

A GUIDE TO THE NATURAL COMMUNITIES OF THE DELAWARE ESTUARY



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A GUIDE TO THE NATURAL COMMUNITIES OF THE DELAWARE ESTUARY: VERSION I

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PREFACE

The *Guide to the Natural Communities of the Delaware Estuary* and its companion, *Key to the Delaware Estuary Ecological Systems and Natural Communities*, are tools for conservation planners and practitioners. The Guide was created to help protect, preserve, and restore many of the species and habitats that comprise the Delaware Estuary Watershed.

The *Guide* describes 185 natural community types encompassing 35 broader-scale ecological systems known to occur in the region. Community types were identified using the National Vegetation Classification System (NVC), approved by the Federal Geographic Data Committee as the U.S. vegetation standard. Each of the three Estuary state's vegetation classifications was crosswalked to the NVC, providing a common language across multiple jurisdictions.

The Guide describes an impressive variety of natural communities within a wide-ranging landscape. The Delaware Estuary Watershed crosses four eco-regional boundaries and contains diverse assemblages of ecological systems. Of the 35 ecological systems, it was found that roughly 26% are upland systems, 49% are wetland systems, 6% are submerged aquatic systems, and 20% are combinations of uplands and wetlands. Likewise, the *Guide* describes a wide array of natural communities. Of the 185 natural communities (plant associations of the NVC), 36% are forest types, 11% are woodland types, 11% are shrubland types, 37% are herbaceous vegetation types, and 3% are sparse vegetation types.

The conservation status ranks of the Estuary's natural communities plays a critical role in developing strategies to protect regional biological diversity. These ranks provide insight to the rarity of some communities within the watershed. When looking at the conservation ranks, it was found that 23% of the associations are considered at-risk globally and 32% are considered at-risk at the state level.

The information contained in the *Guide* can help growth management decision-making, steering development away from ecologically sensitive resources. It can aid land acquisition prioritization, answering questions of rarity and representation in protected areas. Application of the information on the ground can lead to more informed natural resource management on conservation lands and more accurate selection of targets in ecological restoration. Because reference site locations are given, the *Guide* can provide restoration practitioners with an actual site to use as a system of reference. Further, the conservation status rank of communities targeted for restoration can identify the role of a project in regional habitat strategies.

This inventory of the Delaware Estuary's natural communities provides a framework for directing conservation action. Whether through planning or practice, knowing the elements of diversity can help us better protect the most at-risk components of our environment while ensuring that what is common today does not become endangered tomorrow.

ACKNOWLEDGEMENTS

The Partnership for the Delaware Estuary commissioned this work to inform conservation planning and restoration practice in the Estuary region. The Partnership and NatureServe thanks the many people who contributed to this vegetation classification. Countless hours compiling data, photos, reference site information, and edits as well as identifying data gaps to complete this document were contributed by Lesley Sneddon, NatureServe Senior Regional Ecologist; Kathleen Strakosch Walz, New Jersey Natural Heritage Vegetation Ecologist; Stephanie Perles and Greg Podniesinski; Pennsylvania Natural Heritage Ecologists; William McAvoy, Delaware Natural Heritage Botanist; and Robert Coxe, Delaware Natural Heritage Vegetation Ecologist. Kristin Snow, along with Mary Russo, Donna Reynolds and Carol Fogelsong, data mangers at NatureServe, developed a common name function used in this report to translate the scientific plant and animal names into common names. Kristin Snow also implemented the format for this report and Mary Russo edited and entered the data related to this project into the NatureServe conservation database.

Additional contributors include: Dan Salas, (Delaware Riverkeeper Network) and Greg Breese (US Fish & Wildlife Service). Many thanks go to the Society for Ecological Restoration International for providing guidance through the Primer on Ecological Restoration, and specifically, the Chair, Keith Bowers (Biohabitats), Vice-Chair, George Gann (Institute for Regional Conservation) and members, Jim Thorne (Natural Lands Trust), Leslie Sauer, and Andre Clewell for lending this project their collective ears. Sue Gawler (NatureServe Ecologist), Tony Davis, Karl Anderson, Andrew Windisch, Linda Kelly, Nancy Lee Adamson, and David Snyder must also be recognized for their significant contributions.

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.

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. When natural communities are threatened, the many species that depend upon these communities for habitat are similarly fated and the ecological services that would be rendered are lost.

The *Guide to the Natural Communities of the Delaware Estuary (Guide)* describes 35 ecological systems and 185 natural community types known to occur in the region. 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 (Figure 1).

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. 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).

Nearly 88% of the Delaware Estuary Watershed is terrestrial, while a little less than 12% is open water. This document focuses on the terrestrial portion of the region, characterizing upland communities,

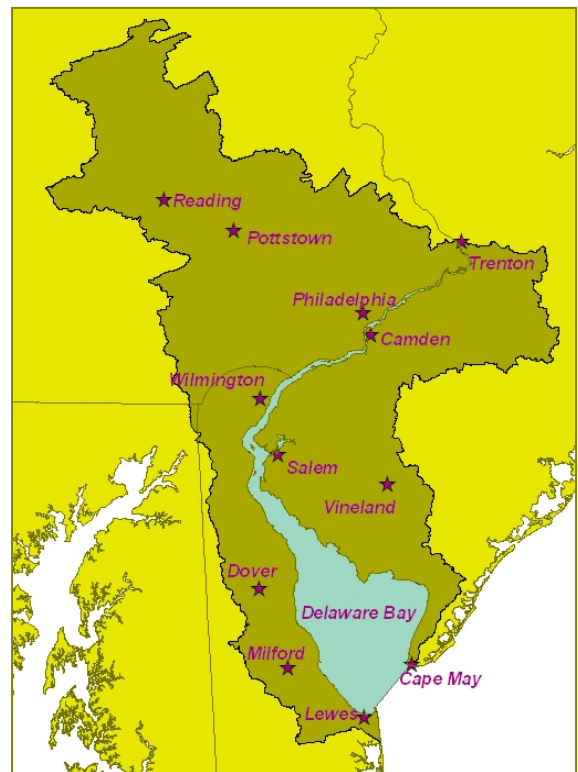


Figure 1. Delaware Estuary Watershed

wetland communities, and submerged aquatic vegetation. The *Guide* does not include descriptions of subterranean or deepwater systems.

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 National Vegetation Classification (NVC), a subset of the International Vegetation Classification.

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 explain why particular natural communities tend to be found together in a given ecological system (Comer 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 1000s of hectares and temporal scales range from 50 to 1000 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 2003).

National Vegetation Classification System

Natural communities in this document refer to the plant association level of the National Vegetation Classification System (NVC). The NVC 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 NVC 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.

Natural communities can be thought of as 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 natural 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 NVC, but efforts have been focused on mid-to late-seral, natural/near natural vegetation. Less-natural and earlier seral vegetation are classified on an as-needed basis for use in various applications (Grossman et al 1998).

The NVC 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 NVC. 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 natural community.

DATA COLLECTION & MAINTENANCE

The *Guide to the Communities of the Delaware Estuary* 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 biological conservation database and serves as a clearinghouse for scientific conservation information. NatureServe maintains a searchable database on their website at www.natureserve.org.

Data Gaps

The *Guide to the Natural Communities of the Delaware Estuary* is the product of an iterative process that will continue to be refined and updated. This document represents the initial iteration of the Estuary's vegetation classification. Additional ecological inventory is needed to identify vegetation communities that may occur in the Estuary 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 in the gaps. Some of the data gaps on the existing communities in the Estuary that may be pertinent to restoration efforts include information on successional trajectory, management concerns, noteworthy species, and reference site locations. In this report, 88% of the reference site fields are complete, 63% of the dynamics/successional trajectory fields are complete, and 57% of the management concerns fields are complete. Additional iterations will be published periodically as mapping of the Estuary's ecological systems proceeds and further ecological inventories are carried out.

FORMAT OF THIS REPORT

The *Guide* contains descriptions of the ecological systems and natural communities that are confirmed to occur, or in some cases, potentially occur in the Delaware Estuary from existing Natural Heritage data. The natural 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, Biotic 4, and are current as of April 2006. Nomenclature for plants follows Kartesz 1999. The Appendices include: a glossary of terms (Appendix A); a table of similar NVC associations for the community types identified in the *Guide* (Appendix B); a crosswalk table of the NVC associations to state community classifications (Appendix C); and, a description of the methodology of Natural Heritage Programs (Appendix D).

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 *Guide*.

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 US-NVC 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

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.

queried for the global range of the ecological systems, so not all species listed will be known from the Delaware Estuary 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: This field is a verbal description of the current total extent of the ecological system, and also lists the subnations (states) and other geographic areas where the system is known to occur.

Delaware Estuary Associations: The communities listed have been identified as occurring or potentially occurring in the Delaware Estuary within a specified ecological system. These communities are a group of plant association types that 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 bio-geographic 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 also located within the watershed.

Natural Communities

Community types are classified under the NVC using Natural Heritage methodology (see Appendix D). The terms Community and NVC Association are used interchangeably and refer to the plant association scale of the NVC hierarchy. Below is an explanation of the information contained in the natural community descriptions.

Name of Community Type: The first name listed in each description is the common or colloquial name of the 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.

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. 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 scientific community. S ranks are demarcated along the same scale as G ranks (Figure 3).

Global/State 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

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

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.

Appendices

The Appendices include: a glossary; a table of the NVC associations and their similar associations in the Delaware Estuary Watershed; a crosswalk table of NVC associations to related or equivalent communities identified in the Delaware, New Jersey, and Pennsylvania state vegetation classifications; and, a description of the Natural Heritage methodology with a standardized plot-sampling field form.

Dichotomous Key

A Key to the Delaware Estuary Ecological Systems and Natural Communities was produced as a companion to the Guide. This document is published separately and is downloadable from www.delawareestuary.org (PDE Report No. 06-03).

**ECOLOGICAL SYSTEMS AND NATURAL COMMUNITIES
OF THE DELAWARE ESTUARY**

ECOLOGICAL SYSTEM: APPALACHIAN (HEMLOCK)-NORTHERN HARDWOOD FOREST

Summary: This forested system of the northeastern U.S. ranges from central New England west to Lake Erie and south to Virginia, continuing down the Appalachians to Georgia in a more attenuated fashion. It is one of the matrix forest types in the northern part of the Central Interior and Appalachian Division. Northern hardwoods such as *Acer saccharum* (sugar maple), *Betula alleghaniensis* (yellow birch), and *Fagus grandifolia* (American beech) are characteristic, either forming a deciduous canopy or mixed with *Tsuga canadensis* (eastern hemlock) (or in some cases *Pinus strobus* (eastern white pine)). Other common and sometimes dominant trees include *Quercus* (oak) spp. (most commonly *Quercus rubra* (northern red oak)), *Liriodendron tulipifera* (tuliptree), *Prunus serotina* (black cherry), and *Betula lenta* (sweet birch). It is of more limited extent and more ecologically constrained in the southern part of its range (more or less from central Virginia southwards), occurring at a smaller spatial extent.

High-ranked Species: *Acrobolbus ciliatus* (G3?), *Aneides aeneus* (G3G4, green salamander), *Brachymerium andersonii* (GH, anderson's brachymerium), *Bryocrumia vivicolor* (G1G2), *Bryoerythrophyllum ferruginascens* (G3G4), *Bryum riparium* (G2G4), *Buckleya distichophylla* (G2, piratebush), *Canis rufus* (G1Q, red wolf), *Carex brysonii* (G1, bryson's sedge), *Catocala marmorata* (G3G4, marbled underwing), *Cephaloziella spinicaulis* (G3G4), *Cheilolejeunea evansii* (G1), *Clematis addisonii* (G2, addison's leatherflower), *Desmognathus aeneus* (G3G4, seepage salamander), *Desmognathus imitator* pop. 1 (G3G4T1Q, waterrock knob salamander), *Desmognathus santeetlah* (G3G4Q, santeetlah dusky salamander), *Desmognathus wrightii* (G3G4, pygmy salamander), *Diervilla rivularis* (G3, mountain bush-honeysuckle), *Drepanolejeunea appalachiana* (G2?), *Fissidens appalachensis* (G2G3), *Hexastylis contracta* (G3, southern heartleaf), *Homaliadelphus sharpii* (G3?, sharp's homaliadelphus), *Hymenophyllum tayloriae* (G2, taylor's filmy fern), *Lejeunea blomquistii* (G1G2, blomquist leafy liverwort), *Lophocolea appalachiana* (G1G2Q), *Marsupella emarginata* var. *latiloba* (G5T1T2), *Metzgeria fruticulosa* (G2Q), *Metzgeria furcata* var. *setigera* (G5T1), *Metzgeria uncigera* (G3), *Microtus chrotorrhinus carolinensis* (G4T3, southern rock vole), *Nardia lescurii* (G3?), *Neotoma magister* (G3G4, Allegheny woodrat), *Pellia appalachiana* (G2), *Plagiochila austinii* (G3), *Plagiochila caduciloba* (G2, gorge leafy liverwort), *Plagiochila eurphyllon* ssp. *echinata* (GNRT2), *Plagiochila sharpii* (G2G4, sharps leafy liverwort), *Plagiochila sullivantii* var. *spinigera* (G2T1), *Plagiochila sullivantii* var. *sullivantii* (G2T2), *Plagiochila virginica* var. *caroliniana* (G3T2), *Plagiochila virginica* var. *virginica* (G3T3), *Plagiomnium carolinianum* (G3, mountain wavy-leaf moss), *Platyhypnidium pringlei* (G2G3), *Plethodon aureolus* (G2G3, tellico salamander), *Plethodon hubrichtii* (G2, peaks of otter salamander), *Plethodon punctatus* (G3, white-spotted salamander), *Plethodon teyahalee* (G3, southern Appalachian salamander), *Plethodon welleri* (G3, weller's salamander), *Porella japonica* ssp. *appalachiana* (G5?T1), *Radula sullivantii* (G3), *Radula voluta* (G3), *Riccardia jugata* (G2), *Schlotheimia lancifolia* (G2, highlands moss), *Shortia galacifolia* var. *brevistyla* (G2T1Q, northern shortia), *Shortia galacifolia* var. *galacifolia* (G2T2, southern shortia), *Sorex palustris punctulatus* (G5T3, southern water shrew), *Stygobromus* sp. 17 (G2, massanutten spring amphipod), *Tetradontium brownianum* (G3G4, little georgia), *Trillium persistens* (G1, persistent trillium), *Triphora trianthophora* (G3G4, threebirds), *Tsuga caroliniana* (G3, Carolina hemlock), *Virginia valeriae pulchra* (G5T3T4, mountain earth snake)

Range: This system is found from central New England south to West Virginia and Georgia. United States: CT, GA, KY, MA, MD, NC, NH, NJ, NY, OH, PA, SC, TN, VA, VT, WV.

Delaware Estuary Associations:

- Central Appalachian Forested Acid Seep
- Central Appalachian White Pine - Eastern Hemlock Forest
- East-central Hemlock Hardwood Forest
- Golden-saxifrage Forested Seep
- Hemlock - Beech - Oak Forest
- Hemlock / White Pine - Red Oak - Mixed Hardwood Forest
- High Allegheny Rich Red Oak - Sugar Maple Forest
- Northern Hardwood Forest
- Red Maple - Blackgum Basin Swamp

- Red Maple Upland Forest
- Red Oak - Northern Hardwood Forest
- White Pine - Hemlock Dry-Mesic Coniferous Forest

CLASSIFIERS FOR APPALACHIAN (HEMLOCK)-NORTHERN HARDWOOD FOREST

Primary Division: 202

Land Cover Class: Forest and Woodland

Spatial Scale & Pattern: Matrix

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

Diagnostic Classifiers: Mesotrophic Soil; Needle-Leaved Tree; Broad-Leaved Deciduous Tree; Pinus spp. - *Tsuga canadensis*

Non-diagnostic Classifiers: Lowland; Forest and Woodland (Treed); Sideslope; Toeslope/Valley Bottom;

Temperate; Acidic Soil; Shallow Soil; Deep Soil; Mineral: W/ A-Horizon >10 cm; Ustic; Long Disturbance Interval;

Moderate (100-500 yrs) Persistence

CENTRAL APPALACHIAN FORESTED ACID SEEP

Acer rubrum - *Nyssa sylvatica* High Allegheny Plateau, Central Appalachian Forest

Range: This acidic deciduous swamp occurs in the central Appalachian Mountains north of the Cumberland drainage in the Central Appalachians and High Allegheny ecoregions, as well as the adjacent Cumberlands and Western Allegheny Plateau. This seep community occurs in the Pennsylvania portion of the Delaware Estuary.

