depleted matrix, and redox depressions. Soil pH averages 4.0 (n=2). The unvegetated surface is predominantly litter, with small amounts of downed wood and standing water, and frequent patches of bare soil. Elevations of documented stands range up to 1300 m.

**Vegetation Description:** This small-patch wetland community is dominated by grasses and forbs, with scattered trees and shrubs. The dominant grasses are *Leersia oryzoides* (rice cutgrass) and *Phalaris arundinacea* (reed canarygrass). Both of these are native species, however, introduction of Eurasian ecotypes and cultivars of *Phalaris arundinacea* (reed canarygrass) and subsequent hybridization with native stock have been blamed for the current invasive capacity of this species. *Leersia* (cutgrass) is strongly dominant at most sites. *Sagittaria latifolia* (broadleaf arrowhead) has high constancy and cover but drops out at the highest elevations. *Scirpus cyperinus* (woolgrass) has high constancy. Additional characteristic herbs include *Boehmeria cylindrica* (smallspike false nettle), *Carex gynandra* (nodding sedge), *Carex intumescens* (greater bladder sedge), *Carex baileyi* (Bailey's sedge), *Dichanthelium clandestinum* (deertongue), *Dulichium arundinaceum* (threeway sedge), *Eupatorium fistulosum* (trumpetweed), *Galium tinctorium* (stiff marsh bedstraw), *Impatiens capensis* (jewelweed), *Juncus effusus* (common rush), *Lobelia siphilitica* (great blue lobelia), *Ludwigia palustris* (marsh seedbox), *Lycopus uniflorus* (northern bugleweed), *Lycopus virginicus* (Virginia water horehound), *Lysimachia terrestris* (earth loosestrife), *Mimulus ringens* (Allegheny monkeyflower), *Polygonum sagittatum* (arrowleaf tearthumb), *Scirpus atrovirens* (green bulrush), and *Typha latifolia* (broadleaf cattail). Cover by nonvascular plants is generally insignificant. Scattered small trees include *Robinia pseudoacacia* (black locust), *Salix nigra* (black willow), and *Fraxinus pennsylvanica* (green ash). The exotic shrub *Rosa multiflora* (multiflora rose) may be invasive in this community. *Cornus amomum* (silky dogwood) and *Cephalanthus occidentalis* (common buttonbush) are characteristic native shrubs. Areas with longer standing water may have aquatic species, including *Callitriche heterophylla* (twoheaded water-starwort) and *Sparganium* (bur-reed) spp. Mean species richness of vascular plants in 19 WV plots was 16 taxa per 400 square meters.

**Characteristic Species:** *Cephalanthus occidentalis* (common buttonbush), *Cornus amomum* (silky dogwood), *Leersia oryzoides* (rice cutgrass), *Scirpus cyperinus* (woolgrass)

**Reference Sites:** Brandywine Watershed, DE

**Global and State Conservation Ranks and Reasons:** GNR (5-Jun-2006). DE:SNR, PA:SNR. Need more complete information on range and occurrences before ranking.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.793415](http://vegbank.org/natureserve/element_global.2.793415)

**References:** Byers et al. 2007, Eastern Ecology Working Group n.d., Grafton and Eye 1982, Putnam 1995, Vanderhorst 2001a, Vanderhorst 2001b, Vanderhorst and Streets 2006, Vanderhorst et al. 2007, Walbridge 1982, Walbridge and Lang 1982, Walton et al. 1996

| MOST ABUNDANT SPECIES |           |   |
|-----------------------|-----------|---|
| STRATUM               | LIFEFORM  | SPECIES   |
| Herb (field)          | Forb      | <i>Sagittaria latifolia</i> (broadleaf arrowhead) |
| Herb (field)          | Graminoid | <i>Phalaris arundinacea</i> (reed canarygrass)    |

---

## SOUTHERN NEW ENGLAND RED MAPLE SEEPAGE SWAMP

*Acer rubrum* - *Fraxinus* (*pennsylvanica*, *americana*) / *Lindera benzoin* / *Symplocarpus foetidus*  
Forest

---

**Range:** This vegetation occurs in southern New England south to the mid-Atlantic states and west to Pennsylvania. It occurs in New Jersey, Pennsylvania and Delaware in the Delaware Estuary.

**Environmental Description:** This association is an acidic seepage swamp of southern New England and adjacent areas dominated by *Acer rubrum* (red maple). It generally occurs in seasonally saturated situations on slightly sloping hillsides, along small streams, or in basins that receive overland flooding in addition to groundwater influence. In general, these swamps are acidic and have some seepage indicators but are not particularly species-rich. Soils are shallow to moderately deep mucks over mineral soils.

### Vegetation Description:

*Acer rubrum* (red maple) dominates the canopy; *Fraxinus pennsylvanica* (green ash) or *Fraxinus americana* (white ash) are usually also found in the canopy. *Fraxinus nigra* (black ash) is not generally associated with this type and, if present, occurs only as scattered individuals. Other canopy associates may include *Liriodendron tulipifera* (tuliptree), *Quercus bicolor* (swamp white oak), and *Ulmus rubra* (slippery elm).



Conifers, such as *Tsuga canadensis* (eastern hemlock) or *Pinus strobus* (eastern white pine), are generally absent or occur in very low abundance. The shrub layer may be fairly open to quite dense, depending on the amount of canopy closure. Shrub species commonly include *Ilex verticillata* (common winterberry), *Rhododendron viscosum* (swamp azalea), *Clethra alnifolia* (coastal sweetpepperbush), *Lindera benzoin* (northern spicebush), and less commonly *Vaccinium corymbosum* (highbush blueberry), *Lyonia ligustrina* (maleberry), *Toxicodendron vernix* (poison sumac), *Viburnum dentatum* (southern arrowwood), and *Viburnum nudum* var. *cassinoides* (withe-rod). The herbaceous layer is variable in cover, and *Symplocarpus foetidus* (skunk cabbage) and *Osmunda cinnamomea* (cinnamon fern) are nearly always present. Other herbaceous species include *Impatiens capensis* (jewelweed), *Carex stricta* (upright sedge), *Veratrum viride* (green false hellebore), *Pilea pumila* (Canadian clearweed), *Osmunda regalis* (royal fern), *Onoclea sensibilis* (sensitive fern), *Thelypteris palustris* (eastern marsh fern), and *Glyceria* (mannagrass) spp. Microtopography is generally pronounced, resulting from tip-ups. Tree seedlings and *Sphagnum* (sphagnum) mosses are common on hummocks but do not in general form extensive carpets. Additional nonvascular species can

Photo by Robert Coxe, Delaware Natural Heritage Program

include *Plagiomnium cuspidatum* (toothed plagiomnium moss) and *Calliergon* (calliergon moss) spp.

**Characteristic Species:** *Acer rubrum* (red maple), *Fraxinus americana* (white ash), *Fraxinus pennsylvanica* (green ash), *Osmunda cinnamomea* (cinnamon fern), *Symplocarpus foetidus* (skunk cabbage)

**Reference Sites:** Clayton County Park, Delaware County, PA

**Global and State Conservation Ranks and Reasons:** G4G5 (30-Jan-2007). DE:SNR, NJ:S3S5, PA:SNR. Although this is a small-patch community, its environmental requirements are quite general, and it occurs where acidic groundwater seepage emerges on the headwaters of stream drainages. The range extent crosses several ecoregions and 10 states. The major threat to this community is housing development, with disruption of groundwater source a lesser threat.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.688675](http://vegbank.org/natureserve/element_global.2.688675)

**References:** Breden 1989, Breden et al. 2001, Cowardin et al. 1979, Eastern Ecology Working Group n.d., Edinger et al. 2002, Ehrenfeld 1977, Enser 1993, Golet et al. 1993, Harrison 2004, Metzler and Barrett 2001, NRCS 2001b, NRCS 2004, Rawinski 1984, Reschke 1990, Sperduto and Nichols 2004, Swain and Kearsley 2001, Thompson 1996, Thompson and Sorenson 2000

| MOST ABUNDANT SPECIES        |                              |  |
|------------------------------|------------------------------|--|
| STRATUM                      | LIFEFORM                     | SPECIES  |
| Tree (canopy & subcanopy)    | Broad-leaved deciduous tree  | <i>Acer rubrum</i> (red maple)                     |
| Shrub/sapling (tall & short) | Broad-leaved deciduous shrub | <i>Clethra alnifolia</i> (coastal sweetpepperbush) |
| Shrub/sapling (tall & short) | Broad-leaved deciduous shrub | <i>Ilex verticillata</i> (common winterberry)      |
| Shrub/sapling (tall & short) | Broad-leaved deciduous shrub | <i>Lindera benzoin</i> (northern spicebush)        |
| Shrub/sapling (tall & short) | Broad-leaved deciduous shrub | <i>Rhododendron viscosum</i> (swamp azalea)        |
| Herb (field)                 | Fern or fern ally            | <i>Osmunda cinnamomea</i> (cinnamon fern)          |
| Herb (field)                 | Forb                         | <i>Symplocarpus foetidus</i> (skunk cabbage)       |

---

## WILLOW RIVER-BAR SHRUBLAND

*Salix nigra* / *Phalaris arundinacea* - *Apocynum cannabinum* Temporarily Flooded Shrubland

---

**Range:** This shrubland occurs in the eastern United States from New Hampshire and Vermont south to Pennsylvania. It occurs in Pennsylvania and Delaware in the Delaware Estuary.

**Environmental Description:** It occurs on cobble substrates with sand and gravel in areas that are flooded only during high-water events but receive winter ice-scour. It occupies an intermediate position along disturbance gradient between open, herbaceous cobble shores and higher floodplain forests.

**Vegetation Description:** This is a willow shrubland of low riverbanks along moderate- to high-energy rivers in the Northeast and High Allegheny Plateau. *Salix nigra* (black willow) is often dominant or codominant with other willows or dogwoods. Less frequent shrubs and tree saplings include *Platanus occidentalis* (American sycamore), *Salix eriocephala* (Missouri River willow), *Salix sericea* (silky willow), *Alnus incana* (gray alder), *Alnus serrulata* (hazel alder), *Alnus viridis* (green

alder) (infrequent), *Cornus amomum* (silky dogwood), *Cornus sericea* (redosier dogwood), *Spiraea alba var. latifolia* (white meadowsweet), *Platanus occidentalis* (American sycamore), and *Populus deltoides* (eastern cottonwood). The herbaceous layer is typically sparse with variable composition, including *Carex torta* (twisted sedge), *Carex trichocarpa* (hairyfruit sedge), *Panicum dichotomiflorum* (fall panicgrass), *Dichanthelium clandestinum* (deertongue), *Echinochloa crus-galli* (barnyardgrass), *Phalaris arundinacea* (reed canarygrass), *Calamagrostis canadensis* (bluejoint), *Apocynum cannabinum* (Indianhemp), *Agrostis* (bentgrass) spp., *Solidago gigantea* (giant goldenrod), *Solidago rugosa* (wrinkleleaf goldenrod), *Eupatorium maculatum* (spotted joepeeweed), *Lysimachia terrestris* (earth loosestrife), *Polygonum* (knotweed) spp., and *Bidens* (beggarticks) spp. Invasive, exotic species can be problematic in this community, including *Polygonum cuspidatum* (Japanese knotweed), *Tussilago farfara* (coltsfoot), and *Cynanchum louiseae* (Louis' swallow-wort).

**Characteristic Species:** *Carex torta* (twisted sedge), *Salix nigra* (black willow)

**Dynamics/Successional Trajectory:** This community is subject to extreme ice-scour events as well as erosion and deposition during floods. The clonal nature of most of the woody species in this community serves to stabilize the substrate and allows rapid regeneration of above-ground biomass following damage and removal caused by flooding/scour events. Unless flow regime is altered (i.e., flow manipulation from dams), this type is relatively persistent, with minor spatial shifts due to erosion and sedimentation during flood events. Flow regulation may cause a shift to more mature vegetation by reducing flood severity and duration.

**Management Concerns:** This type is subject to invasion by some exotic species (e.g., *Lythrum salicaria* (purple loosestrife)). Flow regulation may cause a shift to riparian tall-shrub or forest communities.

**Reference Sites:** Shapnack Island, Delaware Water Gap National Recreation Area, PA, Brandywine Watershed, DE

**Global and State Conservation Ranks and Reasons:** G4? (20-Jun-2006). DE:SNR, NJ:SNR, PA:SNR. This community is not well-documented but occurs over a large range and is a frequent component of floodplain systems.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.689581](http://vegbank.org/natureserve/element_global.2.689581)

**References:** Eastern Ecology Working Group n.d., Fike 1999, Gawler 2002, Metzler and Barrett 2001, Nichols et al. 2001, Perles et al. 2004, Perles et al. 2007, TNC and WPC 2004

| MOST ABUNDANT SPECIES        |                              |                                      |
|------------------------------|------------------------------|--------------------------------------|
| STRATUM                      | LIFEFORM                     | SPECIES                              |
| Shrub/sapling (tall & short) | Broad-leaved deciduous shrub | <i>Cornus amomum</i> (silky dogwood) |
| Shrub/sapling (tall & short) | Broad-leaved deciduous shrub | <i>Salix nigra</i> (black willow)    |



---

## SEMI-NATURAL / ALTERED VEGETATION & CONIFER PLANTATIONS

---

**Summary:** This group of semi-natural or altered vegetation communities is found throughout the Delaware Estuary. The vegetation includes a mosaic of ruderal, introduced and modified or managed communities including successional forests, conifer plantations, successional shrublands, managed old fields and invaded marshes. Canopy composition and cover can vary within examples of this system, but typical tree species include *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), *Liriodendron tulipifera* (tuliptree), *Pinus taeda* (loblolly pine), *Pinus strobus* (white pine), and/or *Pinus virginiana* (Virginia pine). Some characteristic shrubs may include multiflora rose (*Rosa multiflora*). Herbaceous communities include successional old fields and *Phragmites australis* (eastern reed) marshes.

**Range:** This system ranges along the northern Atlantic Coastal Plain, Piedmont and Central Appalachian ecoregions. United States: DE, NJ, PA.

### Delaware Estuary Addendum Associations:

- Northeastern Modified Successional Forest
- Successional Sweetgum Forest
- Successional Tuliptree Forest (Circumneutral Type)
- Successional Tuliptree Forest (Acidic Type)
- Virginia Pine Successional Forest
- Early to Mid Successional Loblolly Pine Forest
- Old-field Eastern Red-cedar Forest
- White Pine Plantation
- Loblolly Pine Plantation
- Norway Spruce Plantation
- Red Pine Plantation
- Japanese Black Pine Forest
- Northeastern Successional Shrubland
- Wet Meadow
- Golden Bamboo Shrubland
- Wisteria Vineland
- Northeastern Old Field
- Upland Switchgrass Herbaceous Vegetation
- Eastern Reed Marsh
- River Seedbox Marsh

### CLASSIFIERS FOR SEMI-NATURAL / ALTERED VEGETATION

**Primary Division:** 203

**Land Cover Class:** Mixed Upland and Wetland; Herbaceous

**Spatial Scale & Pattern:** Large Patch

**Required Classifiers:** Natural/Semi-natural; Vegetated (>10% vasc.); Upland; Wetland

**Diagnostic Classifiers:** Forest and Woodland (Treed); Shrubland; Graminoid; North Atlantic Coastal Plain; Piedmont; Central Appalachian

**Non-diagnostic Classifiers:** Ruderal Vegetation; Introduced Vegetation; Modified/Managed Vegetation

---

## NORTHEASTERN MODIFIED SUCCESSIONAL FOREST

*Prunus serotina* - *Liriodendron tulipifera* - *Acer rubrum* - *Fraxinus americana* Forest

---

**Range:** This vegetation is currently described from Pennsylvania but is of broader distribution in the northeastern U.S including Delaware and New Jersey.

**Environmental Description:** This vegetation occurs on sites that have been cleared for agriculture or otherwise heavily modified in the past. Generally sites are dry-mesic and may have small seepage inclusions in some examples. Environmental setting varies, but generally sites are dry-mesic to mesic, with small seepage inclusions in some examples.

**Vegetation Description:** Tree species may include *Prunus serotina* (black cherry), *Liriodendron tulipifera* (tuliptree), *Fraxinus americana* (white ash), and *Acer rubrum* (red maple). Other associates can include *Juglans nigra* (black walnut), *Sassafras albidum* (sassafras), *Betula populifolia* (gray birch), *Juniperus virginiana* (eastern redcedar), *Acer negundo* (box elder), *Acer saccharinum* (silver maple), *Ailanthus altissima* (tree-of-heaven), *Ulmus americana* (American elm), *Quercus* spp. (oak), *Betula lenta* (sweet birch), *Amelanchier* spp. (serviceberry), and *Robinia pseudoacacia* (black locust). Other woody species may contribute to the canopy or form a tall-shrub layer, including *Lindera benzoin* (northern spicebush) and *Carpinus caroliniana* (American hornbeam). The low-shrub layer, if present, is usually characterized by the presence of *Rubus* spp. (blackberry) such as *Rubus flagellaris* (northern dewberry), *Rubus allegheniensis* (Allegheny blackberry), *Rubus phoenicolasius* (wine raspberry), or *Rubus hispidus* (bristly dewberry). This layer is often dominated by exotic species such as *Lonicera tatarica* (Tatarian honeysuckle), *Lonicera japonica* (Japanese honeysuckle), *Rhamnus cathartica* (common buckthorn), *Crataegus* spp. (hawthorn), *Rosa multiflora* (multiflora rose), and *Berberis thunbergii* (Japanese barberry). The herbaceous layer is variable, often containing grasses and forbs of both native and exotic origin.

**Characteristic Species:** *Prunus serotina* (black cherry), *Liriodendron tulipifera* (tuliptree), *Fraxinus americana* (white ash), and *Acer rubrum* (red maple).

**Dynamics/Successional Trajectory:** Physiognomy of this vegetation is highly variable, ranging from closed forest, open forest, tall dense shrubland, to more open tall shrubland. Early-successional woody species dominate the canopy in a widely variable mix, depending on geographic location. This community is associated with disturbed sites and is characterized by early-successional vegetation, often with a high cover of non-native invasive species in one or more strata. The successional trajectory is typically unclear given the often weedy nature of most stands. When occurring in a matrix of relatively intact mature forest, the adjacent forest type may provide a reasonable guide for the long-term successional trajectory of the stand.

**Management Concerns:** This community represents early-successional, degraded forest stands and is not a management or restoration target. The shrub layer of this community is often dominated by exotic species such as *Lonicera tatarica* (Tatarian honeysuckle), *Lonicera japonica* (Japanese honeysuckle), *Rhamnus cathartica* (common buckthorn), *Crataegus* spp. (hawthorn), *Rosa multiflora* (multiflora rose), and *Berberis thunbergii* (Japanese barberry). The herbaceous layer is variable, often containing grasses and forbs of both native and exotic origin.

**Reference Sites:** No reference sites were identified because this is not a desired target community for conservation. This community is recommended for targeting restoration efforts in the watershed. Examples occur in Supawna Meadows NWR, NJ.