Environmental Description: This community occurs on substrates which are saturated for extended periods during the growing season but which rarely have standing water, including forested seeps, hillsides, streamheads, floodplain edges, and poorly drained depressions. Occurrences tend to be small.

Vegetation Description: Characteristic trees are *Acer rubrum* (red maple) and *Nyssa sylvatica* (blackgum), with other associates including *Tsuga canadensis* (eastern hemlock) and *Betula alleghaniensis* (yellow birch). The shrub stratum includes *Alnus serrulata* (smooth alder), *Photinia pyrifolia* (red chokeberry), *Ilex verticillata* (common winterberry), *Vaccinium corymbosum* (highbush blueberry), *Rhododendron maximum* (great laurel), and *Rubus hispidus* (bristly dewberry). Characteristic herbs include *Osmunda cinnamomea* (cinnamon fern), *Osmunda regalis* (royal fern), *Carex folliculata* (northern long sedge), *Carex trisperma* (three-seed sedge), *Carex intumescens* (greater bladder sedge), *Carex stricta* (tussock sedge), and *Poa trivialis* (rough bluegrass). *Sphagnum* (peatmoss) spp. are typical.

Characteristic Species: *Acer rubrum* (red maple), *Nyssa sylvatica* (blackgum), *Osmunda cinnamomea* (cinnamon fern)

Reference Sites: none identified

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689039

References: Anderson et al. 1998, CAP pers. comm. 1998, Eastern Ecology Working Group n.d., Fike 1999, Harrison 2004

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>Nyssa sylvatica</i> (blackgum)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Alnus serrulata</i> (smooth alder)

CENTRAL APPALACHIAN WHITE PINE - EASTERN HEMLOCK FOREST

Pinus strobus - *Tsuga canadensis* / *Acer pensylvanicum* / *Polystichum acrostichoides* Forest

Range: The range of this community type includes the northern Blue Ridge, Ridge and Valley province, and Appalachian Mountains in Virginia, West Virginia, Maryland, and Pennsylvania. In Virginia, the type has been documented primarily from the northern Blue Ridge but is probably scattered throughout the state's mountain region north of the New River. One outlier apparently belonging to this association has been documented in the western Piedmont. In the Pennsylvania portion of the Delaware Estuary, this association only occurs in fragmented remnant stands.



Photo by Pennsylvania Natural Heritage Program

Environmental Description:

This dry-mesic white pine - hemlock forest of the central Appalachian Mountains and High Allegheny Plateau occurs on well-drained, nutrient-poor acidic soils.

Vegetation Description: Throughout its range, this is a closed-canopy, largely coniferous forest dominated by *Pinus strobus* (eastern white pine) and *Tsuga canadensis* (eastern hemlock) in variable proportions. Canopy associates include *Fagus grandifolia* (American beech), *Acer rubrum* (red maple), *Betula lenta* (sweet birch), *Betula alleghaniensis* (yellow birch), *Quercus rubra* (northern red oak), and *Liriodendron tulipifera* (tuliptree). The often sparse shrub layer contains *Acer pensylvanicum* (striped maple), *Acer spicatum* (mountain maple), and *Hamamelis virginiana* (American witch-hazel). Herb cover is usually limited by deep shade but includes *Cypripedium acaule* (pink lady's-slipper), *Gaultheria procumbens* (wintergreen), *Lycopodium* (clubmoss) spp., *Maianthemum canadense* (Canada mayflower), *Trientalis borealis* (starflower), *Mitchella repens* (partridgeberry), and *Polystichum acrostichoides* (Christmas fern).

Characteristic Species: *Acer pensylvanicum* (striped maple), *Pinus strobus* (eastern white pine), *Polystichum acrostichoides* (Christmas fern), *Tsuga canadensis* (eastern hemlock).

Management Concerns: Hemlock wooly adelgid may have significant negative impacts to the vegetation structure, species composition, and habitat suitability of this association.

Reference Sites: Adams Creek in the Delaware Water Gap National Recreation Area, PA..

Global and State Conservation Ranks and Reasons: G4? (28-Sep-2001). PA: SNR. This is a somewhat geographically restricted type that is apparently uncommon but not rare. Although many small patches probably occur in the northern two-thirds of the Virginia mountains, the compositional integrity of these stands is highly threatened by ongoing outbreaks of the hemlock wooly adelgid (*Adelges tsugae*), an exotic insect pest.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688339

References: Eastern Ecology Working Group n.d., Eyre 1980, Fike 1999, Fleming and Coulling 2001, Fleming et al. 2001, Harrison 2004, Lutz 1930, Rawinski et al. 1996, Smith 1983, VDNH 2003.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus strobus</i> (eastern white pine)
Tree canopy	Needle-leaved tree	<i>Tsuga canadensis</i> (eastern hemlock)
Tree canopy	Broad-leaved deciduous tree	<i>Fagus grandifolia</i> (American beech)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Acer pensylvanicum</i> (striped maple)

EAST-CENTRAL HEMLOCK HARDWOOD FOREST

Tsuga canadensis - *Fagus grandifolia* - *Acer saccharum* / (*Hamamelis virginiana*, *Kalmia latifolia*) Forest

Range: This community is found in parts of the Interior Low Plateau and the Western Allegheny Plateau of the northeastern and east-central United States, ranging from Pennsylvania and Ohio, south to Maryland and West Virginia, and westward to a few stands in Indiana, and possibly Kentucky. Stands in Indiana are not part of the continuous range of *Tsuga canadensis* (eastern hemlock). It occurs in the Pennsylvania portion of the Delaware Estuary.

Environmental Description: Stands occur on dry-mesic to mesic slopes, sometimes in steep-sloped valleys, but also in more gently sloped valleys and rolling lakeplain ridges. Soils are typically acid, silty to sandy loams, with a sandstone or shale parent material (Anderson 1982). Some Indiana stands occur on limestone (M. Homoya pers. comm. 1999).



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: The overstory is dominated by *Tsuga canadensis* (eastern hemlock), *Acer saccharum* (sugar maple), *Acer rubrum* (red maple), and *Fagus grandifolia* (American beech). Rarely does any one of these comprise more than 50% of the mature trees in a stand. Other trees are common in the canopy, among them *Betula alleghaniensis* (yellow birch), *Betula lenta* (sweet birch), *Carya* (hickory) spp., *Liriodendron tulipifera* (tuliptree), *Nyssa sylvatica* (blackgum), *Pinus strobus* (eastern white pine), *Prunus serotina* (black cherry), *Quercus alba* (white oak), *Quercus rubra* (northern red oak), and *Tilia americana* (American basswood). The shrub layer, occasionally sparse, contains *Hamamelis virginiana* (American witch-hazel), *Lindera benzoin* (northern spicebush), and *Viburnum acerifolium* (mapleleaf viburnum), as well as ericaceous shrubs, including *Kalmia latifolia* (mountain laurel) and *Rhododendron maximum* (great laurel). The ground layer contains the ferns *Botrychium virginianum* (rattlesnake fern), *Dryopteris intermedia* (intermediate woodfern), *Dryopteris marginalis* (marginal woodfern), *Polystichum acrostichoides* (Christmas fern), and the herbs *Arisaema triphyllum* (Jack-in-the-pulpit), *Maianthemum canadense* (Canada mayflower), *Mitchella repens* (partridgeberry), *Podophyllum peltatum* (mayapple), *Viola blanda* (sweet white violet), and *Viola rotundifolia* (roundleaf violet), among others.

Characteristic Species: *Acer saccharum* (sugar maple), *Fagus grandifolia* (American beech), *Kalmia latifolia* (mountain laurel).

Management Concerns: Hemlock woolly adelgid may have significant negative impacts to the vegetation structure, species composition, and habitat suitability of this association.

Reference Sites: St. Peters Woods, State Game Land 43, PA.

Global and State Conservation Ranks and Reasons: G3? (29-Sep-2004). PA: SNR. Occurrences are subject to compositional modification by outbreaks of hemlock woolly adelgid (*Adelges tsugae*), an exotic insect pest that causes decline and eventual mortality of *Tsuga canadensis*.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687323

References: Anderson 1982, Black and Mack 1976, Campbell pers. comm., Eastern Ecology Working Group n.d., Fike 1999, Fleming pers. comm., Harrison 2004, Homoya pers. comm., OHNHD unpubl. Data.

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>Acer saccharum</i> (sugar maple)
Tree canopy	Broad-leaved deciduous tree	<i>Fagus grandifolia</i> (American beech)
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	<i>Kalmia latifolia</i> (mountain laurel)
Herb (field)	Fern or fern ally	<i>Polystichum acrostichoides</i> (Christmas fern)

GOLDEN-SAXIFRAGE FORESTED SEEP

Chrysosplenium americanum Herbaceous Vegetation

Range: This association occurs throughout the eastern United States. It occurs in the Pennsylvania portion of the Delaware Estuary and possibly in Delaware.

Environmental Description: This type includes small herbaceous seepage areas with scattered cover of forbs. Herbs are strongly dominant and tend to be relatively diverse, especially where there is greater enrichment. Typically the community is over-topped by trees and shrubs from the surrounding forest, although large examples will be open.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: Characteristic species can include *Chrysosplenium americanum* (American golden-saxifrage), *Cardamine bulbosa* (bulbous bittercress), *Circaea alpina* (alpine enchanter's-nightshade), *Viola cucullata* (marsh blue violet), *Chelone glabra* (white turtlehead), *Glyceria melicaria* (melic manna grass), *Glyceria striata* (fowl mannagrass), *Cinna arundinacea* (sweet woodreed), *Impatiens capensis* (orange jewelweed), *Poa paludigena* (bog bluegrass), *Carex scabrata* (eastern rough sedge), *Mimulus ringens* (Allegheny monkeyflower), *Symplocarpus foetidus* (skunk-cabbage), *Pilea pumila* (Canadian clearweed), *Galium triflorum* (sweet-scent bedstraw), *Saxifraga pennsylvanica* (eastern swamp saxifrage), *Thelypteris noveboracensis* (New York fern), *Veratrum viride* (American false hellebore), *Hydrocotyle americana* (American marsh pennywort), *Onoclea sensibilis* (sensitive fern),

Laportea canadensis (Canadian wood-nettle), *Arisaema triphyllum* (Jack-in-the-pulpit), *Tiarella cordifolia* (heartleaf foamflower), *Carex gynandra* (nodding sedge), *Geum rivale* (purple avens), and the mosses *Rhizomnium punctatum*, *Rhizomnium appalachianum* (Appalachian rhizomnium moss), *Brachythecium rivulare* (waterside feather moss), *Thuidium delicatulum* (delicate fern moss), *Steerecleus serrulatus* (steerecleus moss), and *Bryhnia novae-angliae* (new england bryhnia moss).

Noteworthy Associated Plant and/or Animal Species: *Parnassia glauca* (fen grass-of-parnassus), *Trollius laxus* (American globeflower).

Characteristic Species: *Chrysosplenium americanum* (American golden-saxifrage).

Reference Sites: Warwick County Park in Chester County, PA; Red Clay Creek, DE.

Global and State Conservation Ranks and Reasons: G3G5 (1-Dec-1997). DE: SNR, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685735

References: Bowman 2000, CAP pers. comm. 1998, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Harrison 2004, Metzler and Barrett 2001, Schafale 1998b, Sperduto 2000a, Swain and Kearsley 2000, TDNH unpubl. data, Thompson and Sorenson 2000

MOST ABUNDANT SPECIES				
STRATUM	LIFEFORM	SPECIES		
Herb (field) golden-saxifrage	Forb	<i>Chrysosplenium</i>	<i>americanum</i>	(American)

HEMLOCK - BEECH - OAK FOREST

Tsuga canadensis - *Fagus grandifolia* - *Quercus rubra* Forest

Range: This association is widespread in southern New England and ranges south locally in the northern Piedmont and high Allegheny Mountains to Virginia and West Virginia. In Virginia, the type is confined to the Allegheny Mountain / Laurel Fork area in northwestern Highland County. It occurs in the Pennsylvania portion of the Delaware Estuary.

Environmental Description: This forest occurs on dry to dry-mesic, nutrient-poor, well-drained, often stony sandy loams or loamy sands. Underlying bedrock is acidic. In Virginia, it occupies extremely acidic (mean pH = 3.8), infertile silt loams on mesic to submesic valley sideslopes and broad, convex ridges at elevations from 1000-1200 m.

Vegetation Description: The canopy is codominated by *Tsuga canadensis* (eastern hemlock) and *Fagus grandifolia* (American beech) in variable proportions depending on soil (site) and disturbance characteristics; drier sites tend to have more abundant *Fagus grandifolia* (American beech) and cooler sites tend to have more abundant *Tsuga canadensis* (eastern hemlock). Associated tree species include *Betula lenta* (sweet birch), *Quercus rubra* (northern red oak), *Pinus strobus* (eastern white pine), and *Acer rubrum* (red maple). Shrubs are often sparse but locally abundant and, in addition to saplings of canopy species, include *Hamamelis virginiana* (American witch-hazel), *Acer pensylvanicum* (striped maple), *Viburnum acerifolium* (mapleleaf viburnum), *Kalmia latifolia* (mountain laurel), and in the south *Ilex montana* (mountain holly). The herb layer is generally sparse, but usually includes several of the following: *Mitchella repens* (partridgeberry), *Epifagus virginiana* (beechdrops), *Gaultheria procumbens* (wintergreen), *Maianthemum canadense* (Canada mayflower), *Trientalis borealis* (starflower), *Medeola virginiana* (Indian cucumber-root), *Aralia nudicaulis* (wild sarsaparilla), *Uvularia sessilifolia* (sessile-leaf bellwort), *Dryopteris intermedia* (intermediate woodfern) or *Monotropa uniflora* (Indian-pipe), and occasionally *Lycopodium dendroideum* (tree clubmoss), *Coptis trifolia* (threeleaf goldthread), and *Dennstaedtia punctilobula* (eastern hay-scented fern).

Characteristic Species: *Dryopteris intermedia* (intermediate woodfern), *Fagus grandifolia* (American beech), *Tsuga canadensis* (eastern hemlock).

Management Concerns: Insect pests and pathogens, such as the hemlock woolly adelgid (*Adelges tsugae* (hemlock woolly adelgid)) and beech bark disease (also called beech scale / *Nectria* complex), are serious threats to the dominant canopy trees in this association.

Reference Sites: Green Hill Road Woods, Evansburg State Park, PA.