**Global Conservation Rank and Reasons:** GNA (ruderal) (29-Nov-2004). This vegetation is modified by human activity and not of conservation concern.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.754608](http://vegbank.org/natureserve/element_global.2.754608)

**References:** Eastern Ecology Working Group n.d., Fike 1999, Perles et al. 2005c, Podniesinski et al. 2006

| MOST ABUNDANT SPECIES |                              |  |
|-----------------------|------------------------------|--|
| STRATUM               | LIFEFORM                     | SPECIES  |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Acer rubrum</i> (red maple)                     |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Fraxinus americana</i> (white ash)              |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Liriodendron tulipifera</i> (tuliptree)         |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Prunus serotina</i> (black cherry)              |
| Tree canopy           | Broad-leaved deciduous tree  | <i>Robinia pseudoacacia</i> , (black locust)       |
| Tree subcanopy        | Broad-leaved deciduous tree  | <i>Acer rubrum</i> (red maple)                     |
| Tall shrub/sapling    | Broad-leaved deciduous shrub | <i>Carpinus caroliniana</i><br>(American hornbeam) |
| Tall shrub/sapling    | Broad-leaved deciduous shrub | <i>Lindera benzoin</i> (northern spicebush)        |

---

## SUCCESSIONAL SWEETGUM FOREST

*Liquidambar styraciflua* Forest

---

**Range:** This association may be found throughout the southeastern United States, in the coastal plains and interior ecoregions. It is also attributed to New Jersey and Delaware.

**Environmental Description:** This association is found in uplands that have been heavily impacted by agriculture or other severe disturbances and are recovering.



Photo by Robert Coxe, Delaware Natural Heritage Program

**Vegetation Description:** Stands are dominated by *Liquidambar styraciflua* (sweetgum), sometimes to the exclusion of other species.

**Characteristic Species:** *Liquidambar styraciflua* (sweetgum)

**Dynamics/Successional Trajectory:** These communities represent successional stands of upland *Liquidambar styraciflua* (sweetgum). As the stands mature, they begin to assume the

characteristics of more natural community types. Over time, *Liquidambar styraciflua* (sweetgum) declines and is replaced by oaks, hickories, and/or pines.

**Management Concerns:** This is an upland successional vegetation type composed of native species; it may provide buffer for communities of greater conservation value.

**Reference Sites:** Mispillion Watershed, DE; Cape May NWR NJ

**Global Conservation Rank and Reasons:** GNA (ruderal) (19-Aug-2002). Its conservation value is limited, but it may provide buffer for communities of greater conservation value.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.754608](http://vegbank.org/natureserve/element_global.2.754608)

**References:** Eastern Ecology Working Group n.d., Fike 1999, Perles et al. 2005c, Podniesinski et al. 2006

| MOST ABUNDANT SPECIES |                             |   |
|-----------------------|-----------------------------|---|
| STRATUM               | LIFEFORM                    | SPECIES                                   |
| Tree canopy           | Broad-leaved deciduous tree | <i>Liquidambar styraciflua</i> (sweetgum) |

### SUCCESSIONAL TULIPTREE FOREST (CIRCUMNEUTRAL TYPE)

*Liquidambar styraciflua* - *Liriodendron tulipifera* / (*Cercis canadensis*) / (*Lindera benzoin*) Forest

**Range:** This type occurs in the Ridge and Valley and Cumberland Plateau of Tennessee, the Interior Low Plateau of Kentucky, the Upper East Gulf Coastal Plain of Mississippi, and the Central Appalachian, Piedmont and Inner Coastal Plain regions of Virginia, West Virginia, Maryland, Pennsylvania and Delaware.

**Environmental Description:** These forests are found on disturbed mesic areas underlain by rich soils with moderately high base saturation levels. It occurs on abandoned farmland and townsites, old strip mines, old clearcuts, burned areas, and other areas where the canopy was removed or heavily disturbed in the past. Small patches may occur in areas where canopy disturbance has resulted from natural causes such as windfall or landslides. Soils may be underlain by a variety of geologic strata that weather to base-rich soils including limestone, dolomite, calcareous shale, shell deposits, metabasalts and granitic complexes.

**Vegetation Description:** Stands are dominated by *Liriodendron tulipifera* (tuliptree) but also include various other species, including ones indicative of nutrient-rich or circumneutral environments. Other species include *Liquidambar styraciflua* (sweetgum), *Acer saccharum* (sugar maple), *Aesculus flava* (yellow buckeye), *Platanus occidentalis* (American sycamore), *Quercus rubra* (northern red oak), *Acer rubrum* (red maple), *Robinia pseudoacacia* (black locust), *Juglans nigra* (black walnut), *Halesia tetraptera* (mountain silverbell), *Fraxinus americana* (white ash), *Fagus grandifolia* (American beech), *Magnolia acuminata* (cucumber-tree), *Ulmus rubra* (slippery elm), *Quercus imbricaria* (shingle oak), *Quercus muehlenbergii* (chinkapin oak), and *Carya ovata* (shagbark hickory) (NatureServe Ecology unpubl. data, VDNH unpubl. data, WVNHP unpubl. data.). Species often found in the subcanopy include *Acer saccharum* (sugar maple), *Cercis canadensis* (eastern redbud), *Ulmus alata* (winged elm), *Morus rubra* (red mulberry), *Sassafras albidum* (sassafras), and *Cornus florida* (flowering dogwood). *Cercis canadensis* (eastern redbud) is often abundant on soils underlain by carbonate strata. Shrubs include saplings of the subcanopy and canopy species, as well as *Symphoricarpos orbiculatus* (coralberry), *Lindera benzoin* (northern

spicebush), *Asimina triloba* (pawpaw), and *Juniperus virginiana* var. *virginiana* (eastern redcedar). *Lindera benzoin* (northern spicebush) is often abundant. Exotic shrubs, including *Rosa multiflora* (multiflora rose), *Rubus phoenicolasius* (wine raspberry), and *Lonicera japonica* (Japanese honeysuckle), are present at some sites. Vines, which may be abundant, include *Aristolochia macrophylla* (pipevine), *Toxicodendron radicans* (eastern poison ivy), *Parthenocissus quinquefolia* (Virginia creeper), *Smilax tamnoides* (bristly greenbrier), and *Vitis aestivalis* var. *bicolor* (summer grape). Herbaceous species include the exotics *Microstegium vimineum* (Nepalese browntop), *Alliaria petiolata* (garlic mustard), and *Veronica hederifolia* (ivyleaf speedwell), as well as *Actaea racemosa* (black bugbane), *Ageratina altissima* (white snakeroot), *Arisaema triphyllum* (Jack in the pulpit), *Asarum canadense* (Canadian wildginger), *Caulophyllum thalictroides* (blue cohosh), *Cryptotaenia canadensis* (Canadian honewort), *Galium triflorum* (fragrant bedstraw), *Laportea canadensis* (Canadian woodnettle), *Impatiens pallida* (pale touch-me-not), *Hydrophyllum canadense* (bluntleaf waterleaf), *Osmorhiza longistylis* (longstyle sweetroot), *Adiantum pedatum* (northern maidenhair), *Polygonatum pubescens* (hairy Solomon's seal), *Polystichum acrostichoides* (Christmas fern), *Verbesina alternifolia* (wingstem), *Amphicarpaea bracteata* (American hogpeanut), *Solidago caesia* (wreath goldenrod), and *Polystichum acrostichoides* (Christmas fern). (Andreu and Tukman 1995, NatureServe Ecology unpubl. data, VDNH unpubl. data, WVNHP unpubl. data).

**Characteristic Species:** *Liriodendron tulipifera* (tuliptree), *Acer saccharum* (sugar maple), *Aesculus flava* (yellow buckeye), *Ageratina altissima* (white snakeroot), *Arisaema triphyllum* (Jack in the pulpit), *Aristolochia macrophylla* (pipevine), *Asarum canadense* (Canadian wildginger), *Asimina triloba* (pawpaw), *Carya ovata* (shagbark hickory), *Cercis canadensis* (eastern redbud), *Cryptotaenia canadensis* (Canadian honewort), *Galium triflorum* (fragrant bedstraw), *Lindera benzoin* (northern spicebush), *Osmorhiza longistylis* (longstyle sweetroot), *Parthenocissus quinquefolia* (Virginia creeper), *Polystichum acrostichoides* (Christmas fern), *Toxicodendron radicans* (eastern poison ivy), *Ulmus rubra* (slippery elm)

**Dynamics/Successional Trajectory:** These communities represent successional stands of upland *Liriodendron tulipifera* (tuliptree). As the stands mature, they begin to assume the characteristics of more natural community types. Over time, *Liriodendron tulipifera* (tuliptree) declines and is replaced by oaks, hickories, and other hardwoods.

**Management Concerns:** This forest represents successional vegetation and is thus not of high conservation concern. It is composed largely of native species, though exotics may be locally abundant.

**Reference Sites:** Brandywine Watershed, DE

**Global Conservation Rank and Reasons:** GNA (ruderal) (28-Oct-2003). It is apparently a widespread successional forest of relatively fertile substrates in all provinces of the Mid-Atlantic states and in parts of the Southeast. Its conservation value is limited, but mature examples could provide buffer for communities of greater conservation value.

**References:** Andreu and Tukman 1995, Hall and Mathews 1974, Lea 2000, Lea 2003, Martin 1989, NatureServe Ecology - Southeastern U.S. unpubl. data, Rentch et al. 2005, Schmalzer and DeSelm 1982, Shreve et al. 1910, Southeastern Ecology Working Group n.d., TDNH unpubl. data, VDNH unpubl. data, Vanderhorst 2001a, Vanderhorst et al. 2007, Vanderhorst et al. 2008, WVNHP unpubl. data b, Young et al. 2006

| MOST ABUNDANT SPECIES |                             |  |
|-----------------------|-----------------------------|--|
| STRATUM               | LIFEFORM                    | SPECIES                                    |
| Tree canopy           | Broad-leaved deciduous tree | <i>Liriodendron tulipifera</i> (tuliptree) |

## SUCCESSIONAL TULIPTREE FOREST (ACIDIC TYPE)

*Liriodendron tulipifera* – *Quercus* spp. Forest

**Range:** This association is known from the southern Cumberland Plateau, Piedmont, and Interior Low Plateau of the southeastern U.S. and may also occur in the Upper East Gulf Coastal Plain. It ranges north to the northern Piedmont of New Jersey and adjacent Pennsylvania. It is also known from Alabama, Georgia, Kentucky, Maryland, North Carolina, South Carolina, Tennessee, West Virginia, Pennsylvania and Delaware.

**Environmental Description:** These semi-natural upland deciduous forests are found primarily in areas which were once clearcuts, old fields, or were cleared by fire or other natural disturbances. These successional forests often follow cropping, clearcut logging, or other severe disturbance, and are successional to mixed oak-hickory forests. Examples are common across large areas of the upland landscape which have previously been disturbed. Soils usually exhibit evidence of disturbance and may have little to no organic horizon development. Environmental setting is variable, ranging from level to gently sloping uplands to well-drained floodplains and stream terraces.

**Vegetation Description:** The canopy of this semi-natural upland association is dominated by *Liriodendron tulipifera* (tuliptree). *Quercus* (oak) species (*Quercus alba* (white oak), *Quercus rubra* (northern red oak), *Quercus falcata* (southern red oak), *Quercus nigra* (water oak), *Quercus velutina* (black oak)) are often present; additional associates may include *Acer barbatum* (southern sugar maple), *Acer rubrum* (red maple), *Carya* (hickory) spp., *Fagus grandifolia* (American beech), *Nyssa sylvatica* (blackgum), *Cornus florida* (flowering dogwood), and *Robinia pseudoacacia* (black locust). *Betula lenta* (sweet birch) is a common associate at the northern range limit. Shrub layers may include saplings of the canopy species and *Acer pensylvanicum* (striped maple), *Amelanchier arborea* (common serviceberry), *Hamamelis virginiana* (American witchhazel), *Lindera benzoin* (northern spicebush) (in small amounts), and *Vaccinium pallidum* (Blue Ridge blueberry). Herbs vary across the range but may include *Actaea racemosa* (black bugbane), *Dichanthelium clandestinum* (deertongue), *Dioscorea quaternata* (fourleaf yam), *Galium circaezans* (licorice bedstraw), *Geranium maculatum* (spotted geranium), *Goodyera pubescens* (downy rattlesnake plantain), *Medeola virginiana* (Indian cucumber), *Potentilla simplex* (common cinquefoil), *Scutellaria serrata* (showy skullcap), *Thelypteris noveboracensis* (New York fern), and *Uvularia perfoliata* (perfoliate bellwort). *Lycopodium digitatum* (fan clubmoss) may be abundant in some stands.

**Characteristic Species:** *Acer pensylvanicum* (striped maple), *Acer rubrum* (red maple), *Actaea racemosa* (black bugbane), *Amelanchier arborea* (common serviceberry), *Carya glabra* (pignut hickory), *Dichanthelium clandestinum* (deertongue), *Fagus grandifolia* (American beech), *Galium circaezans* (licorice bedstraw), *Geranium maculatum* (spotted geranium), *Goodyera pubescens* (downy rattlesnake plantain), *Hamamelis virginiana* (American witchhazel), *Lycopodium digitatum* (fan clubmoss), *Medeola virginiana* (Indian cucumber), *Nyssa sylvatica* (blackgum), *Quercus falcata* (southern red oak), *Quercus rubra* (northern red oak), *Quercus velutina* (black oak), *Robinia*

*pseudoacacia* (black locust), *Thelypteris noveboracensis* (New York fern), *Uvularia perfoliata* (perfoliate bellwort), *Vaccinium pallidum* (Blue Ridge blueberry).

**Dynamics/Successional Trajectory:** These communities represent successional stands of upland *Liriodendron tulipifera* (tuliptree) and various oak species. As the stands mature, they begin to assume the characteristics of more natural community types. Over time, *Liriodendron tulipifera* (tuliptree) declines and is replaced by oaks.

**Management Concerns:** This forest represents successional vegetation. It is composed largely of native species, though exotics may be locally abundant.

**Reference Sites:** Valley Forge, PA

**Global Conservation Rank and Reasons:** GNA (ruderal) (19-Aug-2002). This forest represents early-successional vegetation and is thus not of conservation concern. Its conservation value is limited, but mature examples could provide buffer for communities of greater conservation value.

**References:** Ehrenfeld 1977, Gallyoun et al. 1996, Keever 1973, NatureServe Ecology - Southeastern U.S. unpubl. data, Overlease 1987, Russell and Schuyler 1988, Schmalzer and DeSelm 1982, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data, Vanderhorst 2001a, Vanderhorst and Streets 2006

| MOST ABUNDANT SPECIES     |                              |  |
|---------------------------|------------------------------|--|
| STRATUM                   | LIFEFORM                     | SPECIES                                    |
| Tree (canopy & subcanopy) | Broad-leaved deciduous tree  | <i>Liriodendron tulipifera</i> (tuliptree) |
| Tree (canopy & subcanopy) | Broad-leaved deciduous tree  | <i>Quercus</i> spp. (oak species)          |
| Tall shrub/sapling        | Broad-leaved deciduous shrub | <i>Cornus florida</i> (flowering dogwood)  |
| Herb (field)              | Fern or fern ally            | <i>Lycopodium digitatum</i> (fan clubmoss) |

---

## VIRGINIA PINE SUCCESSIONAL FOREST

*Pinus virginiana* Successional Forest

---

**Range:** This successional community is possible in the Piedmont from Pennsylvania south to Alabama, and ranges west into the Appalachians, Ridge and Valley, the Cumberland Plateau, and in scattered locales of the Interior Low Plateau. It occurs in the Pennsylvania and Delaware portions of the Delaware Estuary.

**Environmental**

**Description:** This community occurs in areas where canopy removal has created open



Photo by Robert Coxe, Delaware Natural Heritage Program

conditions and bare mineral soil, allowing for the establishment of *Pinus virginiana* (Virginia pine). These conditions can include old fields, old pastures, clearcuts, and burned or eroded areas. In the Central Appalachians, this vegetation occurs where soft shales have been farmed (primarily in valleys), resulting in stands with nothing but successional species in the understory. Soils underlying these communities are of two general types, i.e., those derived in residuum from calcareous shale and calcareous sandstone of the Middle Ordovician and those of some other origin. Series of the former type include Dandridge (Lithic Ruptic-Alfic Eutrochrepts), Tellico (Typic Rhododults), and Steekee (Ruptic-Ultic Dystrochrepts). Other soil series that this forest type may occur on include Litz, Dewey, Alcoa, Bland, Etowah, Lobdell and Neubert. All of these soils are well-drained and range in pH from moderate acid to very strongly acidic.

**Vegetation Description:** This forest typically has a very dense canopy of *Pinus virginiana* (Virginia pine) and little understory vegetation. *Pinus echinata* (shortleaf pine) and *Pinus rigida* (pitch pine) may co-occur with *Pinus virginiana* (Virginia pine) in the canopy. The canopy can also have significant admixtures of early-successional deciduous trees (e.g., *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), *Liriodendron tulipifera* (tuliptree)). Associated woody and herbaceous species vary with geography but are typically ruderal or exotic species. Shrub and herb strata are absent to sparse in coverage. The subcanopy may contain *Acer saccharum* (sugar maple) and *Cornus florida* (flowering dogwood); other associated species may include *Cercis canadensis* (eastern redbud), *Parthenocissus quinquefolia* (Virginia creeper), *Lonicera japonica* (Japanese honeysuckle), and *Microstegium vimineum* (Japanese stiltgrass) (Andreu and Tukman 1995). The dense ericaceous shrub stratum contains *Vaccinium* spp. (blueberry), *Gaylussacia* spp. (huckleberry), *Kalmia latifolia* (mountain laurel), and *Rhododendron* spp. (rhododendron).

**Characteristic Species:** *Pinus virginiana* (Virginia pine)

**Dynamics/Successional Trajectory:** This is an early-successional forest type. Damage from ice storms can be a main disturbance observed in these stands. In addition, fire and insect infestation are likely damaging agents.

**Management Concerns:** These stands can be managed for pulpwood production. They have a low aesthetic value so would not provide suitable recreational opportunities. Since this association is an early-successional forest type, it typically should not be considered as a restoration target.