Global and State Conservation Ranks and Reasons: G4G5 (26-Jun-1998). PA: SNR. This community type is widely distributed in the northern part of its range. Its long-term viability is threatened by pathogens associated with its two dominant canopy trees.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686026

References: Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Eyre 1980, Fike 1999, Fleming and Coulling 2001, Fleming and Moorhead 1996, Fleming et al. 2001, Gawler 2002, Metzler and Barrett 2001, Rawinski 1984, Reschke 1990, Sperduto and Nichols 2004, Swain and Kearsley 2001, Thompson 1996, Thompson and Sorenson 2000, VDNH 2003.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Tsuga canadensis</i> (eastern hemlock)
Tree canopy	Broad-leaved deciduous tree	<i>Fagus grandifolia</i> (American beech)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Hamamelis virginiana</i> (American witch-hazel)
Herb (field)	Forb	<i>Aralia nudicaulis</i> (wild sarsaparilla)
Herb (field)	Forb	<i>Trientalis borealis</i> (starflower)
Herb (field)	Fern or fern ally	<i>Dryopteris intermedia</i> (intermediate woodfern)

HEMLOCK / WHITE PINE - RED OAK - MIXED HARDWOOD FOREST

Quercus rubra - *Tsuga canadensis* - *Liriodendron tulipifera* / *Hamamelis virginiana* Forest

Range: This vegetation occurs in New Jersey and Pennsylvania and may occur in adjacent states. In the Delaware Estuary, this community occurs in Pennsylvania.

Environmental Description: This vegetation occurs on deep, moist to well-drained loams and silt loams on northern and eastern midslopes and coves. Soils may be rocky, and slopes may be steep.

Vegetation Description: The canopy has a notable presence of *Tsuga canadensis* (eastern hemlock) and/or *Pinus strobus* (eastern white pine). Sharing dominance with these conifers is a variety of oaks and hickories including *Quercus rubra* (northern red oak), *Acer saccharum* (sugar maple), *Fagus grandifolia* (American beech), *Quercus alba* (white oak), *Quercus velutina* (black oak), *Betula lenta* (sweet birch), *Carya alba* (mockernut hickory), *Fraxinus americana* (white ash), *Liriodendron tulipifera* (tuliptree). The subcanopy and shrub layer consists of *Ostrya virginiana* (eastern hop-hornbeam), *Carpinus caroliniana* (American hornbeam), *Kalmia latifolia* (mountain laurel), *Hamamelis virginiana* (American witch-hazel), *Amelanchier laevis* (Allegheny serviceberry), *Lindera benzoin* (northern spicebush), *Viburnum acerifolium* (mapleleaf viburnum), and *Viburnum recognitum* (northern arrow-wood). The herbaceous layer is characterized by *Maianthemum racemosum* (feathery false lily-of-the-valley), *Gaultheria procumbens* (wintergreen), *Maianthemum canadense* (Canada mayflower), and *Podophyllum peltatum* (mayapple).

Characteristic Species: *Gaultheria procumbens* (wintergreen), *Hamamelis virginiana* (American witch-hazel), *Liriodendron tulipifera* (tuliptree), *Maianthemum canadense* (Canada mayflower), *Maianthemum racemosum* (feathery false lily-of-the-valley), *Pinus strobus* (eastern white pine),

Podophyllum peltatum (mayapple), *Quercus rubra* (northern red oak), *Tsuga canadensis* (eastern hemlock).

Management Concerns: Hemlock wooly adelgid may have significant negative impacts to the vegetation structure, species composition, and habitat suitability of this association.

Reference Sites: No reference sites were identified.

Global and State Conservation Ranks and Reasons: G4? (29-Sep-2004). NJ: SNR, PA: SNR. Within its range, this community type occurs extensively in suitable habitats. Occurrences are subject to compositional modification by outbreaks of hemlock woolly adelgid (*Adelges tsugae*), an exotic insect pest that causes decline and eventual mortality of *Tsuga canadensis*.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686716

References: Anderson et al. 1998, Eastern Ecology Working Group n.d., Fike 1999.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Tsuga canadensis</i> (eastern hemlock)
Tree canopy	Broad-leaved deciduous tree	<i>Liriodendron tulipifera</i> (tuliptree)
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> (American witch-hazel)
Herb (field)	Forb	<i>Maianthemum canadense</i> (Canada mayflower)

HIGH ALLEGHENY RICH RED OAK - SUGAR MAPLE FOREST

Quercus rubra - *Acer saccharum* - *Liriodendron tulipifera* Forest

Range: This red oak - sugar maple community is found primarily in the Allegheny Plateau and Appalachian Mountain regions of the United States, with possible extensions east and west of those areas, ranging from southeastern New York and New Jersey, west to Pennsylvania, West Virginia, and southeastern Ohio. It occurs in Pennsylvania's portion of the Delaware Estuary.

Environmental Description: Stands are typically found in coves, on moist north- and east-facing slopes, and on well-drained flats. Soils are slightly acid and of intermediate fertility (Anderson 1982, Reschke 1990, Fike 1999).

Vegetation Description: Stands of this red oak - sugar maple forest contain a closed-canopy tree layer. *Acer saccharum* (sugar maple), *Liriodendron tulipifera* (tuliptree), *Quercus alba* (white oak), and *Quercus rubra* (northern red oak) are the leading dominants. *Acer rubrum* (red maple), *Carya ovata* (shagbark hickory), *Carya alba* (mockernut hickory), *Nyssa sylvatica* (blackgum), and *Quercus velutina* (black oak) are possible associates. *Liriodendron* (tuliptree) dominance may indicate a past disturbance history, and *Carya* (hickory) spp. may share dominance in some stands. There is evidence (Fleming 1999) that *Castanea dentata* (American chestnut) may have been important in these stands prior to its demise. A wide variety of more mesic associates, such as *Betula alleghaniensis* (yellow birch), *Betula lenta* (sweet birch), *Fagus grandifolia* (American beech), and *Fraxinus americana* (white ash), could occur but are negligible in dominance. In addition to *Acer saccharum* (sugar maple) reproduction, some understory species may include *Carpinus caroliniana* (American hornbeam), *Cercis canadensis* (eastern redbud), and *Ostrya virginiana* (eastern hop-hornbeam). Shrub and vine species include *Amelanchier laevis* (Allegheny serviceberry), *Amelanchier arborea* (common serviceberry), *Cornus* (dogwood) spp., *Hamamelis virginiana* (American witch-hazel), *Lindera benzoin* (northern spicebush), *Viburnum acerifolium* (mapleleaf viburnum), *Viburnum recognitum* (northern arrow-wood), and *Vitis riparia* (riverbank grape). Ericaceous shrubs, such as *Kalmia latifolia* (mountain laurel), *Vaccinium angustifolium* (northern lowbush blueberry) and *Vaccinium pallidum* (hillside blueberry), may also be present. The

ground layer species are highly variable but include *Caulophyllum thalictroides* (blue cohosh), *Dennstaedtia punctilobula* (eastern hay-scented fern), *Podophyllum peltatum* (mayapple), *Maianthemum racemosum* (feathery false lily-of-the-valley), *Medeola virginiana* (Indian cucumber-root), *Thelypteris noveboracensis* (New York fern), and *Uvularia sessilifolia* (sessile-leaf bellwort).

Characteristic Species: *Acer saccharum* (sugar maple), *Carpinus caroliniana* (American hornbeam), *Caulophyllum thalictroides* (blue cohosh), *Liriodendron tulipifera* (tuliptree).

Reference Sites: R.B. Gordon Natural Area, Chester County, PA.

Global and State Conservation Ranks and Reasons: GNR (31-Dec-1997). NJ: SNR, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687049

References: Anderson 1982, Braun 1950, Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Fike 1999, Fleming 1999, Lundgren 2001, Metzler and Barrett 2001, Reschke 1990.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Acer saccharum</i> (sugar maple)
Tree canopy	Broad-leaved deciduous tree	<i>Quercus alba</i> (white oak)
Tree canopy	Broad-leaved deciduous tree	<i>Quercus rubra</i> (northern red oak)
Tree subcanopy	Broad-leaved deciduous tree	<i>Acer rubrum</i> (red maple)
Tree subcanopy	Broad-leaved deciduous tree	<i>Acer saccharum</i> (sugar maple)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Viburnum acerifolium</i> (mapleleaf viburnum)
Short shrub/sapling blueberry)	Broad-leaved deciduous shrub	<i>Vaccinium angustifolium</i> (northern lowbush blueberry)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Vaccinium pallidum</i> (hillside blueberry)
Herb (field)	Forb	<i>Podophyllum peltatum</i> (mayapple)
Herb (field) fern)	Fern or fern ally	<i>Dennstaedtia punctilobula</i> (eastern hay-scented fern)

NORTHERN HARDWOOD FOREST

Acer saccharum - *Betula alleghaniensis* -
Fagus grandifolia / *Viburnum lantanoides*
Forest

Range: This association is a widespread matrix forest in central New England and at lower elevations in northern New England and in small pockets of Pennsylvania. An example of this community occurs in the Pennsylvania portion of the Delaware Estuary.

Environmental Description: This association, known commonly as "northern hardwood forest," is a widespread matrix forest. This forest occurs most commonly on acidic (pH 5-6), moderate to well-drained tills at elevations generally below 762 m (2500 feet). In northern New England, they cover extensive mid-elevation ridges; elsewhere slope settings are common.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: The closed-canopy forest has sparse to moderate shrub and herb cover and may have local carpets of tree seedlings in the ground vegetation. Bryoids are a minor component of the forest floor. On some rocky, higher elevation sites,

dense ferns and other herbs may form a lush understory (the "fern-glade variant"). The canopy is dominated by *Acer saccharum* (sugar maple), *Fagus grandifolia* (American beech), and *Betula alleghaniensis* (yellow birch) with associated hardwood species, including *Acer rubrum* (red maple), *Betula papyrifera* (paper birch), and *Fraxinus americana* (white ash). Conifers are usually present at low abundance. Characteristic species include *Pinus strobus* (eastern white pine), *Tsuga canadensis* (eastern hemlock), and in the northern portion of the range *Picea rubens* (red spruce). Oaks are generally not present, although *Quercus rubra* (northern red oak) and (southward) *Quercus alba* (white oak) may be present in low numbers. Characteristic understory shrubs or subcanopy trees include *Viburnum lantanoides* (hobblebush), *Acer spicatum* (mountain maple), and *Acer pensylvanicum* (striped maple). The patchy herbaceous layer is a mix of ferns, rhizomatous herbs and clubmosses. Characteristic species include *Dryopteris intermedia* (intermediate woodfern), *Dryopteris campyloptera* (mountain woodfern), *Huperzia lucidula* (shining clubmoss), *Maianthemum canadense* (Canada mayflower), *Clintonia borealis* (yellow bluebead-lily), *Trientalis borealis* (starflower), *Oclemena acuminata* (whorled wood aster), and *Uvularia sessilifolia* (sessile-leaf bellwort). Occasional species include *Aralia nudicaulis* (wild sarsaparilla), *Trillium erectum* (stinking benjamin), *Trillium undulatum* (painted wakerobin), *Streptopus lanceolatus* (rosy twisted-stalk), *Cinna latifolia* (slender woodreed), *Thelypteris noveboracensis* (New York fern), *Solidago macrophylla* (largeleaf goldenrod), and *Medeola virginiana* (Indian cucumber-root). The bryophyte layer may include *Dicranum* (broom moss) spp. and *Leucobryum glaucum* (pincushion moss). At higher elevations any of the understory herbs characteristic of montane spruce-fir forests may be locally abundant.

Noteworthy Associated Plant and/or Animal Species: *Accipiter striatus* (sharp-shinned hawk), *Aegolius acadicus* (northern saw-whet owl), *Ambystoma maculatum* (spotted salamander), *Contopus virens* (eastern wood-pewee), *Dendroica caerulescens* (black-throated blue warbler), *Dendroica virens* (black-throated green warbler), *Desmognathus fuscus* (dusky salamander), *Empidonax minimus* (least flycatcher), *Empidonax virescens* (acadian flycatcher), *Erethizon dorsatum* (north American porcupine), *Eurycea bislineata* (northern two-lined salamander), *Glaucomys sabrinus* (northern flying squirrel), *Hylocichla mustelina* (wood thrush), *Martes pennanti* (fisher), *Melanerpes carolinus* (red-bellied woodpecker), *Meleagris gallopavo* (wild turkey), *Mniotilta varia* (black-and-white warbler), *Napaeozapus insignis* (woodland jumping mouse), *Notophthalmus viridescens* (eastern newt), *Parula americana* (northern parula), *Peromyscus leucopus* (white-footed deermouse), *Peromyscus maniculatus* (north American deermouse), *Picoides pubescens* (downy woodpecker), *Picoides villosus* (hairy woodpecker), *Piranga olivacea* (scarlet tanager), *Poecile atricapillus* (black-capped chickadee), *Rana sylvatica* (wood frog), *Seiurus aurocapilla* (ovenbird), *Setophaga ruticilla* (American redstart), *Sitta carolinensis* (white-breasted nuthatch), *Sorex cinereus* (cinereus shrew), *Tamias striatus* (eastern chipmunk), *Urocyon cinereoargenteus* (gray fox), *Ursus americanus* (American black bear), *Vireo olivaceus* (red-eyed vireo).

Characteristic Species: *Acer pensylvanicum* (striped maple), *Acer saccharum* (sugar maple), *Acer spicatum* (mountain maple), *Betula alleghaniensis* (yellow birch), *Dryopteris intermedia* (intermediate woodfern), *Fagus grandifolia* (American beech), *Pinus strobus* (eastern white pine), *Tsuga canadensis* (eastern hemlock), *Viburnum lantanoides* (hobblebush).

Dynamics/Successional Trajectory: This is a "climax" forest type where it occurs, with canopy dominants tending to replace themselves under normal small-gap disturbance regimes. Sugar maple leaf litter is high in nitrogen relative to lignin and thus decomposes rapidly, increasing the nutrient pool in the soil organic layer. Structure and composition of the forest are maintained primarily by single small tree-fall gaps. Yellow birch is maintained in the system by mineral soils on "tip-up mounds."

Management Concerns: Deer browse impacts on herbs, shrubs and woody plant regeneration is often severe and may require local intervention to maintain healthy forests. This community often occurs on rich mesic soils which are also vulnerable to a number of invasive herb and shrub species.

Reference Sites: Locust Creek State Park, Schuylkill County, PA.

Global and State Conservation Ranks and Reasons: G5 (7-Dec-2005). NJ: S1S3, PA: SNR. This association is a widespread matrix forest in New England.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684503

References: Adamus 1978, Baldwin 1977, Breden 1989, Breden et al. 2001, Campbell and Eastman 1978, Eastern Ecology Working Group n.d., Edinger et al. 2002, Eyre 1980, Flaccus 1972, Gawler 2002, Gordon 1937b, Kern 1985, Kuchler 1956, Kuchler 1964, Little 1974, McIntosh 1972, Metzler and Barrett 1996, Metzler and Barrett 2001, Moore and Taylor 1927, NAP pers. comm. 1998, Niering 1953, Ohmann and Buell 1968, Rawinski 1984, Simko 1987, Sperduto 1996, Sperduto and Nichols 2004, Thompson 1996, Thompson and Sorenson 2000, Woods 1987.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Acer saccharum</i> (sugar maple)
Tree canopy	Broad-leaved deciduous tree	<i>Betula alleghaniensis</i> (yellow birch)
Tree canopy	Broad-leaved deciduous tree	<i>Fagus grandifolia</i> (American beech)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Acer pensylvanicum</i> (striped maple)

RED MAPLE - BLACKGUM BASIN SWAMP

Acer rubrum - *Nyssa sylvatica* - *Betula alleghaniensis* / *Sphagnum* spp. Forest

Range: This community occurs in Pennsylvania in the Delaware Estuary.