**Reference Sites:** Mispillion Watershed, DE

**Global Conservation Rank and Reasons:** GNA (ruderal) (13-Jun-2000). This forest represents early-successional vegetation and is thus not of conservation concern.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.688932](http://vegbank.org/natureserve/element_global.2.688932)

**References:** Allard 1990, Ambrose 1990a, Andreu and Tukman 1995, Eyre 1980, Fike 1999, Fleming and Coulling 2001, Fleming and Moorhead 2000, Nelson 1986, Patterson et al. 1999, Pyne 1994, Schmalzer and DeSelm 1982, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. Data



| MOST ABUNDANT SPECIES |                              |   |
|-----------------------|------------------------------|---|
| STRATUM               | LIFEFORM                     | SPECIES   |
| Tree canopy           | Needle-leaved tree           | <i>Pinus virginiana</i> (Virginia pine)               |
| Tree subcanopy        | Needle-leaved tree           | <i>Juniperus virginiana</i> (eastern redcedar)        |
| Tree subcanopy        | Broad-leaved deciduous tree  | <i>Acer rubrum</i> (red maple)                        |
| Tree subcanopy        | Broad-leaved deciduous tree  | <i>Cornus florida</i> (flowering dogwood)             |
| Tree subcanopy        | Broad-leaved deciduous tree  | <i>Nyssa sylvatica</i> , (blackgum)                   |
| Tree subcanopy        | Broad-leaved deciduous tree  | <i>Oxydendrum arboreum</i> (sourwood)                 |
| Tall shrub/sapling    | Broad-leaved deciduous shrub | <i>Nyssa sylvatica</i> (blackgum)                     |
| Tall shrub/sapling    | Broad-leaved deciduous shrub | <i>Oxydendrum arboreum</i> (sourwood)                 |
| Tall shrub/sapling    | Broad-leaved deciduous shrub | <i>Vaccinium arboreum</i> (farkleberry)               |
| Tall shrub/sapling    | Broad-leaved deciduous shrub | <i>Vaccinium stamineum</i> (deerberry)                |
| Short shrub/sapling   | Broad-leaved deciduous shrub | <i>Cercis canadensis</i> (eastern redbud)             |
| Short shrub/sapling   | Broad-leaved deciduous shrub | <i>Quercus alba</i> (white oak)                       |
| Short shrub/sapling   | Broad-leaved deciduous shrub | <i>Sassafras albidum</i> (sassafras)                  |
| Herb (field)          | Vine/Liana                   | <i>Lonicera japonica</i><br>(Japanese honeysuckle)    |
| Herb (field)          | Vine/Liana                   | <i>Smilax glauca</i> (whiteleaf greenbrier)           |
| Herb (field)          | Vine/Liana                   | <i>Toxicodendron radicans</i><br>(eastern poison-ivy) |

## EARLY- TO MID-SUCCESSIONAL LOBLOLLY PINE FOREST

*Pinus taeda* | *Liquidambar styraciflua* - *Acer rubrum* var. *rubrum* | *Vaccinium stamineum* Forest

**Range:** This forest ranges from the Mid-Atlantic from Cape May, New Jersey to Delaware, the Piedmont of Virginia, through North Carolina, South Carolina, Georgia and Alabama, extending into the adjacent eastern end of the Upper East Gulf Coastal Plain (e.g., Talladega National Forest).

**Environmental Description:** This forest follows agricultural cropping or silvicultural site preparation on a variety of sites, and presumably is more likely on moderately dissected topography where fire is a rare occurrence. This community usually is not present on steep slopes and does not occur on wet

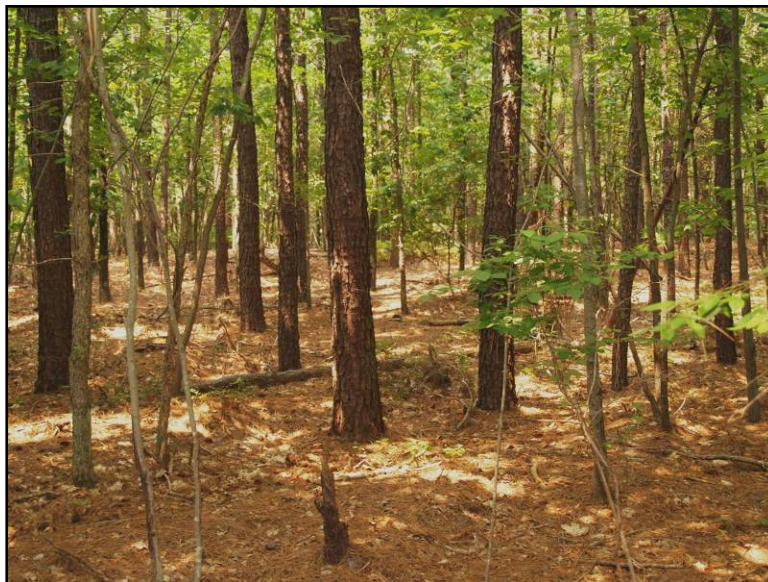


Photo by Robert Coxe, Delaware Natural Heritage Program

soils. It occurs on well- to moderately well-drained soils, usually Ultisols, on sites that formerly were under hardwood cover or subjected to agriculture.

**Vegetation Description:** The tree canopy of *Pinus taeda* (loblolly pine) is at least 60% but may be considerably more dense, up to and including closed canopies. Tree subcanopy density varies with stand disturbance history but generally is <50%. Shrub and herb layer coverages do not exceed 25% and decrease with increasing age of the stand. Other species of pine, especially *Pinus echinata* (shortleaf pine) and *Pinus virginiana* (Virginia pine) may be sparingly present in the canopy. Other species that may be present in the subcanopy can include *Liquidambar styraciflua* (sweetgum), *Acer rubrum* (red maple), *Quercus coccinea* (scarlet oak), *Quercus velutina* (black oak), *Quercus alba* (white oak), *Nyssa sylvatica* (blackgum), *Carya glabra* (pignut hickory), *Carya alba* (mockernut hickory), *Diospyros virginiana* (common persimmon), *Prunus serotina* (black cherry), *Cornus florida* (flowering dogwood), *Liriodendron tulipifera* (tuliptree), and *Sassafras albidum* (sassafras) (NatureServe Ecology unpubl. data). Other species that may be present in the shrub stratum include *Juniperus virginiana* (eastern redcedar), *Vaccinium arboretum* (farkleberry), *Rhus copallinum* (flameleaf sumac), *Gaylussacia baccata* (*Gaylussacia baccata*), *Callicarpa americana* (American beautyberry), and probably others. The herbaceous layer usually forms <5% cover and contains such species as *Gelsemium sempervirens* (evening trumpetflower), *Chimaphila maculata* (striped prince's pine), *Polystichum acrostichoides* (Christmas fern), and *Potentilla canadensis* (dwarf cinquefoil). An example from Oconee National Forest has a thinned canopy and grassy herbaceous layer.

**Characteristic Species:** *Pinus taeda* (loblolly pine)

**Dynamics/Successional Trajectory:** As *Pinus taeda* (loblolly pine) plantations mature, they are likely to develop into this community depending on management. The pine component initially outgrows the hardwoods and typically reaches the canopy first. Hardwoods rapidly fill in and reach the subcanopy if not aggressively suppressed through management. Although stands of this forest are most commonly related to forest management, they may also develop following agriculture on old, abandoned fields adjacent to a significant seed source of *Pinus taeda* (loblolly pine).

**Management Concerns:** This community represents early-successional, degraded forest stands and is not a management or restoration target.

**Reference Sites:** No reference sites were identified because this is not a desired target community for restoration. An example occurs in Cape May NWR, NJ

**Global Conservation Rank and Reasons:** GNA (ruderal) (29-Nov-2004). This vegetation is modified by human activity and not of conservation concern.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.754608](http://vegbank.org/natureserve/element_global.2.754608)

**References:** Allard 1990, Eyre 1980, Felix et al. 1983, Harrison 2004, NatureServe Ecology - Southeastern U.S. unpubl. Data, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. Data, USFS 1988

| MOST ABUNDANT SPECIES |                    |                                    |
|-----------------------|--------------------|------------------------------------|
| STRATUM               | LIFEFORM           | SPECIES                            |
| Tree canopy           | Needle-leaved tree | <i>Pinus taeda</i> (loblolly pine) |

---

## OLD-FIELD EASTERN RED-CEDAR FOREST

### *Juniperus virginiana* Forest

---

**Range:** This association is of broad distribution, occurring widely throughout the northeastern U.S. It has been documented from only a limited range but is undoubtedly more widely distributed.

**Environmental Description:** This is a broadly defined old-field early-successional community occurring in a variety of environmental settings, typically on former agricultural land and other disturbed or degraded environmental settings. Soils are mesic to dry-mesic and moderately well-drained to well-drained.

**Vegetation Description:** *Juniperus virginiana* (eastern redcedar) dominates the canopy layer in stands of this type, which ranges from broadly spaced woodlands to dense and nearly impenetrable thickets. Common associates, typically occurring as scattered individuals, may include *Pinus strobus* (eastern white pine), *Acer rubrum* (red maple), *Liriodendron tulipifera* (tuliptree), *Quercus* (oak) spp., and *Prunus serotina* (black cherry). Shrub cover varies according to canopy closure, with the most forested stands having little or no shrub cover. Exotic shrubs such as *Elaeagnus umbellata* (autumn olive), *Lonicera morrowii* (Morrow's honeysuckle), *Ligustrum vulgare* (European privet), and *Rosa multiflora* (multiflora rose) are most characteristic, along with *Rubus* (blackberry) spp. Herbaceous cover likewise varies. Common species in the more open-canopy stands include old-field denizens such as *Schizachyrium scoparium* (little bluestem), *Andropogon virginicus* (broomsedge bluestem), *Festuca rubra* (red fescue), *Anthoxanthum odoratum* (sweet vernalgrass), *Agrostis gigantea* (redtop), *Elymus repens* (quackgrass), *Solidago rugosa* (wrinkleleaf goldenrod), *Solidago gigantea* (giant goldenrod), *Euthamia graminifolia* (flat-top goldentop), *Monarda fistulosa* (wild bergamot), *Toxicodendron radicans* (eastern poison ivy), *Achillea millefolium* (common yarrow), and *Daucus carota* (Queen Anne's lace). In dense forest stands, herbs may be absent or limited to scattered shade-tolerant species such as *Alliaria petiolata* (garlic mustard), *Allium vineale* (wild garlic), and *Dennstaedtia punctilobula* (eastern hayscented fern).

**Characteristic Species:** *Elaeagnus umbellata* (autumn olive), *Juniperus virginiana* (eastern redcedar), *Lonicera morrowii* (Morrow's honeysuckle), *Rosa multiflora* (multiflora rose), *Schizachyrium scoparium* (little bluestem), *Solidago rugosa* (wrinkleleaf goldenrod), *Toxicodendron radicans* (eastern poison ivy)

**Dynamics/Successional Trajectory:** These forests are often young and result from the colonization of old agricultural fields by *Juniperus virginiana* (eastern redcedar) over native and exotic forbs and grasses. These stands may eventually succeed to other forest types as mid- and late-successional canopy species colonize and subsequently overtop the *Juniperus* (juniper).

**Management Concerns:** This vegetation may be easily restorable by either management, time, or restoration of ecological processes

**Reference Sites:** No reference sites were identified in the Delaware Estuary.

**Global Conservation Rank and Reasons:** GNA (ruderal) (10-Oct-2001). This forest represents early-successional, modified, or silviculturally managed vegetation and is thus not of high conservation concern and does not receive a conservation status rank.

**References:** Clark 1986, Eastern Ecology Working Group n.d., Sneddon and Lundgren 2001, Vanderhorst et al. 2008

| MOST ABUNDANT SPECIES        |                              |  |
|------------------------------|------------------------------|--|
| STRATUM                      | LIFEFORM                     | SPECIES  |
| Tree canopy                  | Needle-leaved tree           | <i>Juniperus virginiana</i> (eastern redcedar)     |
| Shrub/sapling (tall & short) | Broad-leaved deciduous shrub | <i>Lonicera morrowii</i> (Morrow's honeysuckle)    |
| Tall shrub/sapling           | Needle-leaved tree           | <i>Juniperus virginiana</i> (eastern redcedar)     |
| Tall shrub/sapling           | Broad-leaved deciduous shrub | <i>Elaeagnus umbellata</i> (autumn olive)          |
| Short shrub/sapling          | Broad-leaved deciduous shrub | <i>Rosa multiflora</i> (multiflora rose)           |
|                              |                              | <i>Toxicodendron radicans</i> (eastern poison ivy) |
| Herb (field)                 | Forb                         | <i>Solidago rugosa</i> (wrinkleleaf goldenrod)     |
| Herb (field)                 | Graminoid                    | <i>Schizachyrium scoparium</i> (little bluestem)   |

---

## WHITE PINE PLANTATION

### *Pinus strobus* Planted Forest

---

**Range:** This white pine plantation type is found throughout the northeastern and midwestern United States and adjacent Canada.

**Environmental Description:** Stands contain plantations of *Pinus strobus* (eastern white pine) that are maintained for the extraction of forest products. The type does well on a variety of soils. Some have been planted on strip-mine reclamation sites.

**Vegetation Description:** The tree canopy at maturity is usually dense and contains a monospecific layer of *Pinus strobus* (eastern white pine). *Pinus resinosa* (red pine) is occasionally present in small amounts. In older stands or gaps, regenerating trees may include *Fagus grandifolia* (American beech), *Acer saccharum* (sugar maple), *Acer rubrum* (red maple), and *Prunus serotina* (black cherry); *Robinia pseudoacacia* (black locust) and *Betula lenta* (sweet birch) are occasionally present. *Acer pensylvanicum* (striped maple) and *Ostrya virginiana* (hophornbeam) are common small trees. The shrub layer is typically sparse and mostly consists of smaller individuals of the tree species. The field layer varies from sparse to absent; it may be locally well-developed in small openings, with variable composition. In some stands, mosses may be abundant.

**Characteristic Species:** *Pinus strobus* (eastern white pine)

**Dynamics/Successional Trajectory:** *Pinus strobus* (eastern white pine) is susceptible to a variety of pests and diseases, including white pine blister rust (*Cronartium ribicola*) and southern pine beetle (*Dendroctonus frontalis*), which have had some impact on its commercial use. Blister rust was a problem on young plantations but is not much of a problem in larger trees in the east (P. Manion pers. comm. 2001).

**Management Concerns:** This community represents vegetation which has been planted in its current location by humans and/or is treated with annual tillage, a modified conservation tillage, or other intensive management or manipulation. It is not a conservation priority and does not receive a conservation rank

**Reference Sites:** No reference sites were identified because this is not a desired target community for restoration.

**Global Conservation Rank and Reasons:** GNA (cultural) (8-Aug-2000). This vegetation is modified by human activity and not of conservation concern.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.754608](http://vegbank.org/natureserve/element_global.2.754608)

**References:** Allard 1990, Fleming and Coulling 2001, Fleming and Moorhead 2000, Reschke 1990, Southeastern Ecology Working Group n.d., TDNH unpubl. Data, Vanderhorst 2001a, Vanderhorst 2001b, Vanderhorst et al. 2007

| MOST ABUNDANT SPECIES |                    |   |
|-----------------------|--------------------|---|
| STRATUM               | LIFEFORM           | SPECIES                                   |
| Tree canopy           | Needle-leaved tree | <i>Pinus strobus</i> (eastern white pine) |

---

## LOBLOLLY PINE PLANTATION

*Pinus taeda* Planted Forest

---

**Range:** This association is found throughout the southeastern United States from Delaware south.

**Environmental Description:** Stands contain plantations of *Pinus taeda* (loblolly pine) that are maintained for the extraction of forest products. The type occurs on a variety of soils.

### Vegetation Description:

This association represents young, monospecific planted stands of *Pinus taeda* (loblolly pine). Due to the commercial value of this species, this type is widely distributed across much of the southeastern United States from the Interior Highlands to the Coastal Plain, including areas outside the natural range of the species. In most cases these stands support almost no other tree species in the overstory.

Understory composition and density can vary widely

depending upon location, management history, and stand age. Excluded from this association are plantation stands which have "broken up" with age or thinning to approximate a more natural structure. Dense planting in rows, if successful, tends to result in nearly complete canopy closure which persists until the stand has either been regenerated or transitions into a different association. Herbaceous ground cover of any kind tends to be sparse due to reduction during site preparation, the typically dense canopy cover, and to the fact that many young plantations are infrequently burned at best.



Photo by Robert Coxe, Delaware Natural Heritage Program

**Dynamics/Successional Trajectory:** The core concept of stands attributable to this type are those which support dense, often perfect rows of planted *Pinus taeda* (loblolly pine) or otherwise dense, young stands which are established, managed, and/or maintained for the extraction of forest products (usually pulpwood). This association rarely exceeds 20-40 years of age on most timberlands.

**Management Concerns:** This community represents vegetation which has been planted in its current location by humans and/or is treated with intensive management or manipulation. Stands are typically established with mechanical planting, but may also be established through other means. It is not a conservation priority and does not receive a conservation rank

**Reference Sites:** No reference sites were identified because this is not a desired target community for restoration.

**Global Conservation Rank and Reasons:** GNA (ruderal) (29-Nov-2004). This vegetation is modified by human activity and not of conservation concern. An example occurs at Supawna Meadows NWR, NJ

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.754608](http://vegbank.org/natureserve/element_global.2.754608)

**References:** ALNHP 2002, Doyle and Allard 1990, Eyre 1980, Hoagland 1998a, Hoagland 2000, Jones et al. 1981b, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. Data, TNC 1998a

| MOST ABUNDANT SPECIES |                    |                                    |
|-----------------------|--------------------|------------------------------------|
| STRATUM               | LIFEFORM           | SPECIES                            |
| Tree canopy           | Needle-leaved tree | <i>Pinus taeda</i> (Loblolly pine) |

---

## NORWAY SPRUCE PLANTATION

*Picea abies* Planted Forest

---

**Range:** This association is found throughout the eastern United States.

**Environmental Description:** Stands contain plantations of *Picea abies* (Norway spruce) that are maintained for the extraction of forest products. The type occurs on a variety of soils.

**Vegetation Description:** These plantation forests are dominated by the exotic species *Picea abies* (Norway spruce), which makes up 70-100% of the canopy. The understory is typically sparse with little, if any, spruce regeneration. Hardwood regeneration and herbaceous species composition tend to reflect the pre-plantation forest types. In the Southeast this occurs as experimental plantations.

**Dynamics/Successional Trajectory:** The core concept of stands attributable to this type are those which support dense, often perfect rows of planted *Picea abies* (Norway spruce). Hardwood regeneration and herbaceous species composition tend to reflect the pre-plantation forest types

**Management Concerns:** This community represents vegetation which has been planted in its current location by humans and/or is treated with intensive management or manipulation.

**Reference Sites:** Supawna Meadows, NJ

**Global Conservation Rank and Reasons:** GNA (cultural) (8-Aug-2000). This community represents vegetation which has been planted in its current location by humans and/or is treated with annual tillage, a modified conservation tillage, or other intensive management or manipulation. It is not a conservation priority and does not receive a conservation rank.

**References:** Allard 1990, NRCS 2004, Southeastern Ecology Working Group n.d.

| MOST ABUNDANT SPECIES |                    |                                    |
|-----------------------|--------------------|------------------------------------|
| STRATUM               | LIFEFORM           | SPECIES                            |
| Tree canopy           | Needle-leaved tree | <i>Picea abies</i> (Norway spruce) |

---

## RED PINE PLANTATION

*Pinus resinosa* Planted Forest

---

**Range:** This association is found throughout the eastern United States.

**Environmental Description:** Plantations of *Pinus resinosa* (red pine) occur in various settings and soil types.

**Vegetation Description:** *Pinus resinosa* (red pine) makes up 80-100% of the canopy. In older stands, or in canopy gaps, native regeneration includes hardwoods such as *Acer rubrum* (red maple), *Acer saccharum* (sugar maple), and *Fagus grandifolia* (American beech), as well as the conifers *Pinus strobus* (eastern white pine), *Picea rubens* (red spruce), and/or *Tsuga canadensis* (eastern hemlock). *Acer pensylvanicum* (striped maple) may be present as a small tree. Shrubs and herbs are typically few.

**Management Concerns:** This community represents vegetation which has been planted in its current location by humans and/or is treated with intensive management or manipulation.

**Reference Sites:** Brandywine, DE

**Global Conservation Rank and Reasons:** GNA (cultural) (8-Aug-2000). This community represents vegetation which has been planted in its current location by humans and/or is treated with annual tillage, a modified conservation tillage, or other intensive management or manipulation. It is not a conservation priority and does not receive a conservation rank.

**References:** Allard 1990, Coxe 2007, Fleming and Coulling 2001, Fleming and Moorhead 1996, Southeastern Ecology Working Group n.d., TDNH unpubl. data

| MOST ABUNDANT SPECIES |                    |                                  |
|-----------------------|--------------------|----------------------------------|
| STRATUM               | LIFEFORM           | SPECIES                          |
| Tree canopy           | Needle-leaved tree | <i>Pinus resinosa</i> (red pine) |

---

## JAPANESE BLACK PINE FOREST

*Pinus thunbergiana* - (*Pinus nigra*) Forest

---

**Range:** These plantations occur on Cape Cod National Seashore and Boston Harbor Islands National Recreation Area, Massachusetts; Block Island, Rhode Island; Fire Island National Seashore and Gateway National Recreation Area, New York; and Cape May National Wildlife Refuge, New Jersey.

**Environmental Description:** This non-native black pine forest of the northeastern coastal region occurs on well-drained to xeric sandy soils, usually on sand dunes or near-coastal glacial tills.

**Vegetation Description:** These planted stands are of variable canopy height and closure and dominated by *Pinus thunbergiana* (Japanese black pine) or less commonly by *Pinus nigra* (Austrian pine). A frequent canopy associate is *Pinus rigida* (pitch pine). The shrub layer is not well-developed; however, it may contain *Prunus serotina* (black cherry) and *Morella pensylvanica* (northern bayberry). The herbaceous layer is of variable composition, sometimes containing *Panicum virgatum* (switch grass), *Solidago rugosa* (wrinkle-leaf goldenrod), *Hieracium canadense* (Canadian hawkweed), and other herbaceous associates. Vines, including *Toxicodendron radicans* (eastern poison ivy), *Parthenocissus quinquefolia* (Virginia creeper), *Celastrus orbiculatus* (Oriental bittersweet), *Smilax rotundifolia* (roundleaf greenbrier), and *Lonicera japonica* (Japanese honeysuckle), can be common in this community.

**Reference Sites:** Cape May NWR, NJ

**Global Conservation Rank and Reasons:** GNA (cultural) 10-Oct-2001(modified/managed). This planted non-native community is not a conservation priority and therefore does not receive a conservation rank.

**References:** Coxe 2007, Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d.\*, NRCS 2001b, Sneddon and Lundgren 2001, TNC unpubl. data 1995d

| MOST ABUNDANT SPECIES |                    |  |
|-----------------------|--------------------|--|
| STRATUM               | LIFEFORM           | SPECIES  |
| Tree canopy           | Needle-leaved tree | <i>Pinus thunbergiana</i><br>(Japanese black pine) |



---

## NORTHEASTERN SUCCESSIONAL SHRUBLAND

*Elaeagnus umbellata* - *Cornus racemosa* - *Rosa multiflora* - *Juniperus virginiana* Shrubland

---

**Range:** This community is common in former agricultural areas in the northeastern U.S.

**Environmental Description:** This association occurs on former agricultural lands and old fields that are no longer intensively mowed, plowed or managed. These sites contain moderately well-drained to well-drained soils. The shrublands are flat to gently sloping, often bounded by stonewalls or fencerows.

**Vegetation Description:** The structure of this association varies from open fields with scattered tall and short shrubs covering 25% of the field, with herbaceous vegetation in the interstices, to dense "closed-canopy" tall shrublands with sparse ground layer vegetation. Common shrubs include *Elaeagnus angustifolia* (Russian olive), *Cornus racemosa* (gray dogwood), *Viburnum prunifolium* (blackhaw), *Lonicera japonica* (Japanese honeysuckle), *Lonicera morrowii* (Morrow's honeysuckle), *Ligustrum vulgare* (European privet), *Euonymus alatus* (winged burning bush), *Rosa multiflora* (multiflora rose), *Rhus glabra* (smooth sumac), and *Rhus typhina* (staghorn sumac), with patches of herbaceous vegetation among the shrubs. Shorter shrubs include *Berberis thunbergii* (Japanese barberry) and *Rubus* spp. (blackberry), and in some fields *Gaylussacia baccata* (black huckleberry), *Vaccinium pallidum* (blue ridge blueberry), *Vaccinium stamineum* (*Vaccinium stamineum* (deerberry), and/or *Vaccinium angustifolium* (lowbush blueberry). Small trees are often present but form <25% cover; they include *Juniperus virginiana* (eastern redcedar), *Betula populifolia* (gray birch), *Prunus virginiana* (chokecherry), *Cornus florida* (flowering dogwood), *Acer rubrum* (red maple), *Juglans nigra* (black walnut), *Prunus serotina* (black cherry), *Robinia pseudoacacia* (black locust), and *Fraxinus americana* (white ash). The herbaceous layer is variable depending on the density of shrub cover. Typical species are those associated with old fields, grasslands, and agricultural sites. Common species include *Solidago rugosa* (wrinkleleaf goldenrod), *Solidago gigantea* (giant goldenrod), *Solidago nemoralis* (gray goldenrod), *Monarda fistulosa* (wild bergamot), *Anthoxanthum odoratum* (sweet vernalgrass), *Poa pratensis* (Kentucky bluegrass), *Oxalis stricta* (common yellow oxalis), *Viola sororia* (common blue violet), *Euthamia graminifolia* (flat-top goldentop), *Festuca rubra* (red fescue), *Schizachyrium scoparium* (little bluestem), *Pycnanthemum virginianum* (Virginia mountainmint), *Alliaria petiolata* (garlic mustard), *Galium mollugo* (false baby's breath), *Potentilla simplex* (common cinquefoil), *Achillea millefolium* (common yarrow), *Daucus carota* (Queen Anne's lace), *Trifolium repens* (white clover), *Bromus inermis* (smooth brome), *Agrostis gigantea* (redtop), and *Elymus repens* (= *Elytrigia repens*) (quackgrass), among many others. Vines can be absent or dominant, sometimes covering the tall and short shrubs. Common vines are *Vitis aestivalis* (summer grape), *Vitis labrusca* (fox grape), *Toxicodendron radicans* (eastern poison ivy), *Celastrus orbiculatus* (Asian bittersweet), *Parthenocissus quinquefolia* (Virginia creeper), and *Lonicera japonica* (Japanese honeysuckle).

**Characteristic Species:** *Rosa multiflora* (multiflora rose), *Lonicera japonica* (Japanese honeysuckle), *Rubus* spp. (blackberry)

**Dynamics/Successional Trajectory:** This association develops as woody species colonize open fields, typically from the outer edges of the field into the center or as scattered clumps throughout the field.

**Management Concerns:** This is a naturalized type that arises from human disturbance. Many exotic invasive plants are included in this community.

**Reference Sites:** Mispillion Watershed, DE; Cape May NWR and Supawna Meadows NWR NJ

**Global and State Conservation Ranks and Reasons:** GNA (ruderal)

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.685380](http://vegbank.org/natureserve/element_global.2.685380)

**References:** Eastern Ecology Working Group n.d., Keever 1979, Newbold et al. 1988, Overlease 1987

| MOST ABUNDANT SPECIES |                              |  |
|-----------------------|------------------------------|--|
| STRATUM               | LIFEFORM                     | SPECIES  |
| Tall shrub/sapling    | Broad-leaved deciduous shrub | <i>Rosa multiflora</i> (multiflora rose)                 |
| Tall shrub/sapling    | Broad-leaved deciduous shrub | <i>Elaeagnus umbellata</i> (autumn olive)                |
| Tall shrub/sapling    | Broad-leaved deciduous shrub | <i>Viburnum dentatum</i> (arrowwood)                     |
| Woody vine            | Vine/liana                   | <i>Lonicera japonica</i><br>(Japanese honeysuckle)       |
| Woody vine            | Vine/liana                   | <i>Celastrus orbiculatus</i> (Oriental<br>bittersweet)   |
| Woody vine            | Vine/liana                   | <i>Parthenocissus quinquefolia</i><br>(Virginia creeper) |
| Woody vine            | Vine/liana                   | <i>Toxicodendron radicans</i> (poison ivy)               |
| Herb                  | Forb                         | <i>Phytolacca americana</i><br>(American pokeweed)       |

---

### STEEPLEBUSH / REED CANARYGRASS SUCCESSIONAL WET MEADOW

*Spiraea tomentosa* - *Rubus* spp. / *Phalaris arundinacea* Shrubland

---

**Range:** Although this vegetation is widespread, its range has not been evaluated. It is known from the Central Appalachian ecoregion, the High Alleghany Plateau, Western Alleghany Plateau, North Atlantic Coast, and the Lower New England / Northern Piedmont ecoregions, and is likely in others.

**Environmental Description:** This wet meadow vegetation of the northeastern states occurs in a variety of settings, most frequently in low-lying areas of old fields or pastures, headwater basins, or beaver-impacted wetlands. These wetlands typically flood early in the growing season and may be saturated to near the surface for some of the growing season, but they are generally dry for much of the year. The substrate is typically mineral soil with a layer of muck at the surface.

**Vegetation Description:** The physiognomy is complex and variable, ranging from shrub thicket to herbaceous meadow with scattered shrubs. Within each wetland, species may be locally abundant and often have patchy distribution. Shrub species usually include *Spiraea tomentosa* (steplebush), *Spiraea alba* var. *alba* (white meadowsweet), *Cornus amomum* (silky dogwood), *Rubus allegheniensis* (Allegheny blackberry), *Rubus hispidus* (bristly dewberry), *Salix* spp. (willow), and others. The invasive exotic shrubs *Lonicera morrowii* (Japanese honeysuckle) and *Rosa multiflora* (multiflora rose) may be locally abundant. Associated herbaceous species are also variable in composition, depending on land-use history. Commonly seen are *Phalaris arundinacea* (reed canary grass), *Solidago rugosa* (wrinkle-leaf goldenrod), *Solidago gigantea* (giant goldenrod),

*Solidago canadensis* (Canada goldenrod), *Juncus effusus* (common rush), *Scirpus cyperinus* (wool grass), *Leersia oryzoides* (rice cutgrass), *Calamagrostis canadensis* (bluejoint), *Carex scoparia* (broom sedge), *Carex folliculata* (shallow sedge), *Carex lurida*, *Carex lupulina* (hop sedge), *Carex vulpinoidea* (fox sedge), *Carex trichocarpa* (hairyfruit sedge), *Vernonia noveboracensis* (New York ironweed), *Triadenum virginicum* (Virginia marsh St. Johnswort), *Lycopus uniflorus* (northern bugleweed), *Impatiens capensis* (jewelweed), *Eupatorium maculatum* (spotted joepeyeweed), *Polygonum sagittatum* (arrowleaf tearthumb), *Thelypteris palustris* (marsh fern), *Onoclea sensibilis* (sensitive fern), *Eleocharis* spp. (spikerush), and others. *Sphagnum* spp. (sphagnum moss) are often abundant along with lesser amounts of other nonvascular species. The invasive species *Microstegium vimineum* (Japanese stilt grass), *Lythrum salicaria* (purple loosestrife), and *Phragmites australis* (eastern reedgrass) can be abundant or form monocultures in these wetlands.

**Characteristic Species:** *Phalaris arundinacea* (reed canary grass), *Solidago rugosa* (wrinkle-leaf goldenrod), *Rubus* spp. (blackberry), *Spiraea tomentosa* (meadowsweet)

**Dynamics/Successional Trajectory:** This association develops as woody species colonize wet areas of open fields.

**Management Concerns:** This is a naturalized type that arises from human disturbance. Many exotic invasive plants are included in this community.

**Reference Sites:** Supawna Meadows NWR NJ

**Global and State Conservation Ranks and Reasons:** GNR (8-Jul-1999)

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.685380](http://vegbank.org/natureserve/element_global.2.685380)

**References:** Eastern Ecology Working Group n.d., Keever 1979, Newbold et al. 1988, Overlease 1987

| MOST ABUNDANT SPECIES |                              |  |
|-----------------------|------------------------------|--|
| STRATUM               | LIFEFORM                     | SPECIES  |
| Tall shrub/sapling    | Broad-leaved deciduous shrub | <i>Spiraea tomentosa</i> (steeplebush)             |
| Tall shrub/sapling    | Broad-leaved deciduous shrub | <i>Rubus allegheniensis</i> (Allegheny blackberry) |
| Herb                  | Forb                         | <i>Phalaris arundinacea</i> (reed canary grass)    |
| Herb                  | Forb                         | <i>Solidago rugosa</i> (wrinkle-leaf goldenrod)    |

---

## GOLDEN BAMBOO SHRUBLAND

*Phyllostachys aurea* Shrubland

---

**Range:** This vegetation is possible throughout the eastern United States.

**Environmental Description:** This association is found on disturbed lands, often near creeks and other mesic areas.

**Vegetation Description:** This shrubland is dominated by *Phyllostachys aurea* (golden bamboo).

**Characteristic Species:** *Phyllostachys aurea* (golden bamboo)

**Dynamics/Successional Trajectory:** This shrubland is usually a monoculture of *Phyllostachys aurea* (golden bamboo) with little light or resources reaching the understory.

**Management Concerns:** This is a naturalized non native invasive type that arises from human disturbance.

**Reference Sites:** Brandywine Watershed, DE

**Global and State Conservation Ranks and Reasons:** GNA (invasive) (3-Oct-2001); This shrubland represents vegetation dominated by an invasive exotic and thus does not receive a conservation status rank.

**References:** NatureServe Ecology - Southeastern U.S. unpubl. data, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data

| MOST ABUNDANT SPECIES |          |  |
|-----------------------|----------|--|
| STRATUM               | LIFEFORM | SPECIES                                    |
| Tree canopy           | Bamboo   | <i>Phyllostachys aurea</i> (golden bamboo) |
| Tall shrub/sapling    | Bamboo   | <i>Phyllostachys aurea</i> (golden bamboo) |

---

## WISTERIA VINELAND

*Wisteria sinensis* Vine-Shrubland

---

**Range:** This vegetation is known to occur in North Carolina, but most likely occurs throughout the southeastern and Mid Atlantic states of the US. It is reported in Delaware.

**Environmental Description:** This association occurs in a wide variety of habitats, but tends to occur in areas that were formerly second-growth pine or tuliptree woodlands. Since this species invades by overtopping trees, this community tends to occur in highly fragmented areas that are near old homesteads or other past human habitations where wisteria persists. This community is rare across the landscape at this point, but there is the potential for it to occupy more land as fragmentation continues to occur.

**Vegetation Description:** The vegetation is dominated by *Wisteria sinensis* (Chinese wisteria), an exotic vine native to Asia. Wisteria was introduced as an ornamental vine in the South in the 19th century. It is not nearly as invasive as *Pueraria* (kudzu), but in forests that have been disturbed by windstorm or other severe disturbances, it can colonize the canopy and spread to adjacent trees. In areas, where control has not taken place, this species can colonize more than 1 hectare. All existing vegetation is eventually choked out, leaving mounds of dying or dead trees overtopped by layers of *Wisteria sinensis* (Chinese wisteria).

**Characteristic Species:** *Wisteria sinensis* (Chinese wisteria)

**Dynamics/Successional Trajectory:** This shrubland is usually a monoculture of *Wisteria sinensis* (Chinese wisteria). It can colonize the canopy and spread to adjacent trees in forests that have been disturbed by windstorm or other severe disturbances

**Management Concerns:** In areas where control has not taken place, this species can colonize more than 1 hectare. All existing vegetation is eventually choked out, leaving mounds of dying or dead trees overtopped by layers of *Wisteria sinensis* (Chinese wisteria).

**Reference Sites:** in the DE portion of Delaware Estuary

**Global and State Conservation Ranks and Reasons:** GNA (invasive) (15-May-2002); This vegetation is dominated by an exotic species, is of anthropogenic origin, and is thus not a conservation priority.

**References:** Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data

| MOST ABUNDANT SPECIES |          |   |
|-----------------------|----------|---|
| STRATUM               | LIFEFORM | SPECIES                                     |
| Tree canopy           | Vine     | <i>Wisteria sinensis</i> (Chinese wisteria) |
| Tall shrub/sapling    | Vine     | <i>Wisteria sinensis</i> (Chinese wisteria) |

## NORTHEASTERN OLD FIELD

*Dactylis glomerata* - *Phleum pratense* - *Festuca* spp. - *Solidago* spp. Herbaceous Vegetation

**Range:** This vegetation is quite wide-ranging in northeastern and midwestern states and possibly occurs at higher elevations in the southeastern states.

**Environmental Description:** This association occurs on pastures and land that has been tilled. Generally the fields are mowed at least annually.

### Vegetation Description:

In addition to *Dactylis glomerata* (orchardgrass) and *Phleum pratense* (timothy grass), these grassy fields are characterized by graminoids including *Agrostis stolonifera* (creeping bentgrass), *Agrostis hyemalis* (winter bentgrass), *Elymus repens* (quackgrass), *Bromus inermis* (smooth brome), *Bromus tectorum* (cheatgrass), *Lolium perenne* (perennial ryegrass), *Poa pratensis*



Photo by Robert Coxe, Delaware Natural Heritage Program

(Kentucky bluegrass), *Poa compressa* (Canada bluegrass), *Schizachyrium scoparium* (little bluestem)(not in abundance), and *Anthoxanthum odoratum* (sweet vernal grass). Forbs scattered among the grasses are varied but include *Hieracium* spp. (hawkweed), *Oxalis stricta* (common yellow oxalis), *Achillea millefolium* (common yarrow), *Asclepias syriaca* (common milkweed), *Solidago rugosa* (wrinkleleaf goldenrod), *Solidago nemoralis* (gray goldenrod), *Solidago juncea* (early goldenrod), *Solidago canadensis* (Canada goldenrod), *Solidago altissima* (tall goldenrod), *Euthamia graminifolia* (flat-top goldentop), *Cerastium arvense* (field chickweed), *Oenothera biennis* (common evening-primrose), *Potentilla simplex* (common cinquefoil), *Symphyotrichum lateriflorum* (= *Aster lateriflorus*) (calico aster), *Symphyotrichum novae-angliae* (= *Aster novae-angliae*) (New England aster), *Symphyotrichum lanceolatum* (= *Aster simplex*) (white panicle aster), *Daucus*

*carota* (Queen Anne's lace), *Ambrosia artemisiifolia* (annual ragweed), *Vicia cracca* (bird vetch), *Trifolium* spp. (clover), and many others. Physiognomically, these grasslands are generally comprised of mid-height (1-3 feet tall) grasses and forbs, with occasional scattered shrubs. Species composition varies from site to site, depending on land-use history and perhaps soil type, but in general this vegetation is quite wide-ranging in northeastern and midwestern states.