Environmental Description: This blackgum basin swamp of the northeastern United States is found from the central Appalachians north to central New England, at the northern range limit for *Nyssa sylvatica* (blackgum). It occupies saturated or seasonally wet basins, typically perched basins in small watersheds within upland forests. In most settings, the mineral soil is overlain with a shallow to deep peat layer. Conditions are highly acidic and nutrient-poor.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: The canopy is dominated by *Acer rubrum* (red maple) and *Nyssa sylvatica* (blackgum); however, even where red maple is more abundant, the longevity and stature of the blackgum trees give them a strong impact. *Betula alleghaniensis* (yellow birch), *Tsuga canadensis* (eastern hemlock), *Pinus strobus* (eastern white pine), and in the north *Picea rubens* (red spruce) may be minor canopy associates. The most abundant shrubs are *Ilex verticillata* (common winterberry) and *Vaccinium corymbosum* (highbush blueberry); associated shrub species include *Viburnum nudum* var. *cassinoides* (northern wild raisin), *Nemopanthus mucronatus* (catberry), *Kalmia angustifolia* (sheep laurel), *Lyonia ligustrina* (maleberry), and *Cephalanthus occidentalis* (common buttonbush). *Osmunda cinnamomea* (cinnamon fern) is the characteristic dominant in the herb layer, with associates including *Osmunda regalis* (royal fern), *Thelypteris palustris* (eastern marsh fern), *Woodwardia virginica* (Virginia chainfern), *Glyceria canadensis* (rattlesnake manna grass), *Coptis trifolia* (threeleaf goldthread), *Carex trisperma* (three-seed sedge), *Carex intumescens* (greater bladder sedge), *Triadenum virginicum* (Virginia marsh St. John's-wort), and *Symplocarpus foetidus* (skunk-cabbage). Mosses are primarily *Sphagnum* (peatmoss) spp., including *Sphagnum palustre* (prairie peatmoss) and *Sphagnum magellanicum*

(Magellan's peatmoss). These swamps are distinguished from other basin swamps in the Northern Appalachians by the presence of *Nyssa sylvatica* (blackgum). They are distinguished from blackgum swamps further south by the absence of more central-Appalachian species such as *Liquidambar styraciflua* (sweetgum), *Rhododendron maximum* (great laurel), *Rhododendron viscosum* (swamp azalea), and *Magnolia virginiana* (sweetbay).

Characteristic Species: *Acer rubrum* (red maple), *Ilex verticillata* (common winterberry), *Nyssa sylvatica* (blackgum), *Osmunda cinnamomea* (cinnamon fern), *Vaccinium corymbosum* (highbush blueberry).

Dynamics/Successional Trajectory: The tree canopy varies from an open woodland to nearly complete. Shrubs are well represented and may be locally dense. Herbs are likewise patchy, and the herb layer is usually dominated by only a few species. The bryoid layer varies, but is often extensive. Hummock-and-hollow topography is often pronounced, with bryophytes common on the hummocks and in those hollows where water does not stand for long periods.

Reference Sites: near Portland Pumphouse #2, Delaware Water Gap, PA.

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688103

References: Breden et al. 2001, Cain and Penfound 1938, Cowardin et al. 1979, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Gawler 2002, Golet et al. 1993, Harrison 2004, Metzler and Barrett 2001, NAP pers. comm. 1998, Rawinski 1984, Sperduto 2000b, Sperduto et al. 2000b, Swain and Kearsley 2001, Thompson 1996, Thompson and Sorenson 2000, Vogelmann 1976, Windisch 1995c, Zebryk 1990.

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>Nyssa sylvatica</i> (blackgum)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Ilex verticillata</i> (common winterberry)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Vaccinium corymbosum</i> (highbush blueberry)

RED MAPLE UPLAND FOREST

Acer rubrum / *Dennstaedtia punctilobula* Forest

Range: This red maple upland forest occurs in the Pennsylvania portion of the Delaware Estuary.

Environmental Description: This community occurs in upland settings and tends to persist when embedded in an oak forest matrix but is ephemeral as part of a "northern hardwoods" matrix.

Vegetation Description: This is a successional to persistent closed-canopy forest dominated by *Acer rubrum* (red maple). Canopy associates include *Quercus* (oak) spp., *Betula lenta* (sweet birch), *Liriodendron tulipifera* (tuliptree), *Prunus serotina* (black cherry), *Fraxinus americana* (white ash), and *Carya* (hickory) spp. Typical shrubs include *Viburnum acerifolium* (mapleleaf viburnum), *Lindera benzoin* (northern spicebush), *Hamamelis virginiana* (American witch-hazel), *Kalmia latifolia* (mountain laurel), *Gaylussacia baccata* (black huckleberry), and *Cornus*



Photo by Pennsylvania Natural Heritage Program

florida (flowering dogwood). The understory is variable and dominated by *Dennstaedtia punctilobula* (eastern hay-scented fern) and *Thelypteris noveboracensis* (New York fern).

Characteristic Species: *Acer rubrum* (red maple), *Dennstaedtia punctilobula* (eastern hay-scented fern).

Dynamics/Successional Trajectory: This is a successional forest type and is becoming more common where heavy deer browse pressure following canopy disturbance favors red maple regeneration over oaks and other hardwoods. In northern hardwood forests, this type may be considered early- to mid-successional and may be expected to add typical northern hardwood canopy dominants over time (e.g., sugar maple, beech, and hemlock).

Management Concerns: None, not a conservation target. This community is heavily deer browsed.

Reference Sites: No need for reference sites as this community is not a desired target for restoration.

Global and State Conservation Ranks and Reasons: GNR (8-Jul-1999). PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685013

References: Eastern Ecology Working Group n.d., Fike 1999.

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>Betula lenta</i> (sweet birch)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Viburnum acerifolium</i> (mapleleaf viburnum)

RED OAK - NORTHERN HARDWOOD FOREST

Quercus rubra - *Acer saccharum* - *Fagus grandifolia* / *Viburnum acerifolium* Forest

Range: This association occurs in New England and adjacent Canada and in New Jersey. This forest type is very common in the Pennsylvania portion of the Delaware Estuary.

Environmental Description: Transitional between temperate and boreal regions, these mesic forests of oak, beech and maple are distributed across the glaciated northeastern United States. They occur on slightly acidic, well-drained loamy and often rocky soils of intermediate fertility, most often positioned on midslopes and coves. Soil depth is often shallow, but some stands occur on deep tills. Most are at low to mid elevations, usually under 515 m (1700 feet), but in the southern portion of their distribution, they may range up to 765 m (2500 feet).

Vegetation Description: The deciduous-to-mixed canopy is mostly closed, and the lower layers are variable in extent. Tall shrubs are well-represented, although scattered, with occasional denser patches. Herbs are sparse and bryoids are nearly absent. Ericads and other dwarf-shrubs are also nearly absent, a characteristic that distinguishes this association from most other red oak forests in the Northeast. Canopy composition is a variable mixture of *Quercus rubra* (northern red oak) (usually at least 30% of the canopy), *Fagus grandifolia* (American beech), *Acer saccharum* (sugar maple), *Acer rubrum* (red maple), and in some stands, *Pinus strobus* (eastern white pine) or *Tsuga canadensis* (eastern hemlock). In mixed stands, the cover of deciduous trees exceeds that of conifers. Minor canopy associates include *Fraxinus americana* (white ash), *Tilia americana* (American basswood), *Betula lenta* (sweet birch), *Juglans cinerea* (butternut), and *Ulmus americana* (American elm). *Acer pensylvanicum* (striped maple) occurs occasionally as a small tree; *Cornus florida* (flowering dogwood) and *Prunus serotina* (black cherry) are common small trees. *Corylus cornuta* (beaked hazelnut), *Viburnum acerifolium* (mapleleaf viburnum), and *Hamamelis virginiana* (American witch-hazel) are standard shrubs, with *Kalmia latifolia* (mountain laurel) and *Lindera benzoin* (northern spicebush) occasional in all but the northern portions of the range. Typical

species in the herb layer include *Gaultheria procumbens* (wintergreen), *Maianthemum canadense* (Canada mayflower), *Aralia nudicaulis* (wild sarsaparilla), *Trientalis borealis* (starflower), *Uvularia sessilifolia* (sessile-leaf bellwort), *Medeola virginiana* (Indian cucumber-root), *Brachyelytrum erectum* (bearded shorthusk), *Dryopteris intermedia* (intermediate woodfern), *Polystichum acrostichoides* (Christmas fern), *Dennstaedtia punctilobula* (eastern hay-scented fern), *Pteridium aquilinum* (bracken fern), and *Thelypteris noveboracensis* (New York fern). On more nutrient-rich soils, the herb layer may contain *Solidago caesia* (wreath goldenrod), *Caulophyllum thalictroides* (blue cohosh), and *Eurybia divaricata* (white wood-aster).

Characteristic Species: *Acer pensylvanicum* (striped maple), *Aralia nudicaulis* (wild sarsaparilla), *Cornus florida* (flowering dogwood), *Corylus cornuta* (beaked hazelnut), *Fagus grandifolia* (American beech), *Hamamelis virginiana* (American witch-hazel), *Prunus serotina* (black cherry), *Pteridium aquilinum* (bracken fern), *Quercus rubra* (northern red oak), *Trientalis borealis* (starflower), *Viburnum acerifolium* (mapleleaf viburnum).

Reference Sites: (Note: very common forest type - lots of records for it in the PA CNAIs, but none on public land).

Global and State Conservation Ranks and Reasons: G4G5 (7-Dec-2005). NJ: SNR, PA: SNR. This association is well-distributed in the northeastern U.S. in its large-patch setting.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684448

References: Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002, Eyre 1980, Gawler 2002, Metzler and Barrett 2001, Rawinski 1984, Sperduto 2000a, Swain and Kearsley 2001, Thompson 1996, Thompson and Sorenson 2000.

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>Acer saccharum</i> (sugar maple)
Tree canopy	Broad-leaved deciduous tree	<i>Fagus grandifolia</i> (American beech)
Tree canopy	Broad-leaved deciduous tree	<i>Quercus rubra</i> (northern red oak)
Tree subcanopy	Broad-leaved deciduous tree	<i>Acer pensylvanicum</i> (striped maple)
Tree subcanopy	Broad-leaved deciduous tree	<i>Cornus florida</i> (flowering dogwood)
Tree subcanopy	Broad-leaved deciduous tree	<i>Prunus serotina</i> (black cherry)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Corylus cornuta</i> (beaked hazelnut)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Hamamelis virginiana</i> (American witch-hazel)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Viburnum acerifolium</i> (mapleleaf viburnum)
Herb (field)	Forb	<i>Aralia nudicaulis</i> (wild sarsaparilla)
Herb (field)	Forb	<i>Trientalis borealis</i> (starflower)

WHITE PINE - HEMLOCK DRY-MESIC CONIFEROUS FOREST

Pinus strobus - *Tsuga canadensis* Lower New England / Northern Piedmont Forest

Range: This association occurs in the northeastern United States and possibly adjacent Canada. In the Delaware Estuary study area, this association is probably confined to the upper portions of the Schuylkill watershed.

Environmental Description: This dry-mesic coniferous forest usually occurs on sloping (moderately to steeply) sites or in sheltered ravines. Soils are moderately to extremely well-drained (dry-mesic to mesic), loamy sands and sandy loams, often sandy, stony or bouldery.



Photo by Pennsylvania Natural

Vegetation Description: This coniferous forest type is dominated by *Pinus strobus* (eastern white pine) and/or *Tsuga canadensis* (eastern hemlock). Other frequent tree species depend on geography and can include *Acer pensylvanicum* (striped maple), *Quercus rubra* (northern red oak), and *Acer rubrum* (red maple), with *Prunus serotina* (black cherry), *Betula lenta* (sweet birch), *Acer saccharum* (sugar maple), *Fraxinus americana* (white ash), *Betula alleghaniensis* (yellow birch), and *Betula populifolia* (gray birch) occurring less frequently. Although frequent, deciduous tree species generally occur with low abundance. Shrubs are absent or sparse but when present may include *Hamamelis virginiana* (American witch-hazel), *Kalmia latifolia* (mountain laurel), *Vaccinium angustifolium* (northern lowbush blueberry), and *Viburnum acerifolium* (mapleleaf viburnum). The herbaceous layer is generally not well-developed nor diverse and is generally characterized by *Gaultheria procumbens* (wintergreen), *Medeola virginiana* (Indian cucumber-root), and *Thelypteris noveboracensis* (New York fern). Other herbaceous associates often include *Aralia nudicaulis* (wild sarsaparilla), *Uvularia sessilifolia* (sessile-leaf bellwort), *Mitchella repens* (partridgeberry), *Trientalis borealis* (starflower), *Monotropa uniflora* (Indian-pipe), *Dryopteris intermedia* (intermediate woodfern), and *Maianthemum canadense* (Canada mayflower). Nonvascular plants tend to be sparse but can include *Leucobryum albidum* (pincushion moss) and *Polytrichum* (haircap moss) and *Dicranum* (broom moss) species.

Characteristic Species: *Gaultheria procumbens* (wintergreen), *Medeola virginiana* (Indian cucumber-root), *Pinus strobus* (eastern white pine), *Thelypteris noveboracensis* (New York fern), *Tsuga canadensis* (eastern hemlock).

Dynamics/Successional Trajectory: The major natural disturbance in this forest type is generally single-tree blowdowns. Fire is not a particularly important feature of this forest type.

Management Concerns: Hemlock wooly adelgid may have significant negative impacts to the vegetation structure, species composition, and habitat suitability of this association.

Reference Sites: Hogback Road, Delaware Water Gap, PA.

Global and State Conservation Ranks and Reasons: G5 (22-Mar-1999). PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689294

References: Brown et al. 1982a, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Eyre 1980, Fike 1999, Gawler 2002, Gordon 1937a, Hough 1943, Hough and Forbes 1943, MENHP 1991, Metzler and Barrett 2001, NAP pers. comm. 1998, Rawinski 1984, Sperduto and Nichols 2004, Swain and Kearsley 2001, Thompson 1996, Thompson and Sorenson 2000.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus strobus</i> (eastern white pine)
Tree canopy	Needle-leaved tree	<i>Tsuga canadensis</i> (eastern hemlock)
Herb (field)	Fern or fern ally	<i>Thelypteris noveboracensis</i> (New York fern)

ECOLOGICAL SYSTEM: APPALACHIAN SERPENTINE WOODLAND

Summary: This system consists of distinct vegetation associated with ultramafic rock substrates in the Piedmont and Blue Ridge of the eastern United States. Most examples are open woodlands with *Pinus rigida* (pitch pine) and/or *Quercus alba* (white oak) and *Quercus stellata* (post oak) in the often stunted canopy. Extreme edaphic conditions lead to locally xerophytic growing conditions that contribute to relatively open canopies and often grassy ground cover. Unusual and extreme soil chemistry is the primary ecological factor, but fire is an important factor in determining vegetation structure and dynamics.

High-ranked Species: *Canis rufus* (G1Q, red wolf), *Coreopsis delphiniifolia* (G3?Q, larkspur tickseed), *Drepanolejeunea appalachiana* (G2?), *Erynnis martialis* (G3G4, mottled duskywing), *Thalictrum macrostylum* (G3G4, small-leaf meadowrue), *Thaspium pinnatifidum* (G2G3, cutleaf meadow-parsnip), *Viola appalachiensis* (G3, Appalachian blue violet), *Virginia valeriae pulchra* (G5T3T4, mountain earth snake).

Range: This system is widely scattered throughout the southern and central Appalachians and Piedmont, from Pennsylvania to Georgia. United States: GA, MD, NC, PA, SC?, VA?