**Characteristic Species:** *Dactylis glomerata* (orchard grass), *Phleum pretense* (Timothy grass)

**Dynamics/Successional Trajectory:** This broadly defined vegetation type includes pastures and post-agricultural fields and is largely composed of non-native cool-season grasses and herbs (generally of European origin) in the early stages of succession. This association occurs on old fields and pastures that have been tilled.

**Management Concerns:** This is a naturalized type that arises from human disturbance. Generally the fields are mowed at least annually. Many exotic invasive plants are included in this community.

**Reference Sites:** Mispillion Watershed, DE; Cape May NWR and Supawna Meadows NWR, NJ

**Global and State Conservation Ranks and Reasons:** GNA 8-Dec-2005(modified/managed). DE:SNA, NJ:SNA, PA:SNA. This vegetation type includes pasture and post-agricultural fields and is largely composed of non-native grasses and herbs (generally of European origin).

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.685380](http://vegbank.org/natureserve/element_global.2.685380)

References: Clark 1986, Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Ehrenfeld 1977, Elliman 2003, Keever 1979, Newbold et al. 1988, Perles et al. 2005a, Perles et al. 2005b, Perles et al. 2005c, Podniesinski et al. 2006, Sneddon et al. 1995, TDNH unpubl. data

| MOST ABUNDANT SPECIES |           |   |
|-----------------------|-----------|---|
| STRATUM               | LIFEFORM  | SPECIES                                   |
| Herb (field)          | Graminoid | <i>Dactylis glomerata</i> (orchard grass) |
| Herb (field)          | Graminoid | <i>Phleum pretense</i> (Timothy grass)    |
| Herb (field)          | Graminoid | <i>Agrostis</i> spp. (bentgrass)          |
| Herb (field)          | Graminoid | <i>Poa pratensis</i> (Kentucky bluegrass) |

---

## UPLAND SWITCHGRASS VEGETATION

*Panicum virgatum* - (*Andropogon virginicus*) Herbaceous Vegetation

---

**Range:** This herbaceous community is found from Connecticut to Virginia.

**Environmental Description:** This herbaceous community occurs on dry sandy soils in upland settings, particularly abandoned agricultural fields and along roadsides.

**Vegetation Description:** *Panicum virgatum* (switchgrass) is the dominant species, but *Andropogon virginicus* (broomsedge bluestem) may be codominant. Other species may include *Conyza canadensis* (Canadian horseweed), *Tridens flavus* (purpletop tridens), *Rhexia mariana* (Maryland meadowbeauty), *Juncus tenuis* (poverty rush), *Helenium autumnale* (common sneezeweed), *Ageratina altissima* (white snakeroot), *Sorghastrum nutans* (Indiangrass), and *Dichanthelium clandestinum* (deertongue). Scattered woody plants may occur such as *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), and *Pinus taeda* (loblolly pine) in the Mid-Atlantic

region. In examples of this community in Delaware, *Ludwigia alternifolia* (seedbox), *Scirpus cyperinus* (woolgrass), *Solidago rugosa* (wrinkleleaf goldenrod), *Hypericum mutilum* (dwarf St. Johnswort), *Rhynchospora capitellata* (brownish beaksedge), *Vernonia noveboracensis* (New York ironweed), and *Lespedeza repens* (creeping lespedeza) may also be present.

**Characteristic Species:** *Panicum virgatum* (switchgrass)

**Dynamics/Successional Trajectory:** This broadly defined vegetation type includes pastures and post-agricultural fields and is largely composed of native grasses. This association occurs on old fields and pastures that have been tilled and along roadsides.

**Management Concerns:** This is a naturalized type that arises from human disturbance. Generally the fields are mowed at least annually.

**Reference Sites:** Common along roadsides in DE.

**Global and State Conservation Ranks and Reasons:** GNA (ruderal) (9-Apr-2008). DE:SNA, NJ:SNA, PA:SNA. This vegetation type includes pasture, post-agricultural fields, and roadsides and is therefore not of conservation concern.

**References:** Coxe 2007, Eastern Ecology Working Group n.d.

| MOST ABUNDANT SPECIES |           |   |
|-----------------------|-----------|---|
| STRATUM               | LIFEFORM  | SPECIES   |
| Herb (field)          | Graminoid | <i>Panicum virgatum</i> (switch grass)                |
| Herb (field)          | Graminoid | <i>Andropogon virginicus</i><br>(broomsedge bluestem) |

---

## EASTERN REED MARSH

*Phragmites australis* Eastern North America Temperate Semi-natural Herbaceous Vegetation

---

**Range:** This reed marsh type is found across the east-temperate regions of the United States and Canada, ranging from Maine west to the eastern Dakotas and Manitoba, south to Texas and east to Florida. It occurs in all three states in the Delaware Estuary.

**Environmental Description:** Stands occur in semipermanently flooded marshes, ditches, impoundments, etc. that have often been disturbed by human activity.



Photo by Robert Coxe, Delaware Natural Heritage Program

**Vegetation Description:** The vegetation is often variable, as *Phragmites australis* (common reed) will often invade into existing natural or semi-natural communities present on the site. Once firmly established, this community is usually strongly dominated by *Phragmites australis* (common reed), with few or no other vascular plants present.

**Characteristic Species:** *Phragmites australis* (common reed)

**Dynamics/Successional Trajectory:** This community is strongly influenced by anthropogenic disturbances such as ditches and impoundments that freshen marshes and also dry them out. The biology of *Phragmites* (reed) also perpetuates the drying out of marshes because the plant has the ability to grow rapidly in one season and produce a considerable amount of biomass litter, which adds more organic matter to the marsh and thereby effectively creates higher and drier microsites that are favorable to the plant. *Phragmites* (reed) typically excludes the establishment of other species as it consumes available rooting space through dense underground rhizomes and also shades out understory species.

**Management Concerns:** This is a naturalized type that arises from human disturbance. *Phragmites australis* (common reed) is invasive globally, and the formation of these extensive monocultures are often considered fire hazards.

**Reference Sites:** Mispillion Watershed, DE, Bombay Hook NWR, DE; Supawna Meadows NWR, NJ

**Global and State Conservation Ranks and Reasons:** GNA (invasive) (23-Nov-1997). DE:SNA, NJ:SNA, PA:SNA. Although almost always occurring as a naturalized type that arises from human disturbance, some stands in northern Minnesota and further north in Canada may be native. If so, they should be tracked as a separate type.

**VegBank Link for Plot Data:** [http://vegbank.org/natureserve/element\\_global.2.685380](http://vegbank.org/natureserve/element_global.2.685380)

**References:** Bailey 1997, Bailey 1998, Bell et al. 2002, Clancy 1993b, Harris et al. 1996, INAI unpubl. data, Metzler and Barrett 1992, Metzler and Barrett 2001, Nelson 1986, Rawinski 1984, Schafale and Weakley 1990, Schotz pers. comm., Southeastern Ecology Working Group n.d., Swain and Kearsley 2001

| MOST ABUNDANT SPECIES |           |   |
|-----------------------|-----------|---|
| STRATUM               | LIFEFORM  | SPECIES                                   |
| Herb (field)          | Graminoid | <i>Phragmites australis</i> (common reed) |

---

## RIVER SEEDBOX MARSH

*Ludwigia leptocarpa* Semipermanently Flooded Herbaceous Vegetation

---

**Range:** This community has been reported on the coast of Delaware and in Maryland. The species is native to the southeastern United States, and the range maybe expanding into the Northeast, where it may be considered invasive.

**Environmental Description:**

This monotypic vegetation community occurs in wetlands including flats, impoundments, and marshes. In the Mid-Atlantic, this community can be invasive and can out compete and displace other native wetland plants.



**Vegetation Description:** *Ludwigia leptocarpa* (anglestem primrose-willow) makes up at least 80% of the vegetation cover and may approach 100%. The sparse associates include common wetland plants such as *Impatiens capensis* (jewelweed), *Onoclea sensibilis* (sensitive fern), *Thelypteris palustris* (eastern marsh fern), *Carex stricta* (upright sedge), and *Typha* (cattail) spp. Shrubs are sparse or absent.



Photo by Robert Coxe, Delaware Natural Heritage Program

**Characteristic Species:** *Ludwigia leptocarpa* (anglestem primrose-willow)

**Dynamics/Successional Trajectory:** This species can be an opportunistic invader of wetlands at least in Delaware where few or no species remain to indicate the former more native association analog. Otherwise, this species appears to not be invasive and in some cases (in Tennessee) has been listed as a rare plant.

**Management Concerns:** This is a naturalized type that has potential to invade wetlands in the Mid-Atlantic.

**Reference Sites:** Prime Hook National Wildlife Refuge, Delaware

**Global and State Conservation Ranks and Reasons:** G5 (12-11-2006). DE: SNA, This species is native to the southeastern United States. It has potential to invade wetlands in the Mid-Atlantic. A 100-acre monoculture has been reported in Prime Hook National Wildlife Refuge in Delaware and another example occurs in Wicomico County, Maryland.

**References:** Eastern Ecology Working Group n.d.

| MOST ABUNDANT SPECIES |           |  |
|-----------------------|-----------|--|
| STRATUM               | LIFEFORM  | SPECIES  |
| Herb (field)          | Graminoid | <i>Ludwigia leptocarpa</i> (Anglestem primrose-willow) |



## Appendix A. Updates to the *Guide to the Natural Communities of the Delaware Estuary*

In addition to the updated ecological descriptions and new vegetation communities presented in the *Addendum*, the following list of updates to the *Guide* is included for reference.

- The list of component associations for the **Northern Atlantic Coastal Plain Maritime Forest** ecological system has been updated since the *Guide* was published.
- The following ecological systems were deattributed from the Delaware Estuary:
  1. **Atlantic Coastal Plain Mesic and Mixed Hardwood Forest**
    - The northern limit of this ecological system's range is now south of the Delaware Estuary boundary. All vegetation communities previously listed under this ecological system are now moved to Northern Atlantic Coast Hardwood Forest.
  2. **Atlantic Coastal Plain Blackwater Stream Floodplain Forest and Atlantic Coastal Plain Brownwater Stream Floodplain Forest**
    - A newly described ecological system: North Atlantic Coastal Plain Stream and River Floodplain Forest covers these two former ecological systems in the Delaware Estuary. All vegetation communities previously listed under these floodplain forest ecological systems are now listed in the North Atlantic Coastal Plain Stream and River ecological system.
  3. **Southern and Central Appalachian Cove Forest**
    - The range of this ecological system extends to the west and south of the Delaware Estuary. The two natural communities listed for this system in the *Guide* do not occur within the Delaware Estuary boundary and are now deattributed.
- The following natural communities were deattributed from the Delaware Estuary:
  1. **Piedmont Cliff (Acidic Type)** natural community has been replaced by Eastern Temperate Acidic Cliff described in this addendum.
  2. **Basic Mesic Forest** natural community is no longer attributed to the Delaware Estuary because the range is south of the watershed. A similar association, Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest occurs in New Jersey, Delaware, and Pennsylvania within the watershed and is described in the *Guide* and this addendum.
  3. **Upper South Switchgrass Wet Prairie** is deattributed from the DE Estuary because the range of this community is south of the watershed. A similar, undescribed community occurs in New Jersey, but more data is required to classify it.
  4. **Central Appalachian Rich Cove Forest** is no longer attributed to the Delaware Estuary because the range is south and west of the watershed.
  5. **Calcareous Slope** is no longer attributed to the Delaware Estuary because the range is south and west of the watershed.



## GLOSSARY

**alluvial** characterized by the deposition of sediment by a stream or other running water at any point along its course.

**alpine** the zone on mountain tops between permanent snow and the cold limits of trees.

**annual** plant species that complete their life-cycle within a single growing season.

**annual vegetation** associations that persist for less than one year or are dominated by annual species.

**biennial** plant species that complete their life-cycles within two growing seasons.

**boreal** northern biogeographical region typically referring to subpolar and cold temperate areas.

**brackish** tidal water with a salinity of 0.5-30 parts per thousand.

**broad-leaved** describes a plant with leaves that have well-defined leaf blades and are relatively wide in outline (shape) as opposed to needle-like or linear; leaf area is typically greater than 500 square millimeters or 1 square inch.

**bryophyte** nonvascular, terrestrial green plant, including mosses, hornworts, and liverworts.

**bunch grass** multi-stemmed (caespitose) life form of grasses characterized by clumps of erect shoots that slowly spread horizontally by tillers, generally creating distinct individual plants spaced across the ground; often applied to sedges and other graminoids with similar life forms.

**caespitose (cespitose)** describes a low branching pattern from near the base that forms a multistemmed or a bunched appearance.

**cliff** any high, very steep to perpendicular, or overhanging face of a rock outcrop.

**cloud forest** tropical and subtropical montane forest characterized by a high incidence of low-level cloud cover, usually at the canopy level, promoting development of an abundance of vascular epiphytes.

**cold-deciduous** describes a plant that sheds its leaves as a strategy to avoid seasonal periods of low temperature, often initiated by photoperiod; applied to vegetation adapted to seasonal cold season influences (temperate).

**conical-crowned** describes a needle-leaved evergreen tree with a pyramidal or cone-shaped canopy or life form; for example, Douglas fir and silver fir (*Pseudotsuga menziesii* and *Abies amabilis*).

**creeping** describes the pattern of stems growing at or just beneath the surface of the ground and usually producing roots at nodes.

**crustose lichen** lichen life form that grows in intimate contact with its substrate, lacks a lower cortex and rhizoids (root-like structures), and is impossible to separate from the substrate without destroying the thallus; lichen with an unlobed, flattened thallus, growing adnate to the substrate.

**cushion plant** a low, woody, plant life form so densely branched that it forms a compact canopy that is pad- or bolster-like in appearance; usually with microphyllous foliage; characteristic of alpine and tundra plants.

**cylindrical-crowned** describes a needle-leaved evergreen tree with a narrow, essentially cylinder-shaped canopy or life form; for example, subalpine fir and black spruce (*Abies lasiocarpa* and *Picea mariana*).

**deciduous** describes a woody plant that seasonally loses all of its leaves and becomes temporarily bare-stemmed.

**deciduous vegetation** associations in which deciduous woody plants generally contribute 75% or more to total dominant plant cover.

**dominant** an organism, group of organisms, or taxon that by its size, abundance, or coverage exerts considerable influence upon an association's biotic (such as structure and function) and abiotic (such as shade and relative humidity) conditions.

**drought-deciduous** describes a plant that sheds its leaves as a strategy to avoid seasonal periods of high transpiration demand; applied to vegetation adapted to climates with seasonal drought and little cold-season influence (tropical-subtropical).

**dwarf-shrub** low-growing shrub life form usually under 0.5 meter or 1.5 feet tall (never exceeding 1 meter or 3 feet tall) at maturity.

**dwarf-shrubland** vegetation dominated by low-growing shrubs, usually under 0.5 m or 1.5 feet tall; dwarf-shrubs generally form greater than 25% cover, and trees and taller shrubs generally form less than 25% cover. Dwarf-shrub cover may be less than 25% where it exceeds tree, shrub, herb, and nonvascular cover.

**ECS** abbreviation for NatureServe's eastern region (formerly "Eastern Conservation Science").

**ephemeral forb vegetation** annual associations or synusiae that, during favorable periods, dominate areas that are usually sparsely vegetated or unvegetated for most of the year.

**epiphyte** vascular plant that grows by germinating and rooting on other plants or other perched structures; sometimes called "air plants."

**episodic forb vegetation** herbaceous-dominated associations that occupy areas periodically denuded of vegetation.

**ericoid** plants of the Heath Family or Family Ericaceae; for example, heaths, rhododendrons, and blueberries (*Erica*, *Rhododendron*, and *Vaccinium*).

**evergreen** describes a plant that has green leaves all year round; or a plant that in xeric habitats has green stems or trunks and never produces leaves.

**evergreen vegetation** associations in which evergreen woody plants generally contribute 75% or more to total dominant plant cover; vegetation canopy is never without photosynthetic tissue.

**extremely xeromorphic** associations that are adapted primarily to growing in drought-persistent environments and are only secondarily adapted to other environmental stresses; plants typically have several well-developed xeromorphic characteristics.

**facultatively deciduous** describes evergreen species that shed leaves only under extreme conditions; this strategy is often associated with plants found in semiarid saline/alkaline environments; for example, *Atriplex-Kochia* saltbush in Australia and North America.

**foliose lichen** lichen life form that is leafy in appearance and loosely attached to its substrate; lichen with a lobed, flattened thallus growing loosely attached to the substrate, the lobes flattened or inflated with distinctly differentiated upper and lower surfaces; umbilicate lichens are included.

**forb** a broad-leaved herbaceous plant.

**forest** vegetation dominated by trees with their crowns overlapping, generally forming 60 - 100% cover; includes reproductive stages or immature secondary growth stands that are temporarily less than 5 meters or 16.5 feet tall.

**fresh water** water with a salinity of less than 0.5 parts per thousand.

**fruticose lichen** lichen life form that is bunched, shrubby or "hairy" in appearance and loosely attached to its substrate; lichen with the thallus branched, the branches solid, or hollow and round, or flattened without distinctly differentiated upper and lower surfaces; squamulose lichens are included.

**GC** 1. an abbreviation for "global classification" indicating a standard type accepted into the ICEC (compare with "OC"). 2. a global rank indicating that the type is planted or cultivated (see [global rank](#)).

**giant** describes mature forests in which the height of a typical canopy exceeds 50 meters or 165 feet.

**global rank (G Rank)** conservation status rank for natural/near-natural communities:

- GX** **ELIMINATED** throughout its range, with no restoration potential due to extinction of dominant or characteristic species.
- GH** **PRESUMED ELIMINATED (HISTORIC)** throughout its range, with no or virtually no likelihood that it will be rediscovered, but with the potential for restoration (e.g., *Castanea dentata* Forest).
- G1** **CRITICALLY IMPERILED** Generally 5 or fewer occurrences and/or very few remaining acres or very vulnerable to elimination throughout its range due to other factor(s).
- G2** **IMPERILED** Generally 6-20 occurrences and/or few remaining acres or very vulnerable to elimination throughout its range due to other factor(s).
- G3** **VULNERABLE** Generally 21-100 occurrences. Either very rare and local throughout its range or found locally, even abundantly, within a restricted range or vulnerable to elimination throughout its range due to specific factors.
- G4** **APPARENTLY SECURE** Uncommon, but not rare (although it may be quite rare in parts of its range, especially at the periphery). Apparently not vulnerable in most of its range.
- G5** **SECURE** Common, widespread, and abundant (though it may be quite rare in parts of its range, especially at the periphery). Not vulnerable in most of its range.
- GU** **UNRANKABLE** Status cannot be determined at this time.
- G?** **UNRANKED** Status has not yet been assessed.

#### **Modifiers and Rank Ranges**

- ?** A question mark added to a rank expresses an uncertainty about the rank in the range of 1 either way on the 1-5 scale. For example a G2? rank indicates that the rank is thought to be a G2, but could be a G1 or a G3.
- G#G#** Greater uncertainty about a rank is expressed by indicating the full range of ranks which may be appropriate. For example, a G1G3 rank indicates the rank could be a G1, G2, or a G3.
- Q** A "Q" added to a rank denotes questionable taxonomy. It modifies the degree of imperilment and is *only* used in cases where the type would have a *less imperiled* rank if it were not recognized as a valid type (i.e., if it were combined with a more common type). A GUQ rank often indicates that the type is unrankable *because of* daunting taxonomic/definitional questions.

#### **Ranks indicating semi-natural/altered communities:**

- GD** **RUDERAL** Vegetation resulting from succession following anthropogenic disturbance of an area. Generally characterized by unnatural combinations of species (primarily native species, though often containing slight to substantial numbers and amounts of species alien to the region as well).
- GM** **MODIFIED/MANAGED** Vegetation resulting from the management or modification of natural/near natural vegetation, but producing a structural and floristic combination not clearly known to have a natural analogue.
- GW** **INVASIVE** Vegetation dominated by invasive alien species; the vegetation is spontaneous, self-perpetuating, and is not the (immediate) result of planting, cultivation, or human maintenance.

#### **Rank indicating planted/cultivated communities**

- GC** **PLANTED/CULTIVATED** Areas dominated by vegetation that has been planted in its current location by humans and/or is treated with annual tillage, a modified conservation tillage, or other intensive management or manipulation.

**graminoid** grasses and grass-like plants, including sedges and rushes.

**G Rank** see [global rank](#).

**grassland** vegetation dominated by perennial graminoid plants.

**growth form** the shape or appearance of a plant; primarily a reflection of the influence of growing conditions.

**hemi-sclerophyllous** describes a plant with stiff, firm, leathery leaves that partially retain their rigidity during wilting; for example, rhododendron and salal (*Rhododendron* and *Gaultheria*).

**herb** a vascular plant without significant woody tissue above or at the ground; an annual, biennial, or perennial plant lacking significant thickening by secondary woody growth, with perennating buds borne at or below the ground surface (hemicryophytes, geophytes, helophytes, and therophytes of Raunkier).

**herbaceous vegetation** vegetation in which herbs (graminoids, forbs, and ferns) are dominant; herbs generally form at least 25% cover while trees, shrubs, and dwarf-shrubs generally form less than 25% cover. Herb cover may be less than 25% where it exceeds tree, shrub, dwarf-shrub, and nonvascular cover.

**hygromorphous herbs** herbaceous plants structurally adapted for life in water-dominated or aquatic habitats.

**intermittently flooded** substrate is usually exposed, but surface water can be present for variable periods without detectable seasonal periodicity. Inundation is not predictable to a given season and is dependent upon highly localized rain storms. This modifier was developed for use in the arid West for water regimes of Playa lakes, intermittent streams, and dry washes but can be used in other parts of the U.S. where appropriate. This modifier can be applied to both wetland and non-wetland situations. *Equivalent to Cowardin's Intermittently Flooded modifier.*

**irregularly exposed** land surface is exposed by tides less often than daily; the area from mean low tide to extreme low spring tide. *Equivalent to Cowardin's Irregularly Exposed modifier.*

**irregularly flooded** tidal water floods land surface less often than daily. The area must be flooded by tides at least once yearly as a result of extreme high spring tide plus wind plus flow. The area extends from mean high water inland to the maximum extent of tide plus the splash zone. *Equivalent to Cowardin's Irregularly Flooded modifier, except in tidal Riverine, Lacustrine, and Palustrine areas where if an area is only irregularly flooded by fresh tidal waters, the appropriate non-tidal modifier, e.g., Temporarily Flooded, Seasonally Flooded, Semipermanently Flooded, applies.*

**krummholz** growth form assumed by tree species at the upper treeline or in the alpine zone; characterized by a creeping and multi-stemmed growth pattern due to desiccation and physical damage caused by wind and blowing ice crystals near the upper treeline; the same species grows as an erect, single-stemmed tree at lower elevation.

**LACD** abbreviation for NatureServe's Latin American and Caribbean region.

**lichen** an organism generally recognized as a single plant that consists of a fungus and an alga or cyanobacterium living in symbiotic association.

**lignified** describes a plant with woody tissue developed by secondary cell wall thickening by lignin and cellulose.

**life form** the shape or appearance of a plant that mostly reflects inherited or genetic influences.

**low forb** a broad-leaved herbaceous plant usually less than 1 meter or 3 feet tall when inflorescences are fully developed.

**lowland** a large land area with vegetation reflecting limits set by regional climate and soil/site conditions; an area where elevation is not the primary gradient affecting vegetation zonation.

**matted** describes a creeping plant that by reiterative growth has overlapping stems and forms a low, dense ground cover.

**MCS** abbreviation for NatureServe's midwestern region (formerly "Midwest Conservation Science").



**medium-tall grassland** graminoid-dominated vegetation usually between 0.5 to 1 meter or 1.5 to 3 feet tall when inflorescences are fully developed in temperate zones and to 2 meters or 6 feet in tropical zones.

**microphyllous** describes a plant with small leaves; individual leaf surface areas are less than 500 square millimeters or one square inch.

**mixed evergreen-deciduous** describes vegetation in which evergreen and deciduous species each generally contribute 25-75% to the total canopy cover.

**montane** describes the zone in mountainous regions where the influence of altitude (vertical relief) results in local climatic regimes that are sufficiently different from those in the adjacent lowlands as to cause a complex vertical climate-vegetation-soil zonation; includes vegetation at the base of a mountain when it is different from lowland vegetation.

**natural/semi-natural** describes vegetation that has not been planted or treated with an annual management or manipulation regime.

**needle-leaved** describes a plant with slender, elongated leaves; for example, pine and fir trees (*Pinus* and *Abies*).

**nonvascular plant** a plant without specialized water or fluid conductive tissue (xylem and phloem); includes bryophytes, non-crustose lichens, and algae.

**nonvascular vegetation** vegetation that is dominated by nonvascular plants (bryophytes, non-crustose lichens, and algae), generally forming at least 25% cover, with other vegetation forming less than 25 percent cover. Nonvascular cover may be less than 25% where it exceeds tree, shrub, dwarf-shrub, and herb cover.

**OC** an abbreviation for "other classification" indicating a type that is not part of the ICEC, but is a state or local type, a non-terrestrial type, or any other type not accepted into the ICEC.

**pavement** a relatively flat surface of consolidated material, generally exposed bedrock.

**perennial** plant species with a life-cycle that characteristically lasts more than two growing seasons and persists for several years.

**perennial herbaceous vegetation** associations that persist for several years and are dominated by herbaceous species.

**permanently flooded** water covers the land surface at all times of the year in all years. Equivalent to Cowardin's "permanently flooded".

**permanently flooded-tidal** salt water covers the land surface at all times of the year in all years. This modifier applies only to permanently flooded areas irregularly flooded by fresh tidal water. Equivalent to Cowardin's "permanently flooded/tidal".

**planted/cultivated** describes vegetation planted by humans and/or treated with annual management; usually dominated by plants not indigenous to the area.

**polar** geographically, the areas within the Arctic and Antarctic circles in which the sun is entirely not visible for six months and is constantly above the horizon for the next six months; climatically, polar regions are characterized by the lack of a period of warmth and by enduring cold; in polar climates the average temperature of each month is below 10° C (50° F).

**pulvinate mosses** mosses growing in cushion-like mats or clumps.

**rainforest** vegetation in frost-free areas dominated by trees that are always wet from rain.

**regularly flooded** tidal water alternately floods and exposes the land surface daily, from mean low (lower low on West Coast) to mean high (higher high on West Coast). *Equivalent to Cowardin's Regularly Flooded modifier.*

**revolute** rolled toward the lower surface of a leaf.

**rosulate** a plant with leaves arranged in rosettes (circular clusters).

**rounded-crowned** describes a needle-leaved evergreen tree with a basically semi-circular canopy or life form; for example, whitebark pine and alligator juniper (*Pinus albicaulis* and *Juniperus deppeana*).

**saltwater** water with a salinity of greater than 30 parts per thousand.

**saturated** surface water is seldom present, but substrate is saturated to surface for extended periods during the growing season. *Equivalent to Cowardin's Saturated modifier.*

**scale-leaved** describes a plant with small, overlapping leaves that usually lie flat on the stem; for example, eastern redcedar and western redcedar (*Juniperus virginiana* and *Thuja plicata*).

**sclerophyllous** describes a plant with usually evergreen leaves that are stiff and firm and retain their stiffness even when wilted; they are common in, but not restricted to, regions with a long summer drought and predictable yet limited winter rain.

**scree** a sheet of coarse rock debris covering a mountain slope without an adjacent cliff.

**scrub** vegetation dominated by shrubs, including thickets. See [shrubland](#).

**SCS** abbreviation for NatureServe's southeastern region (formerly "Southeast Conservation Science).

**seasonal** showing periodicity related to the seasons; applied to vegetation exhibiting pronounced seasonal periodicity marked by conspicuous physiognomic changes.

**seasonal evergreen vegetation** associations in which most of the upper canopy plants retain leaves year-round and drop some leaves during unfavorable seasons.

**seasonally flooded** surface water is present for extended periods during the growing season, but is absent by the end of the growing season in most years. The water table after flooding ceases is very variable, extending from saturated to a water table well below the ground surface. *Includes Cowardin's Seasonal, Seasonal-Saturated, and Seasonal-Well Drained modifiers.*

**semi-arid** a climatic region having an annual precipitation, usually between 25.4 and 50.8 centimeters or 10 and 20 inches, that is higher than a truly arid climate; typically, vegetation is composed of grasses with or without woody plant layers.

**semi-deciduous vegetation** associations (usually tropical and subtropical) in which most of the upper canopy trees are drought-deciduous and many of the understory trees and shrubs are evergreen. The evergreen and deciduous woody plants are not always separated by layers.

**semi-evergreen vegetation** associations in which evergreen and deciduous species each generally contribute 25-75% of total tree cover; specifically, this term refers to tropical and subtropical vegetation in which most of the upper canopy trees are evergreen mixed with drought-deciduous trees.

**semipermanently flooded** surface water persists throughout growing season in most years except during periods of drought. Land surface is normally saturated when water level drops below soil surface. *Includes Cowardin's Intermittently Exposed and Semipermanently Flooded modifiers.*

**short grassland** graminoid-dominated vegetation usually less than 0.5 meters or 1.5 feet tall when inflorescences are fully developed.

**shrub** a perennial woody species with a life form that is usually less than 4 to 5 meters or 13 to 16 feet in height; typically, plants have several stems arising from or near the ground, but this term includes short tuft-tree, bamboo, and woody vine species; length of vine may exceed 5 meters; shrub species growth form may be taller than 5 meters or single-stemmed under certain environmental conditions.

**shrubland** vegetation dominated by shrubs, generally greater than 0.5 meter or 1.5 feet tall and less than 5 meters or 16 feet tall, and generally forming greater than 25% cover; trees generally form less than 25% cover. Shrub cover may be less than 25% where it exceeds tree, dwarf-shrub, herb, and nonvascular cover. Includes vegetation dominated by woody vines; does not include developing secondary associations dominated by tree species.

**sod grass** a life form of graminoids that tends to develop a solid mat of grass, sedge, etc. over the ground by vegetative increase of rhizomes or stolons; resulting vegetation generally has few spaces between plants.

**sparse vegetation/sparsely vegetated** describes vegetation with low total plant cover. Abiotic substrate features are dominant; vegetation is scattered to nearly absent and generally restricted to areas of concentrated resources. Total vegetation cover is typically less than 25% and greater than 0%. Areas with high cover of crustose lichen and no other vegetation are included here.

**stomata** pores or openings for gas exchange that are generally concentrated on leaf surfaces.

**subalpine** upper mountain vegetation immediately below the cold limits of tree and tall shrub growth.

**subdesert** an area of xerophytic shrubby vegetation with a poorly-developed herbaceous layer.

**submontane** an area where the influence of altitude (vertical relief) does not result in local climate regimes that are sufficiently different from the adjacent lowlands as to cause a complex vegetation-climate-soil zonation; generally includes the foothills of a mountain range; the lowland vegetation at the base of a mountain that displays vegetation zonation.

**subpolar** geographically, the region immediately equatorward of the Arctic and Antarctic circles; climatically, winters are long and extremely cold, and summers are very short; only one month per year has a monthly average warmer than 10° C (50° F); as a rule, the ground is completely covered by snow for at least half a year; the region between the tundra and cold temperate forests or steppes.

**subtropical** pertains to areas within tropical regions with variable (seasonal) temperature and moisture regimes; climatically, it has seasonal variation marked by dry/wet seasons rather than cold/hot seasons; parts of this region are subject to sub-0° C (32° F) temperatures but rarely have freezing periods of 24 hours or longer; in the United States this term includes southern Florida and the southern tip of Texas.

**succulent** a plant with fleshy stems or leaves with specialized tissue for the conservation of water; a xeromorphic strategy for tolerating long periods of drought.

**suffruticose** a somewhat shrubby plant in which the upper vegetative and flowering shoots die back to leave only the lower parts to survive unfavorable seasons.

**synusia** an association of plant species with a similar life form and similar ecological requirements occurring together in the same habitat; sometimes called a "union"; most habitats are occupied by several synusiae, which may grow above each other in layers, beside each other, or in mixture; for example, an open tree synusia or layer over a grass-dominated synusia or layer.

**tall grassland** graminoid-dominated vegetation usually over 1 meter or 3 feet tall when inflorescences are fully developed in temperate zones and greater than 2 meters or 6 feet in tropical zones.

**tall forb** broad-leaved herbaceous plants usually greater than 1 meter or 3 feet tall when inflorescences are fully developed.

**talus** a sloping accumulation of coarse rock fragments at the base of a cliff.

**temperate** geographically, the region between the polar and tropical regions; climatically, the region is moderate with distinct seasons of alternating long, warm summers and short, cold winters.

**temporarily flooded** surface water present for brief periods during growing season, but water table usually lies well below soil surface. Often characterizes flood-plain wetlands. Equivalent to Cowardin's Temporary modifier.

**tidally flooded** flooded by the alternate rise and fall of the surface of oceans, seas, and the bays, rivers, etc. connected to them, caused by the attraction of the moon and sun [or by the back-up of water caused by unfavorable winds].

**tree** perennial, woody species life form with a single stem (trunk), normally greater than 4 to 5 meters or 13 to 16 feet in height; under certain environmental conditions, some tree species may develop a multi-stemmed or short growth form (less than 4 meters or 13 feet in height).

**treeline** a zone where the normal growth of trees is limited; cold temperatures often combined with drought form the upper or arctic treeline, and drought combined with hot temperatures form lower or arid treeline.

**tropical** geographically, the area between the Tropic of Cancer (23 27' N) and the Tropic of Capricorn (23 27' S), which includes tropical montane and alpine zones; climatically, the tropics are described as either the equatorial limits of freeze or, in temperate marine locations without freezing, the 65° F isotherm for the coldest month of the year; generally, tropical regions are characterized by high mean temperatures, small annual variation in temperature, and abundant rainfall throughout the year, although mountainous areas within the tropics are more variable.

**tuft-tree** woody plant with large leaf-fronds or rosulate branches at the tips of major trunk(s); for example, palms and tree ferns.

**tundra** the treeless region north of the Arctic Circle (arctic tundra) or above the treeline of high mountains (alpine tundra) and on some sub-Antarctic islands; characterized by very low winter temperatures, short cool summers, permafrost below a surface layer subject to summer melt, short growing season, and low precipitation.

**tussock** graminoid life form consisting of bunch-like tufts, sometimes more than 1 meter or 3 feet tall, in which the hard, old, withered leaves are intermingled with the fresh, young, green leaves.

**vascular plant** a plant with water and fluid conductive tissue (xylem and phloem); includes seed plants, ferns, and fern allies.

**WCS** abbreviation for NatureServe's western region (formerly "Western Conservation Science").

**winter-rain** a climatic regime characterized by precipitation that occurs mostly as rain during cool winters that alternate with dry, hot summers; often associated with sclerophyllous vegetation.

**woodland** vegetation dominated by open stands of trees with crowns not usually touching (generally forming 25-60% cover); canopy tree cover may be less than 25% in cases where it exceeds shrub, dwarf-shrub, herb, and nonvascular cover, respectively.

**woody** containing lignified plant tissue.

**woody plant** plant species life form with woody tissue and buds on that woody tissue near or at the ground surface or above; plants with limited to extensive thickening by secondary woody growth and with perennating buds; includes phanerophytes and chamaephytes of Raunkier.

**xeromorphic** describes plants with morphological and physiological characters that tolerate persistently low water availability, such as succulence, specialized leaf surfaces for light reflectance or water retention, opportunistic leaf growth, leaf-size reduction with increased thickness and sunken stomata, revolute margins, or stem and leaf modification to form thorns or spines.

## BIBLIOGRAPHY

- Allard, D. J. 1990. Southeastern United States ecological community classification. Interim report, Version 1.2. The Nature Conservancy, Southeast Regional Office, Chapel Hill, NC. 96 pp.
- ALNHP [Alabama Natural Heritage Program]. 2002. Eufaula National Wildlife Refuge: Natural community and rare plant survey. Alabama Natural Heritage Program, The Nature Conservancy, Montgomery.
- Ambrose, J. 1990a. Georgia's natural communities--A preliminary list. Unpublished document. Georgia Natural Heritage Inventory. 5 pp.
- Anderson, D. M. 1996. The vegetation of Ohio: Two centuries of change. Draft. Ohio Biological Survey.
- Andreu, M. G., and M. L. Tukman. 1995. Forest communities of the Tellico Lake Area, East Tennessee. M.F. project report, Duke University, School of the Environment. Durham, NC. 66 pp. plus appendices.
- Aulbach-Smith, C. Personal communication. Botanical Services of SC.
- Bailey, R. 1997. Map: Ecoregions of North America (rev.). Washington, DC: USDA Forest Service in cooperation with The Nature Conservancy and the U.S. Geological Survey. 1:15,000,000.
- Bailey, R. G. 1998. Ecoregion map of North America: Explanatory note. Miscellaneous Publication Number 1548, USDA Forest Service. 10 pp.
- Barry, J. F. 1980. Natural vegetation of South Carolina. University of South Carolina Press, Columbia. 214 pp.
- Bartgis, R. 1986. Natural community descriptions. Unpublished draft. Maryland Natural Heritage Program, Maryland Department of Natural Resources, Annapolis.
- Bell, R., M. Chandler, R. Buchsbaum, and C. Roman. 2002. Inventory of intertidal habitats: Boston Harbor Islands, a National Park area. Technical Report NPS/NERBOST/NRTR-2004/1. USDI National Park Service, Northeast Region, Boston, MA. 13 pp.
- Berdine, M. A. 1998. Maryland vegetation classification. Maryland Department of Natural Resources, Annapolis, MD.
- Boule, M. E. 1979. The vegetation of Fisherman Island, Virginia. *Castanea* 44:98-108.
- Bowman, P. 2000. Draft classification for Delaware. Unpublished draft. Delaware Natural Heritage Program.
- Bratton, S. P., and K. Davison. 1987. Disturbance and succession in Buxton Woods, Cape Hatteras, North Carolina. *Castanea* 52:166-179.
- Breden, T. F. 1989. A preliminary natural community classification for New Jersey. Pages 157-191 in: E. F. Karlin, editor. *New Jersey's rare and endangered plants and animals*. Institute for Environmental Studies, Ramapo College, Mahwah, NJ. 280 pp.
- Breden, T. F., Y. R. Alger, K. S. Walz, and A. G. Windisch. 2001. Classification of vegetation communities of New Jersey: Second iteration. Association for Biodiversity Information and New Jersey Natural Heritage Program, Office of Natural Lands Management, Division of Parks and Forestry, New Jersey Department of Environmental Protection, Trenton.