Delaware Estuary Associations:

- Serpentine Emergent Wetland
- Serpentine Indiangrass - Little Bluestem Grassland
- Serpentine Little Bluestem - Prairie Dropseed Grassland
- Serpentine Red Maple - Oak - Catbrier Serpentine Forest
- Serpentine Red Maple - Pine Forest
- Serpentine Red-cedar - Virginia Pine - Catbrier Serpentine Forest
- Virginia Pine Serpentine Forest

CLASSIFIERS FOR APPALACHIAN SERPENTINE WOODLAND

Primary Division: 202

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); Rock Outcrops/Barrens/Glades

SERPENTINE EMERGENT WETLAND

Deschampsia caespitosa - *Vernonia noveboracensis* Herbaceous Vegetation

Range: This community occurs along groundwater seeps in three of the serpentine barrens in Chester County, Pennsylvania.

Environmental Description: This community occurs in groundwater seep areas of low slope (1-3 degrees) and variable aspect. Soils are typically very wet (saturated) clay loams and sapric peats (muck) derived from serpentine bedrock. Soil depth is generally greater than 30 cm and can exceed 60 cm.

Vegetation Description: This community is very open with woody plants limited to occasional trees, typically *Acer rubrum* (red maple)



Photo by Pennsylvania Natural Heritage Program

along the wetland edge and scattered *Alnus serrulata* (smooth alder) within the wetland. The dominant herbaceous species is *Deschampsia caespitosa* (tufted hairgrass). Other important herbaceous species include *Leersia oryzoides* (rice cutgrass), *Sorghastrum nutans* (yellow Indiangrass), *Juncus tenuis* (poverty rush), *Vernonia noveboracensis* (New York ironweed), and *Dichanthelium clandestinum* (deer-tongue witchgrass).

Characteristic Species: *Deschampsia caespitosa* (tufted hairgrass), *Vernonia noveboracensis* (New York ironweed).

Dynamics/Successional Trajectory: This community is driven by fluctuations in groundwater and the serpentine bed rock geology associated with the seep community.

Reference Sites: Nottingham and Chrome serpentine barrens, PA.

Global and State Conservation Ranks and Reasons: GNR (20-Sep-2005). PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.787677

References: Eastern Ecology Working Group n.d., Fike 1999, Podniesinski et al. unpubl. data 1999.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Deschampsia caespitosa</i> (tufted hairgrass)
Herb (field)	Graminoid	<i>Leersia oryzoides</i> (rice cutgrass)

SERPENTINE INDIANGRASS - LITTLE BLUESTEM GRASSLAND

Sorghastrum nutans - *Schizachyrium scoparium* Serpentine Herbaceous Vegetation

Range: This community occurs in serpentine barrens located within Chester County in Pennsylvania and on Staten Island, New York.

Environmental Description: This serpentine grassland community is associated with soils derived from weathered serpentine bedrock. It occurs over shallow (15-25 cm deep) silt loam to clay loam soils on low to mid slopes with a northerly aspect.

Vegetation Description: The dominant species in this community are *Sorghastrum nutans* (yellow Indiangrass) and *Schizachyrium*



Photo by Pennsylvania Natural Heritage Program

scoparium (little bluestem). Other characteristic herbaceous species may include *Symphotrichum depauperatum* (serpentine American-aster), *Vernonia noveboracensis* (New York ironweed), *Achillea millefolium* (common yarrow), *Deschampsia caespitosa* (tufted hairgrass), *Packera anonyma* (Small's groundsel), *Oenothera fruticosa* ssp. *glauca* (narrowleaf evening-primrose), *Setaria parviflora* (yellow foxtail grass), *Panicum virgatum* (switchgrass), *Danthonia spicata* (poverty oatgrass), *Symphotrichum ericoides* (white heath aster), *Symphotrichum lateriflorum* (calico aster), *Ageratina aromatica* (lesser snakeroot), *Potentilla simplex* (common cinquefoil), and *Asclepias viridiflora* (green comet milkweed). In Pennsylvania, the only important woody species is *Juniperus virginiana* (eastern red-cedar) which may have up to 40% cover in some grasslands. In New York, trees may cover 20-40% and typically include *Betula populifolia* (gray birch), *Quercus velutina* (black oak), *Sassafras albidum* (sassafras), and *Populus tremuloides* (quaking aspen).

Noteworthy Associated Plant and/or Animal Species: *Atrytone arogos* (arogos skipper).

Characteristic Species: *Sorghastrum nutans* (yellow Indiangrass).

Dynamics/Successional Trajectory: This grassland community is adapted to the weathering of serpentine bedrock. It was once thought that the lack of canopy cover was maintained by the unique edaphic features of the chrome series soils, but in the last 20 years many sites have been invaded by dense *Pinus virginiana* (Virginia pine) (Tyndall 1992a). In this community, eastern red-cedar can reach up to 40% in canopy cover. Further establishment and expansion of eastern red-cedar in this grassland community type may alter the light regime and promote substantial soil development (up to 10 cm in 20 years). Under these conditions, an entirely different community develops as the influence of the bedrock is buffered by the soil/litter accumulation. As the canopy closes, the grassland community can succeed into a serpentine woodland or forest, and a dense understory of *Smilax rotundifolia* (roundleaf greenbrier) may become established. Some of the characteristic herbaceous serpentine species apparently may persist in the ground layer as scattered non-flowering individuals; other populations appear to die out but may persist in the seed bank.

Management Concerns: Selective cutting has been effective in restoring degraded sites to their previous composition and structure, but most researchers believe that without regular burning to prevent soil development the herbaceous serpentine plant communities may not persist. There is substantial evidence that most of the existing areas were regularly burned by Native Americans (Marye 1920, 1955a, 1955b, 1955c) and perhaps maintained by grazing after European settlement.

Reference Sites: Chrome and Nottingham Serpentine Barrens, PA; Unionville, Fern Hill, Brintons Quarry (Chester), PA; Pink Hill (Delaware).

Global and State Conservation Ranks and Reasons: G1G2 (21-Sep-2005). PA: SNR. New ranking will need to be developed for each serpentine association.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.787695

References: Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Marye 1920, Marye 1955a, Marye 1955b, Marye 1955c, Podniesinski et al. unpubl. data 1999, Smith n.d.a, Tyndall 1992a.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Sorghastrum nutans</i> (yellow Indiangrass)

SERPENTINE LITTLE BLUESTEM - PRAIRIE DROPSEED GRASSLAND

Schizachyrium scoparium - *Sporobolus heterolepis* Serpentine Herbaceous Vegetation

Range: This community occurs in serpentine barrens located within Chester and Lancaster counties in Pennsylvania and in Cecil County, Maryland.

Environmental Description: This serpentine grassland community is associated with soils derived from weathered serpentine bedrock. It typically occurs on mid to upper slopes on very shallow (0-10 cm deep) stony or gravelly sand or silt loam soils. Exposed bedrock and bare ground are common at some locations. Soils are typically very dry, reflecting well-drained to excessively well-drained soil conditions and



Photo by Pennsylvania Natural Heritage Program

shallow depth to bedrock. Slope aspect is variable but is rarely due east. The slope angle ranges from 1-16 degrees and is most often between 3 and 6 degrees. A subtype of this community occurs on gravel barrens in Pennsylvania and Maryland. These barrens have the same species composition; however, they typically have less than 60% vegetation cover and exposed serpentine bedrock and gravel as the dominant cover type. Gravel barrens occur at mid-slope positions with a steep slope (>6 degrees and as much as 16 degrees). Gravel barrens are also more likely to have a southern aspect.

Vegetation Description: The dominant species in this community are the grasses *Schizachyrium scoparium* (little bluestem) and *Sporobolus heterolepis* (prairie dropseed). Other characteristic herbaceous species may include *Symphotrichum depauperatum* (serpentine American-aster), *Scleria pauciflora* (papillose nutrush), *Cerastium arvense* var. *villosum* (field chickweed), *Solidago nemoralis* (gray goldenrod), *Packera anonyma* (Small's groundsel), *Dichanthelium sphaerocarpon* (round-fruit witchgrass), and *Arabis lyrata* (lyrate rockcress). Woody plants are rare and usually include *Juniperus virginiana* (eastern red-cedar) or pine seedlings and saplings of *Pinus rigida* (pitch pine) and/or *Pinus virginiana* (Virginia pine).

Noteworthy Associated Plant and/or Animal Species: *Talinum teretifolium* (eastern fameflower).

Characteristic Species: *Schizachyrium scoparium* (little bluestem), *Sporobolus heterolepis* (prairie dropseed), *Symphotrichum depauperatum* (serpentine American-aster).

Dynamics/Successional Trajectory: This grassland community is adapted to the weathering of serpentine bedrock. It was once thought that the lack of canopy cover was maintained by the unique edaphic features of the chrome series soils, but in the last 20 years, many sites have been invaded by dense *Pinus virginiana* (Virginia pine) (Tyndall 1992a). Selective cutting has been effective in restoring degraded sites to their previous composition and structure, but most researchers believe that without regular burning to prevent soil development the herbaceous serpentine plant communities may not persist. There is substantial evidence that most of the existing areas were regularly burned by Native Americans (Marye 1920, 1955a, 1955b, 1955c) and perhaps maintained by grazing after European settlement.

Management Concerns: Selective cutting has been effective in restoring degraded sites to their previous composition and structure, but most researchers believe that without regular burning to prevent soil development the herbaceous serpentine plant communities may not persist. There is substantial evidence that most of the existing areas were regularly burned by Native Americans (Marye 1920, 1955a, 1955b, 1955c) and perhaps maintained by grazing after European settlement.

Reference Sites: Nottingham, Chrome, Goat Hill, New Texas and Rock Springs Serpentine barrens, PA.

Global and State Conservation Ranks and Reasons: G1G2 (21-Sep-2005). PA: SNR. New ranking will need to be developed for each serpentine association.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.787699

References: Eastern Ecology Working Group n.d., Fike 1999, Harrison 2004, Marye 1920, Marye 1955a, Marye 1955b, Marye 1955c, Podniesinski et al. unpubl. data 1999, Smith n.d.a, Tyndall 1992a, Tyndall 1992b, Tyndall and Farr 1990.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Schizachyrium scoparium</i> (little bluestem)

SERPENTINE RED MAPLE - OAK - CATBRIER SERPENTINE FOREST

Acer rubrum - *Quercus* spp. / *Smilax* spp. Serpentine Forest

Range: This community occurs in serpentine barrens located within Chester and Lancaster counties in Pennsylvania and on Staten Island, New York.

Environmental Description: This serpentine plant community is associated with soils derived from weathered serpentine bedrock. It typically occurs on upper slopes and interfluvies with a southerly aspect. Soils are silt loams, greater than 30 cm deep.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: In Pennsylvania serpentine barrens, the forest or woodland canopy is dominated by *Acer rubrum* (red maple) and *Quercus alba* (white oak), as well as other oak species, including *Quercus falcata* (southern red oak), *Quercus rubra* (northern red oak), and *Quercus velutina* (black oak). On Staten Island, New York, the canopy includes *Betula populifolia* (gray birch) and *Populus tremuloides* (quaking aspen) in addition to *Quercus velutina* (black oak) and *Sassafras albidum* (sassafras). The subcanopy is characterized by *Acer rubrum* (red maple), *Quercus alba* (white oak), *Nyssa sylvatica* (blackgum), and *Prunus serotina* (black cherry). The shrub layer is dominated by *Smilax rotundifolia* (roundleaf greenbrier) and/or *Smilax glauca* (whiteleaf greenbrier). *Vaccinium pallidum* (hillside blueberry), *Rubus allegheniensis* (Allegheny blackberry), *Gaylussacia baccata* (black huckleberry), *Prunus serotina* (black cherry), *Morella pensylvanica* (northern bayberry), *Rhus copallinum* (winged sumac), and/or *Viburnum recognitum* (northern arrow-wood) may also be present in the shrub layer. The herbaceous layer under the canopy cover is depauperate and typically dominated by *Smilax rotundifolia* (roundleaf greenbrier), *Smilax glauca* (whiteleaf greenbrier), and *Microstegium vimineum* (Japanese stiltgrass). Other typical herbaceous species include *Danthonia spicata* (poverty oatgrass), *Carex glaucoidea* (blue sedge), and *Lonicera japonica* (Japanese honeysuckle).

Noteworthy Associated Plant and/or Animal Species: *Atrytone arogos* (arogos skipper).

Characteristic Species: *Acer rubrum* (red maple), *Quercus alba* (white oak), *Smilax rotundifolia* (roundleaf greenbrier)

Dynamics/Successional Trajectory: This plant community is adapted to the weathering of serpentine bedrock. It was once thought that the lack of canopy cover was maintained by the unique edaphic features of the chrome series soils, but in the last 20 years, many sites have been invaded by dense *Pinus virginiana* (Virginia pine) (Tyndall 1992a). In Pennsylvania, red maple and white oak are the canopy dominants of this type; while in New York, dominant canopy species include black oak, sassafras, and gray birch. This phenomenon dramatically alters the light regime and promotes substantial soil development (up to 10 cm in 20 years). Under these conditions, an entirely different community develops as the influence of the bedrock is buffered by the soil/litter accumulation. This closed-canopy serpentine forest typically exhibits a dense understory of *Smilax rotundifolia* (roundleaf greenbrier).

Management Concerns: Exotic plants such as *Lonicera japonica* (Japanese honeysuckle) occur in this community. Some of the characteristic herbaceous serpentine species apparently persist in the ground layer as scattered non-flowering individuals; other populations appear to die out but may persist in the seed bank. Selective cutting has been effective in restoring degraded sites to their previous composition and structure, but most researchers believe that without regular burning to prevent soil development the

serpentine plant communities will not persist. There is substantial evidence that most of the existing areas were regularly burned by Native Americans (Marye 1920, 1955a, 1955b, 1955c) and perhaps maintained by grazing after European settlement.

Reference Sites: Chrome, Goat Hill, New Texas, and Rock Springs Serpentine barrens, PA.

Global and State Conservation Ranks and Reasons: G1G2 (20-Sep-2005). PA: SNR. New ranking will need to be developed for each Pennsylvania serpentine association.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.787680

References: Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Marye 1920, Marye 1955a, Marye 1955b, Marye 1955c, Podniesinski et al. unpubl. data 1999, Smith n.d.a, Tyndall 1992a.

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>Quercus alba</i> (white oak)
Shrub/sapling (tall & short)	Vine/Liana	<i>Smilax rotundifolia</i> (roundleaf greenbrier)
Herb (field)	Graminoid	<i>Danthonia spicata</i> (poverty oatgrass)

SERPENTINE RED MAPLE - PINE FOREST

Acer rubrum - *Pinus virginiana* - *Pinus rigida* / *Microstegium vimineum* - *Smilax* spp. Serpentine Forest

Range: This community occurs in serpentine barrens located within Chester and Lancaster counties in Pennsylvania and Cecil County in Maryland.

Environmental Description: This serpentine plant community is associated with soils derived from weathered serpentine bedrock. It typically occurs on mid to low slopes. Soils are typically silt loams or occasionally clay loam and exceed 50 cm in depth.

Vegetation Description: Dominant canopy trees include *Acer rubrum* (red maple), *Pinus virginiana* (Virginia pine), *Pinus rigida* (pitch pine), and *Juniperus virginiana* (eastern red-cedar). The subcanopy is dominated by *Acer rubrum* (red maple). The shrub layer is characterized by *Lindera benzoin* (northern spicebush) and *Acer rubrum* (red maple). The herbaceous layer is dominated by *Microstegium vimineum* (Japanese stiltgrass), *Smilax rotundifolia* (roundleaf greenbrier), *Smilax glauca* (whiteleaf greenbrier), and *Lonicera japonica* (Japanese honeysuckle).

Characteristic Species: *Acer rubrum* (red maple), *Lindera benzoin* (northern spicebush), *Microstegium vimineum* (Japanese stiltgrass), *Pinus rigida* (pitch pine), *Pinus virginiana* (Virginia pine).

Dynamics/Successional Trajectory: This plant community is adapted to the weathering of serpentine bedrock. It was once thought that the lack of canopy cover was maintained by the unique edaphic features of the chrome series soils, but in the last 20 years, many sites have been invaded by dense *Pinus virginiana* (Virginia pine) (Tyndall 1992a). In this serpentine barren community red maple, Virginia pine and pitch pine are the canopy dominants of this type. This phenomenon dramatically alters the light regime and promotes substantial soil development (up to 10 cm in 20 years). Under these conditions, an entirely different community develops as the influence of the bedrock is buffered by the soil/litter accumulation. This closed-canopy serpentine forest typically exhibits a dense understory of *Smilax rotundifolia* (roundleaf greenbrier).

Management Concerns: Some of the characteristic herbaceous serpentine species apparently persist in the ground layer as scattered non-flowering individuals; other populations appear to die out but may persist in the seed bank. Selective cutting has been effective in restoring degraded sites to their previous composition and structure, but most researchers believe that without regular burning to prevent soil development the serpentine plant communities will not persist. There is substantial evidence that most of

the existing areas were regularly burned by Native Americans (Marye 1920, 1955a, 1955b, 1955c) and perhaps maintained by grazing after European settlement.

Reference Sites: Nottingham, Chrome, Goat Hill, New Texas and Rock Springs Serpentine barrens, PA; Pilot Serpentine Barren, MD.

Global and State Conservation Ranks and Reasons: G1G2 (20-Sep-2005). PA: SNR. New ranking will need to be developed for each Pennsylvania serpentine association.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.787687

References: Eastern Ecology Working Group n.d., Fike 1999, Marye 1920, Marye 1955a, Marye 1955b, Marye 1955c, Podniesinski et al. unpubl. data 1999, Smith n.d.a, Tyndall 1992a, Tyndall and Farr 1990.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus rigida</i> (pitch pine)
Tree canopy	Needle-leaved tree	<i>Pinus virginiana</i> (Virginia pine)
Shrub/sapling (tall & short)	Broad-leaved deciduous tree	<i>Acer rubrum</i> (red maple)
Herb (field)	Graminoid	<i>Microstegium vimineum</i> (Japanese stiltgrass)

SERPENTINE RED-CEDAR - VIRGINIA PINE - CATBRIER SERPENTINE FOREST

Juniperus virginiana - *Pinus virginiana* / *Smilax rotundifolia* Serpentine Forest

Range: This community occurs in serpentine barrens located within Chester and Lancaster counties in Pennsylvania and Cecil County in Maryland.

Environmental Description: This serpentine plant community is associated with soils derived from weathered serpentine bedrock and typically occurs on the upper portions of moderate to steep slopes (typically 5-25 degrees) commonly with a northerly and/or easterly aspect. Soils are typically well-drained and somewhat moist to dry. Soil texture is characteristically silt loam or clay loam and may be stony to stone-free. Soil depth varies from 4 cm to >30 cm but is typically 10 to 20 cm deep.

Vegetation Description: The dominant canopy trees are *Pinus virginiana* (Virginia pine) and *Juniperus virginiana* (eastern red-cedar). *Sassafras albidum* (sassafras) and *Acer rubrum* (red maple) also are present but are not abundant in the canopy. The low-shrub layer is sparse and consists mainly of occasional hardwood seedlings. The dense shade of the conifer overstory and the accumulation of needle litter have produced a depauperate herbaceous layer. *Smilax rotundifolia* (roundleaf greenbrier) is the dominant species in the herbaceous layer and also acts as a liana, climbing into the conifer canopy and forming an often impenetrable curtain. Characteristic herbaceous species include *Microstegium vimineum* (Japanese stiltgrass), *Danthonia spicata* (poverty oatgrass), and *Polystichum acrostichoides* (Christmas fern).

Characteristic Species: *Juniperus virginiana* (eastern red-cedar), *Pinus virginiana* (Virginia pine).

Dynamics/Successional Trajectory: This plant community is adapted to the weathering of serpentine bedrock. It was once thought that the lack of canopy cover was maintained by the unique edaphic features of the chrome series soils, but in the last 20 years, many sites have been invaded by dense *Pinus virginiana* (Virginia pine) (Tyndall 1992a). In this community, Virginia pine and eastern red-cedar are the canopy dominants. This phenomenon dramatically alters the light regime and promotes substantial soil development (up to 10 cm in 20 years). Under these conditions, an entirely different community develops as the influence of the bedrock is buffered by the soil/litter accumulation. This closed-canopy serpentine forest exhibits a dense understory of *Smilax rotundifolia* (roundleaf greenbrier).

Management Concerns: Some of the characteristic herbaceous serpentine species apparently persist in the ground layer as scattered non-flowering individuals; other populations appear to die out but may persist in the seed bank. Selective cutting has been effective in restoring degraded sites to their previous composition and structure, but most researchers believe that without regular burning to prevent soil development the serpentine plant communities will not persist. There is substantial evidence that most of the existing areas were regularly burned by Native Americans (Marye 1920, 1955a, 1955b, 1955c) and perhaps maintained by grazing after European settlement.

Reference Sites: Chrome, New Texas Serpentine Barrens, PA, and Pilot Serpentine Barren, MD.

Global and State Conservation Ranks and Reasons: G1G2 (20-Sep-2005). PA: SNR. New ranking will need to be developed for each serpentine association.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.787691

References: Eastern Ecology Working Group n.d., Fike 1999, Marye 1920, Marye 1955a, Marye 1955b, Marye 1955c, Podniesinski et al. unpubl. data 1999, Smith n.d.a, Tyndall 1989, Tyndall 1992a, Tyndall and Farr 1989.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Juniperus virginiana</i> (eastern red-cedar)
Tree canopy	Needle-leaved tree	<i>Pinus virginiana</i> (Virginia pine)

VIRGINIA PINE SERPENTINE FOREST

Pinus virginiana / *Quercus marilandica* Serpentine Forest

Range: This type is currently described from Cecil County in Maryland and Lancaster and Chester counties in Pennsylvania.

Environmental Description: This community type is a successional forest occurring on soils underlain and influenced by serpentine bedrock. It occurs on upper slopes and ridgetops with variable slopes (0-10 degrees) with a west, northwest or north aspect. Soils are somewhat moist to dry silt loams or clay loams.

Vegetation Description: This serpentine woodland/forest is dominated by *Pinus virginiana* (Virginia pine) with a subcanopy of *Quercus marilandica* (blackjack oak). Other tree associates include *Quercus stellata* (post oak), *Sassafras albidum* (sassafras), *Prunus serotina* (black cherry), *Nyssa sylvatica* (blackgum), *Juniperus virginiana* (eastern red-cedar), and *Robinia pseudoacacia* (black locust). A dense shrub layer dominated by *Smilax rotundifolia* (roundleaf greenbrier) and/or *Smilax glauca* (whiteleaf greenbrier) is characteristic in canopy openings. Other shrubs may include *Vaccinium pallidum* (hillside blueberry), *Vaccinium stamineum* (deerberry), *Gaylussacia baccata* (black huckleberry), *Quercus ilicifolia* (bear oak), and *Quercus prinoides* (dwarf chinquapin oak). Herbs may include *Aralia nudicaulis* (wild sarsaparilla), *Pteridium aquilinum* (bracken fern), *Microstegium vimineum* (Japanese stiltgrass), *Dichanthelium dichotomum* (witchgrass), and *Danthonia spicata* (poverty oatgrass). In some woodlands with less canopy cover and stonier soils, *Schizachyrium scoparium* (little bluestem) and *Sporobolus heterolepis* (prairie dropseed) dominate patches of the herbaceous layer along with scattered individuals of *Symphotrichum depauperatum* (serpentine American-aster), *Scleria pauciflora* (papillose nutrush), *Cerastium arvense* var. *villosum* (field chickweed), *Solidago nemoralis* (gray goldenrod), *Packera anonyma* (Small's groundsel), *Dichanthelium sphaerocarpon* (round-fruit witchgrass), and *Arabis lyrata* (lyrate rockcross).

Characteristic Species: *Pinus virginiana* (Virginia pine), *Quercus marilandica* (blackjack oak), *Smilax glauca* (whiteleaf greenbrier), *Smilax rotundifolia* (roundleaf greenbrier).

Dynamics/Successional Trajectory: This plant community is adapted to the weathering of serpentine bedrock. It was once thought that the lack of canopy cover was maintained by the unique edaphic features of the chrome series soils, but in the last 20 years, many sites have been invaded by dense *Pinus virginiana* (Virginia pine) (Tyndall 1992a). In serpentine barrens in Pennsylvania, Virginia pine and black jack oak are the canopy dominants of this type. This phenomenon dramatically alters the light regime and promotes substantial soil development (up to 10 cm in 20 years). Under these conditions, an entirely different community develops as the influence of the bedrock is buffered by the soil/litter accumulation. This closed-canopy serpentine forest is dominated by red maple and various oaks and typically exhibits a dense understory of *Smilax rotundifolia* (roundleaf greenbrier).

Management Concerns: Some of the characteristic herbaceous serpentine species apparently persist in the ground layer as scattered non-flowering individuals; other populations appear to die out but may persist in the seed bank. Selective cutting has been effective in restoring degraded sites to their previous composition and structure, but most researchers believe that without regular burning to prevent soil development the serpentine plant communities will not persist. There is substantial evidence that most of the existing areas were regularly burned by Native Americans (Marye 1920, 1955a, 1955b, 1955c) and perhaps maintained by grazing after European settlement.

Reference Sites: Nottingham, Chrome, Goat Hill, New Texas and Rock Springs Serpentine barrens, PA; Pilot Serpentine Barren, MD.

Global and State Conservation Ranks and Reasons: GNA (modified/managed) (1-Dec-1997). PA: SNA.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684859

References: Eastern Ecology Working Group n.d., Fike 1999, Marye 1920, Marye 1955a, Marye 1955b, Marye 1955c, Podniesinski et al. unpubl. data 1999, Tyndall 1989, Tyndall 1992a.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus virginiana</i> (Virginia pine)
Shrub/sapling (tall & short)	Vine/Liana	<i>Smilax glauca</i> (whiteleaf greenbrier)
Shrub/sapling (tall & short)	Vine/Liana	<i>Smilax rotundifolia</i> (roundleaf greenbrier)
Herb (field)	Graminoid	<i>Danthonia spicata</i> (poverty oatgrass)

ECOLOGICAL SYSTEM: ATLANTIC COASTAL PLAIN BLACKWATER STREAM FLOODPLAIN FOREST

Summary: This Atlantic Coastal Plain system, which is apparently most abundant in the Carolinas, occurs in floodplains of small streams that carry little mineral sediment (blackwater streams). These streams have their headwaters in sandy portions of the Coastal Plain. The water is usually strongly stained by tannins but has little suspended clay and is not turbid. Depositional landforms may be absent or present only in limited variety and of small size. Soils are usually strongly acidic. Periodicity of flooding ranges from long (semipermanent) in the wettest portions to short in higher gradient streams. Some small blackwater streams have most of their flow from sandhill seepage and have limited fluctuation in water levels. Vegetation varies from north to south, but generally consists almost entirely of forests of wetland trees, but occasional, small shrubby sloughs may also be present. A variety of tree species may be present; wetter examples (especially toward the northern range limits of this system) are often strongly dominated by *Taxodium distichum* (bald-cypress) and *Nyssa biflora* (swamp blackgum). Other examples have mixtures of these species with *Quercus* (oak) spp. and other bottomland hardwoods tolerant of blackwater conditions. Species richness ranges from low to moderate, but is lower than in comparable brownwater systems. Flooding is an important ecological factor in this system and may be the most important factor separating it from adjacent systems. Flooding brings nutrients and excludes non-flood-tolerant species. Unlike river systems, flooding tends to be variable and of shorter duration.

Range: This system is potentially found throughout the Atlantic Coastal Plain north to Maryland, Delaware and New Jersey, but it is most abundant in North Carolina and South Carolina. United States: DE, FL, GA, MD, NC, NJ, SC, VA.

Delaware Estuary Associations:

- Atlantic White-cedar / Seaside Alder Swamp
- Coastal Plain Atlantic White-cedar - Red Maple Swamp

CLASSIFIERS FOR ATLANTIC COASTAL PLAIN BLACKWATER STREAM FLOODPLAIN FOREST

Primary Division: 203

Land Cover Class: Woody Wetland

Spatial Scale & Pattern: Linear

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

Diagnostic Classifiers: Riverine / Alluvial [Blackwater]

Non-diagnostic Classifiers: Forest and Woodland (Treed)

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 or inkberry or little gallberry), and *Clethra alnifolia* (coastal sweet-pepperbush). The herbaceous layer is comprised of *Decodon verticillatus* (swamp-loosestrife), *Peltandra virginica* (green arrow-arum), *Nymphaea odorata* (white water-lily), *Carex exilis* (meager sedge), *Dichanthelium dichotomum* (witchgrass), *Oxypolis rigidior* (common water-dropwort), *Triadenum virginicum* (Virginia marsh St. John's-wort), *Dulichium arundinaceum* (threeway sedge), *Glyceria obtusa* (Atlantic mannagrass), *Rhynchospora alba* (white

beaksedge), *Carex atlantica* (prickly bog sedge), *Selaginella apoda* (meadow spike-moss), *Drosera rotundifolia* (roundleaf sundew), *Juncus militaris* (bayonet rush), *Vaccinium macrocarpon* (large cranberry), *Calopogon tuberosus* (tuberous grass-pink), and *Eriocaulon decangulare* (ten-angle pipewort). Floating mats within mill ponds have a unique species assemblage including *Xyris difformis* (bog yellow-eyed-grass), *Fuirena* (umbrella-sedge) spp., *Hypericum mutilum* (dwarf St. John's-wort), *Juncus pelocarpus* (brown-fruit rush), *Juncus canadensis* (Canadian rush), *Fimbristylis* (fimbry) sp., and *Rhynchospora macrostachya* (tall horned beaksedge).

Noteworthy Associated Plant and/or Animal Species: *Alnus maritima* (seaside alder).

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

Management Concerns: This association may be of artificial origin, as a result of damming. More information is needed.

Reference Sites: Prime Hook, DE.

Global and State Conservation Ranks and Reasons: GNR (17-Apr-2000). DE: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685928

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

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Chamaecyparis thyoides</i> (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)

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 sweet-pepperbush), *Ilex glabra* (inkberry or little gallberry), *Gaylussacia frondosa* (dangleberry), *Rhododendron viscosum* (swamp azalea), *Smilax rotundifolia* (roundleaf greenbrier), and *Smilax laurifolia* (blaspheme-vine). 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. John's-wort), *Pogonia ophioglossoides* (rose pogonia), *Boehmeria cylindrica* (small-spike false nettle), *Carex collinsii* (Collins' sedge), and *Carex folliculata* (northern long sedge). In canopy openings, *Orontium aquaticum* (golden club) and *Iris versicolor* (harlequin blueflag) may also occur. Sphagnum mosses form a moderately dense to dense bryophyte layer; species include *Sphagnum magellanicum* (Magellan's peatmoss), *Sphagnum cuspidatum* (toothed peatmoss), *Sphagnum pulchrum* (beautiful peatmoss), *Sphagnum flavicomans* (peatmoss), *Sphagnum recurvum* (recurved peatmoss), and *Sphagnum fallax* (flat-top bogmoss).