- Brush, G. S., C. Lenk, and J. Smith. 1980. The natural forests of Maryland: An explanation of the vegetation map of Maryland. *Ecological Monographs* 50:77-92.
- Byers, E. A., J. P. Vanderhorst, and B. P. Streets. 2007. Classification and conservation assessment of high elevation wetland communities in the Allegheny Mountains of West Virginia. West Virginia Natural Heritage Program, West Virginia Division of Natural Resources, Elkins.
- CAP [Central Appalachian Forest Working Group]. 1998. Central Appalachian Working group discussions. The Nature Conservancy, Boston, MA.
- Chapman, K. A., D. A. Albert, and G. A. Reese. 1989. Draft descriptions of Michigan's natural community types. Michigan Department of Natural Resources, Lansing, MI. 35 pp.
- Clampitt, C. A. 1991. The upland plant communities of Seashore State Park, Virginia Beach, Virginia. *Virginia Journal of Science* 42:419-435.
- Clancy, K. 1993a. Selected rare and historical vascular plants of Delaware. *Bartonia* 57:75-92.
- Clancy, K. 1993b. A preliminary classification of the natural communities of Delaware. Unpublished draft, Delaware Natural Heritage Inventory, Division of Parks and Recreation, Dover. 30 pp.
- Clancy, K. 1996. Natural communities of Delaware. Unpublished review draft. Delaware Natural Heritage Program, Division of Fish and Wildlife, Delaware Division of Natural Resources and Environmental Control, Smyrna, DE. 52 pp.
- Clark, J. S. 1986. Vegetation and land-use history of the William Floyd Estate, Fire Island National Seashore, Long Island, New York. USDI, National Park Service, North Atlantic Region, Office of Scientific Studies. 126 pp.
- Collins, B. R., and K. H. Anderson. 1994. Plant communities of New Jersey. Rutgers University Press, New Brunswick, NJ. 287 pp.
- Comer, P., D. Faber-Langendoen, R. Evans, S. Gawler, C. Josse, G. Kittel, S. Menard, M. Pyne, M. Reid, K. Schulz, K. Snow, and J. Teague. 2003. Ecological systems of the United States: A working classification of U.S. terrestrial systems. NatureServe, Arlington, VA.
- Coulling, P. P. 2002. A preliminary classification of tidal marsh, shrub swamp, and hardwood swamp vegetation and assorted non-tidal, chiefly non-maritime, herbaceous wetland communities of the Virginia Coastal Plain. October 2002. Virginia Department of Conservation and Recreation, Division of Natural Heritage. Natural Heritage Technical Report 02-18. 30 pp.
- Coulling, P. P. 2007. Unpublished data. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond.
- Coulling, Phil. Personal communication. Vegetation Ecologist. Department of Conservation & Recreation, 217 Governor St., Richmond, VA 23219.
- Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service, Biological Service Program. FWS/OBS-79/31. Washington, DC. 103 pp.
- Coxe, R. 2007. Guide to Delaware vegetation communities. Unpublished document. Delaware Natural Heritage Program, Smyrna.

- Daiber, F. C., L. L. Thornton, K. A. Bolster, T. G. Campbell, O. W. Crichton, G. L. Esposito, D. R. Jones, and J. M. Tyrawski. 1976. An atlas of Delaware's wetlands and estuarine resources. College of Marine Studies, University of Delaware, Newark. 528 pp.
- Denny, C. S., and J. P. Owens. 1979. Sand dune on the Delmarva Peninsula, Maryland and Delaware. U.S. Geological Survey, Professional Paper 1067-C.
- Dowhan, J. J., and R. Rozsa. 1989. Flora of Fire Island, Suffolk County, New York. Bulletin of the Torrey Botanical Club 116:265-282.
- Doyle, K. M., and D. J. Allard. 1990. Applying an ecosystem classification on national forest land in the southeastern United States: A pilot study. 108 pp. plus appendices.
- Eastern Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe, Boston, MA.
- Edinger, G. J., D. J. Evans, S. Gebauer, T. G. Howard, D. M. Hunt, and A. M. Olivero, editors. 2002. Ecological communities of New York state. Second edition. A revised and expanded edition of Carol Reschke's ecological communities of New York state. (Draft for review). New York Natural Heritage Program, New York State Department of Environmental Conservation, Albany, NY.
- Ehrenfeld, J. G. 1977. Vegetation of Morristown National Historical Park: Ecological analysis and management alternatives. Final Report. USDI National Park Service Contract No. 1600-7-0004. 166 pp.
- Ehrenfeld, J. G., and M. Gulick. 1981. Structure and dynamics of hardwood swamps in the New Jersey Pine Barrens: Contrasting patterns in trees and shrubs. American Journal of Botany 68:471-481.
- Elliman, T. 2003. Boston Harbor Islands plant communities. Report submitted to Massachusetts Natural Heritage & Endangered Species Program, Massachusetts Division of Fisheries & Wildlife, Westborough.
- Enser, R. 1993. Natural community classification for Rhode Island (draft). Rhode Island Natural Heritage Program. Providence, RI.
- Enser, R. 1999. Natural communities of Rhode Island. Unpublished draft, December 1999. 22 pp.
- Eyre, F. H., editor. 1980. Forest cover types of the United States and Canada. Society of American Foresters, Washington, DC. 148 pp.
- Felix, A. C., III, T. L. Sharik, B. S. McGinnes, and W. C. Johnson. 1983. Succession in loblolly pine plantations converted from second growth forest in the central Piedmont of Virginia. The American Midland Naturalist 110:365-380.
- Fike, J. 1999. Terrestrial and palustrine plant communities of Pennsylvania. Pennsylvania Natural Diversity Inventory. Pennsylvania Department of Conservation and Recreation. Bureau of Forestry. Harrisburg, PA. 86 pp.
- Fleming, G. P. 1998. Virginia natural community framework, version January 30, 1998. Unpublished document. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond. 6 pp.

- Fleming, G. P. 1999. Plant communities of limestone, dolomite, and other calcareous substrates in the George Washington and Jefferson national forests, Virginia. Natural Heritage Technical Report 99-4. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond. Unpublished report submitted to the USDA Forest Service. 218 pp. plus appendices.
- Fleming, G. P. 2001a. Community types of Coastal Plain calcareous ravines in Virginia. Preliminary analysis and classification. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. 4 pp.
- Fleming, G. P., and N. E. Van Alstine. 1999. Plant communities and floristic features of sinkhole ponds and seepage wetlands in southeastern Augusta County, Virginia. *Banisteria* 13:67-94.
- Fleming, G. P., and P. P. Coulling. 2001. Ecological communities of the George Washington and Jefferson national forests, Virginia. Preliminary classification and description of vegetation types. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. 317 pp.
- Fleming, G. P., and W. H. Moorhead, III. 1996. Ecological land units of the Laurel Fork Area, Highland County, Virginia. Virginia Department of Conservation and Recreation, Division of Natural Heritage. Natural Heritage Technical Report 96-08. Richmond. 114 pp. plus appendices.
- Fleming, G. P., and W. H. Moorhead, III. 2000. Plant communities and ecological land units of the Peter's Mountain area, James River Ranger District, George Washington and Jefferson national forests, Virginia. Natural Heritage Technical Report 00-07. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond. Unpublished report submitted to the USDA Forest Service. 195 pp. plus appendices.
- Fleming, G. P., P. P. Coulling, D. P. Walton, K. M. McCoy, and M. R. Parrish. 2001. The natural communities of Virginia: Classification of ecological community groups. First approximation. Natural Heritage Technical Report 01-1. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. Unpublished report. January 2001. 76 pp.
- Fleming, G. P., P. P. Coulling, K. D. Patterson, and K. M. McCoy. 2004. The natural communities of Virginia: Classification of ecological community groups. Second approximation. Natural Heritage Technical Report 04-01. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. [<http://www.dcr.virginia.gov/dnh/ncintro.htm>]
- Fleming, Gary P. Personal communication. Ecologist, Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA.
- Fleming, L. M. 1978. Delaware's outstanding natural areas and their preservation. Delaware Nature Education Society, Inc., Hockessin, DE. 422 pp.
- FNAI [Florida Natural Areas Inventory]. 1992a. Natural communities. Unpublished document. The Nature Conservancy, Florida Natural Areas Inventory, Tallahassee. 6 pp.
- Foti, T., compiler. 1994b. Natural vegetation classification system of Arkansas, draft five. Unpublished document. Arkansas Natural Heritage Commission, Little Rock. 8 pp.
- Foti, T., M. Blaney, X. Li, and K. G. Smith. 1994. A classification system for the natural vegetation of Arkansas. *Proceedings of the Arkansas Academy of Science* 48:50-53.



- Frye, R. J., II, and J. A. Quinn. 1979. Forest development in relation to topography and soils on a floodplain of the Raritan River, New Jersey. *Bulletin of the Torrey Botanical Club* 106:334-345.
- Gallyoun, M., G. Meyer, A. Andreu, and W. Slocumb. 1996. Mapping vegetation communities with The Nature Conservancy's vegetation classification system on five small national parks in the southeastern USA. Unpublished report. The Nature Conservancy, Southeast Regional Office, Conservation Science Department, Chapel Hill, NC.
- Gawler, S. C. 2002. Natural landscapes of Maine: A guide to vegetated natural communities and ecosystems. Maine Natural Areas Program, Department of Conservation, Augusta, ME. [in press]
- Golet, F. C., A. J. K. Calhoun, W. R. DeRagon, D. J. Lowry, and A. J. Gold. 1993. Ecology of red maple swamps in the glaciated Northeast: A community profile. USDI Fish & Wildlife Service, Washington, DC. 151 pp.
- Good, R. E. 1965. Salt marsh vegetation, Cape May, New Jersey. *Bulletin of the New Jersey Academy of Science* 10:1-11.
- Gould, A. M. A., and M. A. Berdine. 1998. Identification and protection of reference wetland natural communities in Maryland: Northern Piedmont and Blue Ridge circumneutral seepage swamps. The Biodiversity Program, Maryland Department of Natural Resources, Wildlife and Heritage Division, Annapolis. 77 pp. plus appendices.
- Govus, T. E. 1998. Fort Pulaski National Monument Inventory. Final report. Purchase Order # 1443PX509097564. Prepared for National Park Service, Southeast Region, Atlanta, GA. 41 pp.
- Grafton, W. N., and O. L. Eye. 1982. Vascular flora of eight selected West Virginia wetlands with special reference to rare species. Pages 107-115 in: *Proceedings of the Symposium on Wetlands of the Unglaciated Appalachian Region*. West Virginia University, Morgantown.
- Greller, A. M. 1977. A classification of mature forests on Long Island, New York. *Bulletin of the Torrey Botanical Club* 104:376-382.
- Hall, R. L., and E. D. Mathews. 1974. Soil survey of Charles County, Maryland. U.S. Department of Agriculture Soil Conservation Service. Washington, DC.
- Harcombe, P. A., and J. E. Neville. 1977. Vegetation types of Chambers County, Texas. *The Texas Journal of Science* 29:209-234.
- Harris, A. G., S. C. McMurray, P. W. C. Uhlig, J. K. Jeglum, R. F. Foster, and G. D. Racey. 1996. Field guide to the wetland ecosystem classification for northwestern Ontario. Ontario Ministry of Natural Resources, Northwest Science and Technology, Thunder Bay, Ontario. Field guide FG-01. 74 pp. plus appendix.
- Harrison, J. W. 2007. The natural communities of Maryland: First approximation. Maryland Department of Natural Resources, Wildlife and Heritage Services, Annapolis. Unpublished report. October 2007. 112 pp.
- Harrison, J. W., and P. Stango, III. 2003. Shrubland tidal wetland communities of Maryland's Eastern Shore: Identification, assessment and monitoring. Maryland Natural Heritage Program, Maryland Department of Natural Resources, Annapolis. 118 pp.

- Harrison, J. W., compiler. 2004. Classification of vegetation communities of Maryland: First iteration. A subset of the International Classification of Ecological Communities: Terrestrial Vegetation of the United States, NatureServe. Maryland Natural Heritage Program, Maryland Department of Natural Resources, Annapolis. 243 pp.
- Harrison, J. W., P. Stango, III, and M. C. Aguirre. 2004. Forested tidal wetland communities of Maryland's eastern shore: Identification, assessment, and monitoring. Unpublished report submitted to the Environmental Protection Agency. Maryland Department of Natural Resources, Natural Heritage Program, Annapolis. 96 pp.
- Harrison, Jason W. Personal communication. State Community Ecologist, Maryland Wildlife and Heritage Division, Department of Natural Resources, Tawes State Office Building, E-1, Annapolis, MD 21401.
- Harvill, A. M., Jr. 1967. The vegetation of Assateague Island, Virginia. *Castanea* 32:105-108.
- Heckscher, S. 1994. The vegetation of the Glades Region, Cumberland County, New Jersey. *Bartonia* 58:101-113.
- Higgins, E. A. T., R. D. Rappleye, and R. G. Brown. 1971. The flora and ecology of Assateague Island. University of Maryland Experiment Station Bulletin A-172. 70 pp.
- Hill, S. R. 1986. An annotated checklist of the vascular flora of Assateague Island (Maryland and Virginia). *Castanea* 5:265-305.
- Hoagland, B. 2000. The vegetation of Oklahoma: A classification for landscape mapping and conservation planning. *The Southwestern Naturalist* 45(4):385-420.
- Hoagland, B. W. 1998a. Classification of Oklahoma vegetation types. Working draft. University of Oklahoma, Oklahoma Natural Heritage Inventory, Norman. 43 pp.
- Hunt, D. 1997a. Long Island oak forest project: Classification justification. Unpublished materials. New York Natural Heritage Program, Latham, NY.
- Hunt, D. 1998. Official NY designation of red maple - sweetgum swamp community. Unpublished memorandum. New York Natural Heritage Program, Latham, NY. 1 p. plus attachments.
- INAI [Iowa Natural Areas Inventory]. No date. Vegetation classification of Iowa. Iowa Natural Areas Inventory, Iowa Department of Natural Resources, Des Moines.
- Jones, S. M., D. H. Van Lear, and S. K. Cox. 1981b. Major forest community types of the Savannah River Plant: A field guide. USDE Savannah River Plant, National Environmental Research Park Program. Report No. SRO-NERP-9. 79 pp. plus 24 illustrations.
- Karlin, E. 1988. Report on New Jersey conifer swamp study. Unpublished report to the New Jersey Natural Heritage Program.
- Kearsley, J. 1999b. The natural communities of Massachusetts: Palustrine section. July 1999 Draft. 101 pp.
- Keever, C. 1973. Distribution of major forest species in southeastern Pennsylvania. *Ecological Monographs* 43:303-327.
- Keever, C. 1979. Mechanisms of plant succession on old fields of Lancaster County, Pennsylvania. *Bulletin of the Torrey Botanical Club* 106(4):299-308.

- Klemas, V., F. C. Daiber, D. S. Bartlett, O. W. Crichton, and A. O. Fornes. 1973. Coastal vegetation of Delaware. University of Delaware, College of Marine Studies. 27 pp.
- Klotz, L. H. 1986. The vascular flora of Wallops Island and Wallops Mainland, Virginia. *Castanea* 51:306-326.
- Lea, C. 2000. Plant communities of the Potomac Gorge and their relationship to fluvial factors. M.S. thesis, George Mason University. Fairfax, VA. 219 pp.
- Lea, C. 2003. Vegetation types in the National Capital Region Parks. Draft for review by NatureServe, Virginia Natural Heritage, West Virginia Natural Heritage, Maryland Natural Heritage, and National Park Service. March 2003. 140 pp.
- Ludwig, J. D., G. P. Fleming, C. A. Pague, and T. J. Rawinski. 1993. A natural heritage inventory of mid-Atlantic region national parks in Virginia: Shenandoah National Park. Natural Heritage Technical Report 93-5. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond. 352 pp.
- Martin, W. E. 1959b. The vegetation of Island Beach State Park, New Jersey. *Ecological Monographs* 29:1-46.
- Martin, W. H. 1989. Forest patterns in the Great Valley of Tennessee. *Journal of the Tennessee Academy of Science* 64:137-144.
- McCormick, J. 1979. The vegetation of the New Jersey Pine Barrens. In: R. T. T. Formann, editor. *Pine Barrens: Ecosystem and landscape*. Academic Press, New York.
- McCrain, G. R., and B. H. Church. 1985. An analysis of past and present plant community patterns in Moores Creek National Battlefield along with associated impacts affecting distribution and restoration. Prepared by Resource Management Co., Raleigh, NC, under Purchase Order Number PX-5550-3-0062 for the USDI, National Park Service, Southeast Regional Office, Atlanta, GA.
- Meininger, J. 1998. Forest communities of Zekiah Swamp Nontidal Wetland of Special State Concern. Wildlife and Heritage Division, Maryland Department of Natural Resources. Annapolis, MD.
- Mercer, J. L. 1978. Westmoreland County Tidal Marsh Inventory. Special Report No. 59 in *Applied Marine Science and Ocean Engineering*. Virginia Institute of Marine Science. Gloucester Point, VA. 108 pp.
- Metzler, K. J., and J. Barrett. 1992. Connecticut community classification. Unpublished draft. Connecticut Department of Environmental Protection, Natural Resources Center, Natural Diversity Database, Hartford.
- Metzler, K. J., and J. P. Barrett. 2001. Vegetation classification for Connecticut. Draft 5/21/2001. Connecticut Department of Environmental Protection, Natural Resources Center, Natural Diversity Database, Hartford.
- Metzler, K. J., and J. P. Barrett. 2004. Vegetation classification for Connecticut. Draft. State Geological and Natural History Survey of Connecticut, Department of Environmental Protection, Hartford, CT.