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

Reference Sites: Brendan Byrne State Forest, 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

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> (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> (highbush blueberry)
Herb (field)	Fern or fern ally	<i>Osmunda cinnamomea</i> (cinnamon fern)

ECOLOGICAL SYSTEM: ATLANTIC COASTAL PLAIN BROWNWATER STREAM FLOODPLAIN FOREST

Summary: This Atlantic Coastal Plain system ranges from the Inner Coastal Plain of Maryland, to the Outer Coastal Plain of southeastern Virginia to Georgia on floodplains of smaller streams that carry significant mineral sediment (brownwater or redwater streams). These streams have their headwaters in the Piedmont, Blue Ridge, or other interior regions, or in portions of the Coastal Plain where fine-textured sediment predominates. The water generally carries substantial amounts of silt and clay. Depositional landforms, at least a natural levee, are often distinctly present but are fairly small relative to the scale of communities but help create some variation in duration of flooding and nutrient input. Soils are generally fertile and not strongly acidic. Flooding is generally seasonal, but may range to nearly semipermanent. Vegetation consists almost entirely of forests of wetland trees. Wetter examples are strongly dominated by *Taxodium distichum* (bald-cypress) and *Nyssa* (blackgum) spp. Other examples have mixtures of these species with *Quercus* (oak) spp. and other bottomland hardwoods. Except in the very wet examples, understory, shrub, and herb layers are generally well-developed and woody vines are also prominent. Flooding is an important ecological factor in this system and may be the most important factor separating it from adjacent systems. Flooding brings nutrients and excludes non-flood-tolerant species. Unlike river systems, flooding tends to be variable and of shorter duration.

Range: This system is found throughout the Atlantic Coastal Plain, from New Jersey, Delaware and Maryland to southeastern Georgia. United States: DE, GA, MD, NC, NJ, SC, VA

Delaware Estuary Associations:

- Coastal Plain Oak Floodplain Swamp

CLASSIFIERS FOR ATLANTIC COASTAL PLAIN BROWNWATER STREAM FLOODPLAIN FOREST

Primary Division: 203

Land Cover Class: Woody Wetland

Spatial Scale & Pattern: Linear

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

Diagnostic Classifiers: Riverine / Alluvial [Brownwater]

Non-diagnostic Classifiers: Forest and Woodland (Treed)

COASTAL PLAIN OAK FLOODPLAIN SWAMP

Quercus (palustris, phellos) - Acer rubrum / Cinna arundinacea Forest

Range: This community is found in the Chesapeake Bay region north to the southern Coastal Plain of New Jersey and Pennsylvania. It occurs in Cape May, New Jersey within the estuary.

Environmental Description: This floodplain swamp community of the Chesapeake Bay Lowlands ecoregion and environs occurs in topographic depressions within alluvial floodplains. It occurs in pockets of saturated soils in, or at the edges of, depressions within a larger floodplain forest with annual flooding. Soils are poorly drained loams or clay loams.

Vegetation Description: The tree canopy is dominated by *Quercus palustris* (pin oak), *Quercus phellos* (willow oak), *Acer rubrum* (red maple), and *Liquidambar styraciflua* (sweetgum). The shrub layer is of relatively low cover and comprised of *Viburnum dentatum* (southern arrow-wood), *Viburnum prunifolium* (smooth blackhaw), and *Ilex verticillata* (common winterberry). *Vaccinium corymbosum* (highbush blueberry) is a less frequent shrub layer associate. Typical vines include *Toxicodendron radicans* (eastern poison-ivy), *Parthenocissus quinquefolia* (Virginia creeper), and *Smilax rotundifolia* (roundleaf greenbrier). The herb layer is characterized by *Cinna arundinacea* (sweet woodreed), *Boehmeria cylindrica* (small-spike false nettle), *Symphotrichum lateriflorum* var. *lateriflorum* (calico aster), and *Carex* (sedge) spp., with less frequent associates including *Arisaema triphyllum* (Jack-in-the-pulpit),

Eurybia divaricata (white wood-aster), *Lycopus virginicus* (Virginia water-horehound), *Ranunculus abortivus* (kidneyleaf buttercup), *Euonymus americanus* (American strawberry-bush), *Chasmanthium laxum* (slender spikegrass), and *Glyceria striata* (fowl mannagrass).

Characteristic Species: *Boehmeria cylindrica* (small-spike false nettle), *Cinna arundinacea* (sweet woodreed), *Quercus palustris* (pin oak)

Dynamics/Successional Trajectory: This floodplain forest is subject to annual flooding.

Reference Sites: Cape May, NJ, and potentially Cedar Swamp WMA, New Castle County, DE

Global and State Conservation Ranks and Reasons: GNR (27-Mar-2000). DE?: SNA, NJ?:SNA, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689632

References: Eastern Ecology Working Group n.d., Fleming et al. 2001, Harrison 2004, Harrison and Stango 2003, Patterson pers. comm., Thomson et al. 1999

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>Quercus palustris</i> (pin oak)
Tree canopy	Broad-leaved deciduous tree	<i>Quercus phellos</i> (willow oak)
Herb (field)	Graminoid	<i>Cinna arundinacea</i> (sweet woodreed)

ECOLOGICAL SYSTEM: ATLANTIC COASTAL PLAIN MESIC HARDWOOD FOREST

Summary: This upland system of the Atlantic Coastal Plain ranges from southern New Jersey south to Georgia in a variety of moist but non-wetland sites that are naturally sheltered from frequent fire. Such sites include lower slopes and bluffs along streams and rivers in dissected terrain, mesic flats between drier pine-dominated uplands and floodplains, and local topographic high areas within bottomland terraces or nonriverine wet flats. Soil textures are variable in both texture and pH. The vegetation consists of forests dominated by combinations of trees that include a significant component of mesophytic deciduous hardwood species, such as *Fagus grandifolia* (American beech) or *Acer barbatum* (southern sugar maple). Its southern limit is generally exclusive of the natural range of *Pinus glabra* (spruce pine) as mapped by Kossuth and Michael (1990) and *Magnolia grandiflora* (southern magnolia) as mapped by Outcalt (1990). Upland and bottomland oaks at the mid range of moisture tolerance are usually also present, particularly *Quercus alba* (white oak), but sometimes also *Quercus falcata* (southern red oak), *Quercus michauxii* (swamp chestnut oak), *Quercus shumardii* (shumard oak), or *Quercus nigra* (water oak). *Pinus taeda* (loblolly pine) is sometimes present, but it is unclear if it is a natural component or has entered only as a result of past cutting. Analogous systems on the Gulf Coastal Plain have pine as a natural component, and this may be true for some examples of this system. Understories are usually well-developed. Shrub and herb layers may be sparse or moderately dense. Within its range, *Sabal minor* (dwarf palmetto) may be a prominent shrub. Species richness may be fairly high in basic sites but is fairly low otherwise.

Range: This system ranges from southern New Jersey south to central Georgia in the Atlantic Coastal Plain. United States: DE, GA, MD, NC, NJ, SC, VA

Delaware Estuary Associations:

- Basic Mesic Ravine Forest
- Mesic Coastal Plain Oak Forest
- Mid-Atlantic Mesic Mixed Hardwood Forest
- Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest

Similar Ecological Systems in the Delaware Estuary:

- Atlantic Coastal Plain Brownwater Stream Floodplain Forest

CLASSIFIERS FOR ATLANTIC COASTAL PLAIN MESIC 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

BASIC MESIC RAVINE FOREST

Fagus grandifolia - *Quercus muehlenbergii* / *Sanguinaria canadensis* Forest

Range: This community occurs in Virginia; however the same marl ravine community, or a very closely related community to this, occurs in New Jersey within the Delaware Estuary boundary.

Environmental Description: These rich mesophytic to submesophytic forests of calcareous ravines are found in the southeastern Virginia Coastal Plain, the adjacent Piedmont, and also in New Jersey. Habitats are north- to east-facing slopes and adjacent low interfluvial downcut into Tertiary shell deposits or limesands, including the Pliocene marine shell deposits of the calcium-rich Yorktown Formation.

Vegetation Description: The canopies of stands of this association are typically dominated by variable combinations of *Fagus grandifolia* (American beech), *Quercus rubra* (northern red oak), *Quercus muehlenbergii* (chinquapin oak), *Tilia americana* var. *americana* (American basswood), *Liriodendron tulipifera* (tuliptree), and *Quercus alba* (white oak). Although generally not as constant or abundant as *Fagus grandifolia* (American beech) or *Quercus muehlenbergii* (chinquapin oak) occurs in 75% of the plot samples and is a good diagnostic species. Characteristic or locally important understory species include *Magnolia tripetala* (umbrella magnolia), *Ulmus rubra* (slippery elm), *Ilex opaca* var. *opaca* (American holly), *Cornus alternifolia* (alternate-leaf dogwood), *Cercis canadensis* var. *canadensis* (eastern redbud), and *Carpinus caroliniana* (American hornbeam). Common herbs are *Polystichum acrostichoides* (Christmas fern), *Asarum canadense* (Canadian wild ginger), *Hepatica nobilis* var. *obtusata* (round-lobe liverleaf), *Arisaema triphyllum* (Jack-in-the-pulpit), *Actaea racemosa* (black cohosh), *Cardamine concatenata* (cutleaf toothwort), *Sanguinaria canadensis* (bloodroot), *Adiantum pedatum* (northern maidenhair), *Packera aurea* (golden ragwort), and *Luzula acuminata* var. *carolinae* (southern hairy woodrush). The grass *Brachyelytrum erectum* (bearded shorthusk) is abundant and characteristic of more submesic habitats (e.g., convex north slopes) occupied by the type. A number of herbaceous species found in this association are either at or near their northern range limit or are disjunct from a primary range farther west. Species in this group include *Chasmanthium sessiliflorum* (longleaf spikegrass), *Malaxis spicata* (Florida adder's-mouth), *Ponthieva racemosa* (hairy shadow-witch), *Panax quinquefolius* (American ginseng), *Actaea pachypoda* (white baneberry), *Solidago flexicaulis* (zigzag goldenrod), *Desmodium glutinosum* (large tick-trefoil), *Mitella diphylla* (twoleaf miterwort), *Thalictrum dioicum* (early meadowrue), *Prenanthes trifoliolata* (gall-of-the-earth), *Aralia racemosa* (American spikenard), *Scutellaria ovata* (heartleaf skullcap), *Deparia acrostichoides* (silver false spleenwort), and *Diplazium pycnocarpon* (glade fern). More floristic information is available in Ware and Ware (1992).

Characteristic Species: *Magnolia tripetala* (umbrella magnolia), *Quercus muehlenbergii* (chinquapin oak)

Management Concerns: Some stands have been impacted by removal of more valuable timber species (e.g., *Quercus alba* (white oak), *Quercus muehlenbergii* (chinquapin oak), *Quercus rubra* (northern red oak)). Timber harvesting degrades this community by allowing additional light and aggressive growth of invasive alien plants which thrive in well-lit, calcareous situations, including *Lonicera japonica* (Japanese honeysuckle). Residential and commercial development are additional threats to these historically protected ravine forests.

Reference Sites: Crosswicks Creek, NJ; Ors Creek, NJ

Global and State Conservation Ranks and Reasons: G2? (8-Jan-2001). NJ: SNR. This association is restricted to the southeastern Virginia Coastal Plain and possibly the adjacent Piedmont, on north- to east-facing slopes and adjacent low interfluves downcut into Tertiary shell deposits or lime sands, including the Pliocene marine shell deposits of the calcium-rich Yorktown Formation. Many herbaceous species found in this association are either at or near their northern range limit or are disjunct from a primary range farther west. A few examples are protected in Colonial National Park, Virginia, but others (including the best examples) are highly threatened by timber removal and development. Note: this is, or is related to, marl ravine association(s) in New Jersey; more inventory is needed to compare the types.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687025

References: Fleming et al. 2001, Fleming pers. comm., Patterson pers. comm., Southeastern Ecology Working Group n.d., VDNH 2003, Ware and Ware 1992

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>Quercus muehlenbergii</i> (chinquapin oak)
Tree subcanopy	Broad-leaved evergreen tree	<i>Ilex opaca</i> var. <i>opaca</i> (American holly)
Herb (field)	Forb	<i>Polystichum acrostichoides</i> (Christmas fern)
Herb (field)	Forb	<i>Sanguinaria canadensis</i> (bloodroot)

MESIC COASTAL PLAIN OAK FOREST

Quercus falcata - *Quercus phellos* / *Ilex opaca* Forest

Range: This Coastal Plain oak forest is currently described from New Jersey to Maryland. This community occurs in all three states within the Delaware Estuary.

Environmental Description: These forests occur on somewhat poorly-drained sands where the water table is close to the soil surface; they often border wetlands.

Vegetation Description: The canopy dominants include *Quercus falcata* (southern red oak), *Quercus phellos* (willow oak), *Quercus alba* (white oak), *Quercus michauxii* (swamp chestnut oak), with *Liquidambar styraciflua* (sweetgum) and *Acer rubrum* (red maple) common associates. Pines may be present, including *Pinus rigida* (pitch pine) or *Pinus echinata* (shortleaf pine) in New Jersey, or *Pinus taeda* (loblolly pine) in Delaware. A subcanopy is often present with *Ilex opaca* (American holly), *Vaccinium corymbosum* (highbush blueberry), and *Amelanchier canadensis* (Canada serviceberry). *Gaylussacia frondosa* (dangleberry) forms a patchy shrub layer draped with *Smilax rotundifolia* (roundleaf greenbrier), and the herb layer is sparse with species such as *Chasmanthium laxum* (slender spikegrass), *Osmunda regalis* (royal fern), and *Mitchella repens* (partridgeberry).

Characteristic Species: *Ilex opaca* (American holly), *Quercus falcata* (southern red oak), *Quercus phellos* (willow oak)

Dynamics/Successional Trajectory: This association grades into upland oak forests.

Management Concerns: This community typically occurs in a fragmented landscape setting and therefore is prone to invasion by exotic species.

Reference Sites: Milford Neck, DE; Prime Hook, DE; Five-mile Woods Preserve, Bucks County, PA

Global and State Conservation Ranks and Reasons: GNR (1-Dec-1997). DE: SNR, NJ: S2S3.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.683319

References: Berdine 1998, Bowman 2000, Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Harrison 2004, Harrison and Stango 2003, Windisch pers. comm.

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 phellos</i> (willow oak)
Tree subcanopy	Broad-leaved evergreen tree	<i>Ilex opaca</i> (American holly)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Gaylussacia frondosa</i> (dangleberry)

MID-ATLANTIC MESIC MIXED HARDWOOD FOREST

Fagus grandifolia - *Quercus (alba, rubra)* - *Liriodendron tulipifera* / *Polystichum acrostichoides* Forest

Range: This association is currently described from Virginia northward to southern New England. The type is characteristic of the Coastal Plain throughout its range and of the Piedmont from south-central Virginia through much of Maryland. Small outliers of this vegetation occur at low elevations on both flanks of the Blue Ridge in Virginia and Maryland. This type occurs in the Delaware Estuary, in both New Jersey and Delaware.

Environmental Description: This forest association occurs on mesic to submesic slopes or gentle gradients. Ravines in dissected topography are particularly typical sites in the Piedmont and parts of the Inner Coastal Plain. The type also occupies rolling uplands with deep soils. Soils are typically well-drained, acidic sandy and silt loams derived from parent material of low to moderate fertility.