- NatureServe Ecology - Southeastern United States. No date. Unpublished data. NatureServe, Durham, NC.
- NatureServe. 2005. Upper Anacostia Watershed: Plant communities of conservation significance. Unpublished report. NatureServe, Arlington, VA. 12 pp. plus appendices.
- Nelson, J. B. 1986. The natural communities of South Carolina: Initial classification and description. South Carolina Wildlife and Marine Resources Department, Division of Wildlife and Freshwater Fisheries, Columbia, SC. 55 pp.
- New Jersey Department of Environmental Protection. 2001. New Jersey 1995/97 Land Use / Land Cover - Level 3 Modified. Land Use Land Cover (Anderson) Classification System (derived from: A Land Use and Land Cover Classification System for Use with Remote Sensor Data, U.S. Geological Survey Professional Paper 964, 1976: edited by NJDEP, OIRM, BGIA, 1998, 2000, 2001). New Jersey Department of Environmental Protection, Trenton.
- Newbold, A. 1994. Report of wetlands vegetation study, 1994, Valley Forge National Historical Park. Unpublished report. 6 pp.
- Newbold, A., J. Evert, and J. Holt. 1988. Rare plant and general flora survey of the White Clay Creek Park, Newcastle County, Delaware. 40 pp.
- Nichols, W. F., J. M. Hoy, and D. D. Sperduto. 2001. Open riparian communities and riparian complexes in New Hampshire. New Hampshire Natural Heritage Inventory, DRED Division of Forests and Lands, Concord, NH. 82 pp. plus appendices.
- NRCS [Natural Resources Conservation Service]. 2001b. Soil survey of Gateway National Recreation Area, New York and New Jersey. USDA Natural Resources Conservation Service and USDI National Park Service, Gateway National Recreation Area in partnership with Cornell University Agricultural Experiment Station and New York City Soil and Water Conservation District.
- NRCS [Natural Resources Conservation Service]. 2004. Soil survey of Saratoga County, New York. USDA Natural Resources Conservation Service. 590 pp.
- Olsson, H. 1979. Vegetation of the New Jersey Pine Barrens: A phytosociological classification. Pages 245-263 in: R. T. T. Forman, editor. Pine Barrens: Ecosystem and landscape. Academic Press, New York.
- Overlease, W. R. 1978. A study of forest communities in southern Chester County, Pennsylvania. Proceedings of the Pennsylvania Academy of Science 52:37-44.
- Overlease, W. R. 1987. 150 years of vegetation change in Chester County, Pennsylvania. *Bartonia* 53:1-12.
- Patterson, K. D., C. J. Ulrey, and J. Drake. 1999. Vegetation classification of Great Smoky Mountains National Park: Cades Cove and Mount Le Conte quadrangles. Unpublished report submitted to BRD-NPS Vegetation Mapping Program. The Nature Conservancy, Chapel Hill, NC.
- Patterson, Karen D. Personal communication. Ecologist, Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA.

- Peet, R. K., T. R. Wentworth, M. P. Schafale, and A.S. Weakley. 2002. Unpublished data of the North Carolina Vegetation Survey. University of North Carolina, Chapel Hill.
- Perles, S. J., G. S. Podniesinski, E. A. Zimmerman, W. A. Millinor, and L. A. Sneddon. 2006b. Vegetation classification and mapping at Friendship Hill National Historic Site. Technical Report NPS/NER/NRTR--2006/041. National Park Service, Philadelphia, PA.
- Perles, S. J., G. S. Podniesinski, E. A. Zimmerman, W. A. Millinor, L. A. Sneddon. 2006a. Vegetation classification and mapping at Fort Necessity National Battlefield. Technical Report NPS/NER/NRTR--2006/038. National Park Service, Philadelphia, PA.
- Perles, S. J., G. S. Podniesinski, E. Eastman, L. A. Sneddon, and S. C. Gawler. 2007. Classification and mapping of vegetation and fire fuel models at Delaware Water Gap National Recreation Area: Volume 2 of 2 -Appendix G. Technical Report NPS/NER/NRTR--2007/076. National Park Service, Philadelphia, PA.
- Perles, S. J., G. S. Podniesinski, W. A. Millinor, and L. A. Sneddon. September 2006c. Vegetation classification and mapping at Gettysburg National Military Park and Eisenhower National Historic Park. Technical Report NPS/NER/NRTR--2006/058. National Park Service, Philadelphia, PA.
- Perles, S., G. Podniesinski, and J. Wagner. 2004. Classification, assessment and protection of non-forested floodplain wetlands of the Susquehanna drainage. Report to the U.S. Environmental Protection Agency and Pennsylvania Department of Conservation and Natural Resources. Pennsylvania Natural Heritage Program, Harrisburg. 128 pp.
- Podniesinski, G. 1999. Milford shale barrens red-cedar - prickly pear shrubland community and prickly pear population monitoring plan. Report to the National Park Service, Delaware Water Gap National Recreation Area, Research and Resource Planning Office. Pennsylvania Science Office of The Nature Conservancy, Middletown, PA. 8 pp.
- Podniesinski, G. S. 2005. Draft Delaware Water Gap National Recreation Area descriptions of dry ridgetops and grassland types. Unpublished report. Pennsylvania Natural Heritage Program.
- Podniesinski, G., and J. Kunsman. 1999. Status of the prickly pear cactus (*Opuntia humifusa*) populations and associated red-cedar - prickly pear shrubland community at the Milford shale barrens after the spring 1999 wildfire. Report to the National Park Service, Delaware Water Gap National Recreation Area, Research and Resource Planning Office. Pennsylvania Science Office of The Nature Conservancy, Middletown, PA. 4 pp.
- Putnam, N. [1995]. Plant communities of the Meadow River wetlands. Final report submitted to the West Virginia Division of Natural Resources.
- Pyne, M. 1994. Tennessee natural communities. Unpublished document. Tennessee Department of Conservation, Ecology Service Division, Nashville. 7 pp.
- Rawinski, T. 1984. Natural community description abstract - southern New England calcareous seepage swamp. Unpublished report. The Nature Conservancy, Boston, MA. 6 pp.
- Rawinski, T. J. 1997. Vegetation ecology of the Grafton Ponds, York County, Virginia, with notes on waterfowl use. Natural Heritage Technical Report 97-10. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond. 42 pp. plus appendix.

- Rawinski, T. J., G. P. Fleming, and F. V. Judge. 1994. Forest vegetation of the Ramsey's Draft and Little Laurel Run Research Natural Areas, Virginia: Baseline ecological monitoring and classification. Natural Heritage Technical Report 94-14. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond. 45 pp. plus appendices.
- Rawinski, T. J., K. N. Hickman, J. Waller-Eling, G. P. Fleming, C. S. Austin, S. D. Helmick, C. Huber, G. Kappesser, F. C. Huber, Jr., T. Bailey, and T. K. Collins. 1996. Plant communities and ecological land units of the Glenwood Ranger District, George Washington and Jefferson national forests, Virginia. Virginia Department of Conservation and Recreation, Division of Natural Heritage. Natural Heritage Technical Report 96-20. Richmond. 65 pp. plus appendices.
- Rentch, J. S., R. H. Forney, S. L. Stephenson, H. S. Adams, W. N. Grafton, R. B. Coxe, and H. H. Mills. 2005. Vegetation patterns within the lower Bluestone River gorge in southern West Virginia. *Castanea* 70:170-183.
- Reschke, C. 1990. Ecological communities of New York State. New York Natural Heritage Program. New York State Department of Environmental Conservation. Latham, NY. 96 pp.
- Reschke, Carol. Personal communication. Ecologist, New York Natural Heritage Program. New York State Department of Environmental Conservation, Latham, NY.
- Robichaud, B., and M. F. Buell. 1973. Vegetation of New Jersey. Rutgers University Press, New Brunswick, NJ. 340 pp.
- Russell, E. W. B., and A. E. Schuyler. 1988. Vegetation and flora of Hopewell Furnace National Historic Site, eastern Pennsylvania. *Bartonia* 54:124-143.
- Schafale, M. 2000. Fourth approximation guide. Coastal Plain. January 2000 draft. North Carolina Natural Heritage Program, Raleigh.
- Schafale, M. P., and A. S. Weakley. 1990. Classification of the natural communities of North Carolina. Third approximation. North Carolina Department of Environment, Health, and Natural Resources, Division of Parks and Recreation, Natural Heritage Program, Raleigh. 325 pp.
- Schmalzer, P. A., and H. R. DeSelm. 1982. Vegetation, endangered and threatened plants, critical plant habitats and vascular flora of the Obed Wild and Scenic River. Unpublished report. USDI National Park Service, Obed Wild and Scenic River. 2 volumes. 369 pp.
- Schotz, Al. Personal communication. Community Ecologist. Alabama Natural Heritage Program. Huntingdon College, Massey Hall, 1500 East Fairview Avenue, Montgomery, AL 36106-2148.
- Shreve, F., M. A. Chrysler, F. H. Blodgett, and F. W. Besley. 1910. The plant life of Maryland. Maryland Weather Service. Special Publication, Volume III. Johns Hopkins Press. Baltimore, MD.
- Shreve, F., M. A. Chrysler, F. H. Bodgett, and F. W. Besley. 1910. The plant life of Maryland. The Johns Hopkins Press, Baltimore, MD. Special Publications Volume III. 533 pp.
- Sipple, W. S., and W. A. Klockner. 1984. Uncommon wetlands in Coastal Plain of Maryland. Pages 111-137 in: A. W. Norden, et al., editors. Threatened and endangered plants and animals of Maryland. Special Publication 84-I. Maryland Natural Heritage Program.

- Sneddon, L. A., and M. G. Anderson. 1994. A classification scheme for Coastal Plain pondshore and related vegetation from Maine to Virginia. Supplement to Bulletin of the Ecological Society of America 77 (Abstract).
- Sneddon, L. A., K. J. Metzler, and M. Anderson. 1995. A classification and description of natural community alliances and selected community elements of the Delaware Estuary. In: L. E. Dove and R. M. Nyman, editors. Living resources of the Delaware Estuary. The Delaware Estuary Program. 530 pp. plus appendices.
- Sneddon, L., and J. Lundgren. 2001. Vegetation classification of Fire Island National Seashore and William Floyd Estate. Final Draft. TNC/ABI Vegetation Mapping Program. 87 pp.
- Sneddon, L., and S. Menard, editors. 2002. International classification of ecological communities: Terrestrial vegetation of the United States, Western Allegheny Plateau. Draft revisions based on contributions of the Western Allegheny Plateau Ecology Group. Unpublished report. NatureServe, Boston, MA.
- Sneddon, L., M. Anderson, and K. Metzler. 1996. Community alliances and elements of the Eastern Region. Unpublished report. The Nature Conservancy, Eastern Heritage Task Force, Boston, MA. 235 pp.
- Soil Conservation Service. 1987. Soil survey of Nassau County, New York. USDA Soil Conservation Service. 156 pp.
- Southeastern Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe, Durham, NC.
- Sperduto, D. 1992. Natural communities of New Hampshire. Working draft. New Hampshire Natural Heritage Inventory, Dept. of Resources and Economic Development. Concord, NH.
- Sperduto, D. D. 2000a. Natural communities of New Hampshire: A guide and classification. Near final unformatted draft without pictures and illustrations; includes upland classification. New Hampshire Natural Heritage Inventory, DRED Division of Forests and Lands, Concord, NH. 127 pp.
- Sperduto, D. D. 2000b. A classification of wetland natural communities in New Hampshire. New Hampshire Natural Heritage Inventory, Department of Resources and Economic Development, Division of Forests and Lands. Concord, NH. 156 pp.
- Sperduto, D. D., and W. F. Nichols. 2004. Natural communities of New Hampshire: A guide and classification. New Hampshire Natural Heritage Inventory, DRED Division of Forests and Lands, Concord. 242 pp.
- Stalter, R. 1990. The vascular flora of Assateague Island, Virginia. Bulletin of the Torrey Botanical Club 117:48-56.
- Stalter, R., and E. E. Lamont. 1990. The vascular flora of Assateague Island, Virginia. Bulletin of the Torrey Botanical Club 117:48-56.
- Stephenson, S. L., and H. S. Adams. 1991. Upland oak forests of the Ridge and Valley Province in southwestern Virginia. Virginia Journal of Science 42:371-380.

- Strakosch Walz, K., K. Anderson, L. Kelly, and D. Snyder. 2006. New Jersey ecological community crosswalk. Unpublished report. New Jersey Department of Environmental Protection, Office of Natural Lands Management, Trenton.
- Strakosch-Walz, K. 2004 The vegetation of pine barren riverside savannas of New Jersey: Ecological community classification. Draft report. New Jersey Natural Heritage Program, Office of Natural Lands Management, Trenton. 42 pp.
- Swain, P. C., and J. B. Kearsley. 2000. Classification of natural communities of Massachusetts. July 2000 draft. Natural Heritage and Endangered Species Program, Massachusetts Division of Fisheries and Wildlife. Westborough, MA.
- Swain, P. C., and J. B. Kearsley. 2001. Classification of natural communities of Massachusetts. September 2001 draft. Natural Heritage and Endangered Species Program, Massachusetts Division of Fisheries and Wildlife. Westborough, MA.
- Tatnall, R. 1946. Flora of Delaware and the eastern shore. The Society of Natural History of Delaware, Wilmington.
- TDNH [Tennessee Division of Natural Heritage] Unpublished data. Tennessee Division of Natural Heritage, 14th Floor, L&C Tower, 401 Church Street, Nashville, TN 37243-0447. 615-532-0431
- Thompson, E. 1996. Natural communities of Vermont uplands and wetland. Nongame and Natural Heritage Program, Department of Fish and Wildlife in cooperation with The Nature Conservancy, Vermont chapter. 34 pp.
- Thompson, E. H., and E. R. Sorenson. 2000. Wetland, woodland, wildland: A guide to the natural communities of Vermont. The Nature Conservancy and the Vermont Department of Fish and Wildlife. University Press of New England, Hanover, NH. 456 pp.
- Thomson, D., A. M. Gould, and M. A. Berdine. 1999. Identification and protection of reference wetland natural communities in Maryland: Potomac watershed floodplain forests. The Biodiversity Program, Maryland Department of Natural Resources, Wildlife and Heritage Division. Annapolis. 119 pp.
- Tiner, R. W., Jr. 1984. Wetlands of the United States: Current status and recent trends. USDI Fish and Wildlife Service, National Wetlands Inventory 59 pp.
- Tiner, R. W., Jr. 1985a. Wetlands of Delaware. Cooperative publication of USDI Fish & Wildlife Service, National Wetlands Inventory, Newton Corner, MA, and Delaware Department of Natural Resources and Environmental Control, Dover, DE. 77 pp.
- Tiner, R. W., Jr. 1985b. Wetlands of New Jersey. USDI Fish & Wildlife Service, National Wetlands Inventory, Newton Corner, MA. 117 pp.
- TNC [The Nature Conservancy]. 1995c. NBS/NPS Vegetation Mapping Program: Vegetation classification of Assateague Island National Seashore. Unpublished report. The Nature Conservancy, Eastern Regional Office, Boston, MA.
- TNC [The Nature Conservancy]. 1998a. An investigation and assessment of the vegetation of Arnold Air Force Base. Coffee and Franklin counties, Tennessee. The Nature Conservancy, Tennessee Field Office, Nashville. 37 pp. plus appendices.



- TNC [The Nature Conservancy]. 1998c. Vegetation Classification of Rock Creek Park. Report for the NBS/NPS Vegetation Mapping Program. The Nature Conservancy, Boston. 50 pp.
- TNC and WPC [The Nature Conservancy and Western Pennsylvania Conservancy]. 2004. Classification, assessment, and protection of non-forested floodplain wetlands of the Susquehanna drainage. Pennsylvania Natural Heritage Program, Harrisburg, PA. 128 pp.
- Tyndall, R. W., K. A. McCarthy, J. C. Ludwig, and A. Rome. 1990. Vegetation of six Carolina bays in Maryland. *Castanea* 55:1-21.
- USFS [U.S. Forest Service]. 1988. Silvicultural examination and prescription field book. USDA Forest Service, Southern Region. Atlanta, GA. 35 pp.
- Vanderhorst, J. 2000b. Plant communities of Harper's Ferry National Historical Park: Analysis, characterization, and mapping. West Virginia Natural Heritage Program, West Virginia Division of Natural Resources, Elkins, WV. 37 pp.
- Vanderhorst, J. 2001a. Plant community classification and mapping of the Camp Dawson Collective Training Area, Preston County, West Virginia. West Virginia Natural Heritage Program, West Virginia Division of Natural Resources, Elkins. 101 pp.
- Vanderhorst, J. 2001b. Plant communities of the New River Gorge National River, West Virginia: Northern and southern thirds. Non-game Wildlife and Natural Heritage Program, West Virginia Division of Natural Resources. Elkins. 146 pp.
- Vanderhorst, J. P., B. P. Streets, J. Jeuck, and S. C. Gawler. 2008. Vegetation classification and mapping of Bluestone National Scenic River, West Virginia. Technical Report NPS/NER/NRTR-2008/xxx. National Park Service. Philadelphia, PA. [in preparation]
- Vanderhorst, J. P., J. Jeuck, and S. C. Gawler. 2007. Vegetation classification and mapping of New River Gorge National River, West Virginia. Technical Report NPS/NER/NRTR-2007/092. USDI National Park Service. Philadelphia, PA.
- Vanderhorst, J., and B. P. Streets. 2006. Vegetation classification and mapping of Camp Dawson Army Training Site, West Virginia: Second approximation. Natural Heritage Program, West Virginia Division of Natural Resources, Elkins. 83 pp.
- VDNH [Virginia Division of Natural Heritage]. 2003. The natural communities of Virginia: Hierarchical classification of community types. Unpublished document, working list of November 2003. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Ecology Group, Richmond.
- VDNH [Virginia Division of Natural Heritage]. No date. Unpublished data. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond.
- Walbridge, M. R. 1982. Vegetation patterning and community distribution in four high-elevation headwater wetlands in West Virginia. M.S. thesis, West Virginia University, Morgantown.
- Walbridge, M. R., and G. E. Lang. 1982. Major plant communities and patterns of community distribution in four wetlands of the unglaciated Appalachian region. In: R. B. MacDonald, editor. *Proceedings of the Symposium on Wetlands of the Unglaciated Appalachian Region*. West Virginia University, Morgantown.

- Walton, D. P., C. M. Jesse, and N. J. Putnam. 1996. Plant communities of the Ohio River riparian zone. Natural Heritage Program, West Virginia Division of Natural Resources, Elkins.
- Windisch, A. G. 1995b. Natural community inventory of Fort Dix, New Jersey. The Nature Conservancy report. New Jersey Natural Heritage Program, Office of Natural Lands Management. Trenton, NJ. 81 pp.
- Wistendahl, W. A. 1958. The flood plain of the Raritan River, New Jersey. *Ecological Monographs* 28:129-153.
- WPC and TNC [Western Pennsylvania Conservancy and The Nature Conservancy]. 2002. Classification, assessment, and protection of forest floodplain wetlands of the Susquehanna drainage. Pennsylvania Natural Heritage Program, Harrisburg, PA. 160 pp.
- WVNHP [West Virginia Natural Heritage Program]. No date. Unpublished data. West Virginia Natural Heritage Program, Elkins.
- Young, J., G. Fleming, P. Townsend, and J. Foster. 2006. Vegetation of Shenandoah National Park in relation to environmental gradients. Final Report v.1.1. Research technical report prepared for USDI, National Park Service. USGS/NPS Vegetation Mapping Program. 92 pp. plus appendices.
- Zanoni, T. A., P. G. Risser, and I. H. Butler. 1979. Natural areas for Oklahoma. Oklahoma Natural Heritage Program, Norman. 72 pp.