Photo by Keith Clancey

Vegetation Description: Rangewide, this vegetation type is characteristically a mixed mesophytic forest dominated by *Fagus grandifolia* (American beech), *Quercus alba* (white oak), *Quercus rubra* (northern red oak), and *Liriodendron tulipifera* (tuliptree) in various proportions. Overstory associates over the range include *Carya alba* (mockernut hickory), *Carya glabra* (pignut hickory), *Quercus velutina* (black oak), *Quercus falcata* (southern red oak), *Quercus coccinea* (scarlet oak), *Liquidambar styraciflua* (sweetgum), *Acer rubrum* (red maple), *Nyssa sylvatica* (blackgum), and *Fraxinus americana* (white ash). The subcanopy is characterized by young *Fagus grandifolia* (American beech), *Acer rubrum* (red maple), *Carpinus caroliniana* (American hornbeam), *Cornus florida* (flowering dogwood), *Ilex opaca* (American holly), and *Sassafras albidum* (sassafras). The shrub layer varies from very sparse to well-developed and can include *Asimina triloba* (common pawpaw), *Viburnum acerifolium* (mapleleaf viburnum), *Viburnum dentatum* (southern arrow-wood), and *Euonymus americana*. Heath shrubs, such as *Vaccinium corymbosum* (highbush blueberry) and *Vaccinium pallidum* (hillside blueberry), may be common but not abundant. Vines are common, including *Parthenocissus quinquefolia* (Virginia creeper), *Smilax glauca* (whiteleaf greenbrier), and *Toxicodendron radicans* (eastern poison-ivy). The herb layer is comprised of *Polystichum acrostichoides* (Christmas fern), *Uvularia perfoliata* (perfoliate bellwort), *Cypripedium acaule* (pink lady's-slipper), *Mitchella repens* (partridgeberry), *Tipularia discolor* (crippled crane-fly), *Goodyera pubescens* (downy rattlesnake-plantain), *Eurybia divaricata* (white wood-aster), *Chimaphila maculata* (striped pipsissewa), *Carex swanii* (swan's sedge), *Medeola virginiana* (Indian cucumber-root), *Athyrium filix-femina* (common ladyfern), *Carex digitalis* (slender wood sedge), *Carex willdenowii* (Willdenow's sedge), *Epifagus virginiana* (beechdrops), *Maianthemum canadense* (Canada mayflower), *Desmodium nudiflorum* (naked-flower tick-trefoil), *Polygonatum biflorum* (smooth Solomon's-seal), *Podophyllum peltatum* (mayapple), *Arisaema triphyllum* (Jack-in-the-pulpit), and *Maianthemum racemosum* (feathery false lily-of-the-valley). Several intergrading compositional variants have been noted in regional and local landscape analyses. On more submesic, convex slopes, *Fagus grandifolia* (American beech), *Quercus alba* (white oak), *Cornus florida* (flowering dogwood), and *Vaccinium pallidum* (hillside blueberry) tend to be prominent, while pronounced mesophytes, such as *Carpinus caroliniana* (American hornbeam) and herbaceous species in general, are usually sparse. Coastal Plain stands tend to have understories heavily dominated by *Ilex opaca* (American holly), while Piedmont stands generally have only scattered *Ilex opaca* (American holly), as well as slightly higher herbaceous richness.

Characteristic Species: *Fagus grandifolia* (American beech), *Liriodendron tulipifera* (tuliptree), *Polystichum acrostichoides* (Christmas fern)

Reference Sites: Augustine Creek, DE; Clayton Park (Monmouth County Park), Imlaystown, NJ

Global and State Conservation Ranks and Reasons: G5 (24-Jan-2005). DE: S5, NJ: S3, PA: S1. This association is common and widespread on the eastern Coastal Plain.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684506

References: Bartgis 1986, Berdine 1998, Bernard and Bernard 1971, Bowman 2000, Breden 1989, Breden et al. 2001, Clancy 1993b, Clancy 1996, Davis et al. 1992, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fleming 2001, Fleming et al. 2001, Fleming pers. comm., Harrison 2004, Lea 2003, McCoy and Fleming 2000, Metzler and Barrett 2001, Patterson pers. comm., Rawinski 1984, Robichaud and Buell 1973, Smith 1983

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>Liriodendron tulipifera</i> (tuliptree)
Tree canopy	Broad-leaved deciduous tree	<i>Quercus alba</i> (white oak)
Tree subcanopy	Broad-leaved deciduous tree	<i>Cornus florida</i> (flowering dogwood)
Tree subcanopy	Broad-leaved evergreen tree	<i>Ilex opaca</i> (American holly)
Herb (field)	Vine/Liana	<i>Parthenocissus quinquefolia</i> (Virginia creeper)
Herb (field)	Forb	<i>Podophyllum peltatum</i> (mayapple)
Herb (field)	Forb	<i>Polygonatum biflorum</i> (smooth Solomon's-seal)
Herb (field)	Fern or fern ally	<i>Polystichum acrostichoides</i> (Christmas fern)

NORTHERN COASTAL PLAIN/PIEDMONT BASIC MESIC HARDWOOD FOREST

Fagus grandifolia - *Liriodendron tulipifera* - *Carya cordiformis* / *Lindera benzoin* / *Podophyllum peltatum* Forest

Range: This community occurs in Delaware, New Jersey and Maryland.

Environmental Description: This association comprises luxuriant mesophytic forests of deep, sheltered ravines with base-rich soils in the northern portions of the Coastal Plain and adjacent Piedmont. In the Piedmont, these soils are derived from amphibolite and other mafic rocks. Coastal Plain habitats are in ravines that have downcut into Tertiary shell deposits or limesands. Although very high compared to those of most Coastal Plain soils, soil pH and base cation levels at plot sampling sites indicate only moderate fertility (G. Fleming unpubl. data). Mean soil chemistry values for the 12 plots are: pH = 5.0, Ca = 1353 (ppm), Mg = 163, Fe = 160, Mn = 128, Cu = 0.19, Zn = 3.9, Al = 780, P = 47, K = 117, cation exchange capacity = 14.2, total base saturation = 61.7%.

Vegetation Description: *Fagus grandifolia* (American beech) and *Liriodendron tulipifera* (tuliptree) are the principal canopy dominants, with *Carya cordiformis* (bitternut hickory) and *Quercus rubra* (northern red oak) as constant associates. Additional trees that may be locally important are *Juglans nigra* (black walnut), *Ulmus rubra* (slippery elm), *Quercus alba* (white oak), *Quercus muehlenbergii* (chinquapin oak), and *Fraxinus americana* (white ash). Stands typically have dense understories dominated by *Lindera benzoin* (northern spicebush). Herb layers are lush but tend to be characterized by patch-dominance of clonal forbs and ferns. *Podophyllum peltatum* (mayapple), *Arisaema triphyllum* (Jack-in-the-pulpit), *Circaea lutetiana* ssp. *canadensis* (broadleaf enchanter's-nightshade), *Maianthemum racemosum* ssp. *racemosum* (feathery false lily-of-the-valley), and *Polystichum acrostichoides* (Christmas fern) are widespread and abundant herbs. More locally abundant herbs include *Cystopteris protrusa* (lowland bladderfern), *Deparia acrostichoides* (silver false spleenwort), *Diplazium pycnocarpon* (glade fern),

Actaea racemosa (black cohosh), *Phegopteris hexagonoptera* (broad beech fern), *Nemophila aphylla* (small-flower baby-blue-eyes), and *Actaea pachypoda* (white baneberry). Many additional low-cover herbaceous species are present in plot-sampled stands.

Characteristic Species: *Carya cordiformis* (bitternut hickory)

Management Concerns: Many of these ravine areas, historically protected from land use, are being developed for residential and commercial uses in New Jersey. Invasive plants can also be a problem in the openings of this forest.

Reference Sites: Marl ravines on the Inner Coastal Plain of NJ

Global and State Conservation Ranks and Reasons: G4? (9-May-2002). DE: SNR, NJ: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688077

References: Eastern Ecology Working Group n.d., Fleming et al. 2001, Fleming unpubl. data, Harrison 2004, VDNH 2003

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>Liriodendron tulipifera</i> (tuliptree)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Lindera benzoin</i> (northern spicebush)
Herb (field)	Forb	<i>Podophyllum peltatum</i> (mayapple)

ECOLOGICAL SYSTEM: ATLANTIC COASTAL PLAIN NORTHERN 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* (peatmoss)-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 barren gentian), *Helonias bullata* (G3, swamp-pink), *Narthecium americanum* (G2, bog 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. United States: CT, DE, MA, MD, NJ, NY, VA

Delaware Estuary Associations:

- Atlantic White-cedar / Seaside Alder Swamp
- Blueberry Wetland Thicket
- Coastal Plain Atlantic White-cedar - Red Maple Swamp
- Coastal Plain Atlantic White-cedar Swamp
- Red Maple / Seaside Alder Woodland
- Southern Red Maple - Black Gum Swamp Forest

Similar Ecological Systems in the Delaware Estuary:

- North-Central Appalachian Acidic Swamp

CLASSIFIERS FOR ATLANTIC COASTAL PLAIN NORTHERN BASIN PEAT SWAMP

Primary Division: 203

Land Cover Class: Woody Wetland

Spatial Scale & Pattern: Large patch

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

Non-diagnostic Classifiers: Forest and Woodland (Treed); Depressional [Peaty]; Isolated Wetland [Partially Isolated]

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 or little gallberry), and *Clethra alnifolia* (coastal sweet-pepperbush). The herbaceous layer is comprised of *Decodon verticillatus* (swamp-loosestrife), *Peltandra virginica* (green arrow-arum), *Nymphaea odorata* (white water-lily), *Carex exilis* (meager sedge), *Dichanthelium dichotomum* (witchgrass), *Oxypolis rigidior* (common water-dropwort), *Triadenum virginicum* (Virginia marsh St. John's-wort), *Dulichium arundinaceum* (threeway sedge), *Glyceria obtusa* (Atlantic mannagrass), *Rhynchospora alba* (white beaksedge), *Carex*

atlantica (prickly bog sedge), *Selaginella apoda* (meadow spike-moss), *Drosera rotundifolia* (roundleaf sundew), *Juncus militaris* (bayonet rush), *Vaccinium macrocarpon* (large cranberry), *Calopogon tuberosus* (tuberous grass-pink), and *Eriocaulon decangulare* (ten-angle pipewort). Floating mats within mill ponds have a unique species assemblage including *Xyris difformis* (bog yellow-eyed-grass), *Fuirena* (umbrella-sedge) spp., *Hypericum mutilum* (dwarf St. John's-wort), *Juncus pelocarpus* (brown-fruit rush), *Juncus canadensis* (Canadian rush), *Fimbristylis* (fimbry) sp., and *Rhynchospora macrostachya* (tall horned beaksedge).

Noteworthy Associated Plant and/or Animal Species: *Alnus maritima* (seaside alder)

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

Management Concerns: This association may be of artificial origin, as a result of damming. More information is needed.

Reference Sites: Prime Hook, DE

Global and State Conservation Ranks and Reasons: GNR (17-Apr-2000). DE: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685928

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

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Chamaecyparis thyoides</i> (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)

BLUEBERRY WETLAND THICKET

Vaccinium corymbosum - *Rhododendron viscosum* - *Clethra alnifolia* Shrubland

Range: This type occurs from New Hampshire south to New Jersey, Delaware and possibly Pennsylvania. It has been confirmed in the New Jersey and Delaware portions of the Delaware Estuary.

Environmental Description: This community typically occurs on a shallow organic layer over sand.

Vegetation Description: This type is a tall-shrub swamp where the dominant shrubs include *Vaccinium corymbosum* (highbush blueberry), *Ilex verticillata* (common winterberry), and *Rhododendron viscosum* (swamp azalea). Scattered *Acer rubrum* (red maple) are not uncommon. Associated shrub species may include *Clethra alnifolia* (coastal sweet-pepperbush), *Chamaedaphne calyculata* (leatherleaf), *Ilex glabra* (inkberry or little gallberry), *Leucothoe racemosa* (swamp doghobble), *Lyonia ligustrina* (maleberry), *Decodon verticillatus* (swamp-loosestrife), *Cephalanthus occidentalis* (common buttonbush), *Kalmia angustifolia* (sheep laurel), and *Photinia* (redtip, chokeberry) spp.. Herbaceous species commonly include *Osmunda cinnamomea* (cinnamon fern), *Osmunda regalis* (royal fern), *Lycopus uniflorus* (northern bugleweed), *Glyceria striata* (fowl mannagrass), and *Woodwardia virginica* (Virginia chainfern). *Sphagnum fimbriatum* (fringed bog moss), *Sphagnum rubellum* (red peatmoss), *Sphagnum magellanicum* (Magellan's peatmoss), *Sphagnum fallax* (flat-top bogmoss), and *Sphagnum viridum* (peatmoss) are characteristic.

Characteristic Species: *Rhododendron viscosum* (swamp azalea), *Sphagnum fallax* (flat-top bogmoss), *Sphagnum fimbriatum* (fringed bog moss), *Sphagnum magellanicum* (Magellan's peatmoss), *Sphagnum rubellum* (red peatmoss), *Sphagnum viridum* (peatmoss)

Dynamics/Successional Trajectory: This community is influenced by a strongly fluctuating water table with flooded conditions in spring and early summer followed by a drop in the water table below soil surface usually by late summer.

Reference Sites: Widespread throughout NJ and DE

Global and State Conservation Ranks and Reasons: GNR (14-Apr-1998). DE: SNR, NJ: S1S3, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685525

References: Breden et al. 2001, Conard 1935, Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Fike 1999, Gawler 2002, Golet 1973, Johnson 1981b, Lynn and Karlin 1985, Metzler and Barrett 2001, Niering and Egler 1966, Reschke 1990, Schall and Murley 1984, Sperduto 2000a, Sperduto and Nichols 2004

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Ilex verticillata</i> (common winterberry)
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Rhododendron viscosum</i> (swamp azalea)
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Vaccinium corymbosum</i> (highbush blueberry)
Herb (field)	Forb	<i>Calla palustris</i> (water arum)
Herb (field)	Forb	<i>Lycopus uniflorus</i> (northern bugleweed)
Herb (field)	Graminoid	<i>Glyceria striata</i> (fowl mannagrass)
Herb (field)	Fern or fern ally	<i>Osmunda cinnamomea</i> (cinnamon fern)
Herb (field)	Fern or fern ally	<i>Osmunda regalis</i> (royal fern)
Herb (field)	Fern or fern ally	<i>Woodwardia virginica</i> (Virginia chainfern)

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 sweet-pepperbush), *Ilex glabra* (inkberry or little gallberry), *Gaylussacia frondosa* (dangleberry), *Rhododendron viscosum* (swamp azalea), *Smilax rotundifolia* (roundleaf greenbrier), and *Smilax laurifolia* (blaspheme-vine). 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. John's-wort), *Pogonia ophioglossoides* (rose pogonia), *Boehmeria cylindrica* (small-spike false nettle), *Carex collinsii* (collins' sedge), and *Carex folliculata* (northern long sedge). In canopy openings, *Orontium aquaticum* (golden club) and *Iris versicolor* (harlequin blueflag) may also occur. Sphagnum mosses form a moderately dense to dense bryophyte layer; species include *Sphagnum magellanicum* (Magellan's peatmoss), *Sphagnum cuspidatum* (toothed peatmoss), *Sphagnum pulchrum* (beautiful peatmoss), *Sphagnum flavicomans* (peatmoss), *Sphagnum recurvum* (recurved peatmoss), and *Sphagnum fallax* (flat-top bogmoss).

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

Reference Sites: Brendan Byrne State Forest, 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

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> (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> (highbush blueberry)
Herb (field)	Fern or fern ally	<i>Osmunda cinnamomea</i> (cinnamon fern)

COASTAL PLAIN ATLANTIC WHITE-CEDAR SWAMP

Chamaecyparis thyoides / *Ilex glabra* - *Rhododendron viscosum* Forest

Range: This association occurs on the Atlantic Coastal Plain from Massachusetts to New Jersey and Delaware.

Environmental Description: This community generally occurs in basins overlying sand and gravel deposits or occasionally over glacial lake sediments. Water-saturated peat overlies mineral sediments. Standing water is usually present for at least half the growing season. Water and soil are nutrient-poor, especially low in nitrogen and phosphorus, and high in iron.

Vegetation Description: This Atlantic white-cedar swamp is dominated by *Chamaecyparis thyoides* (Atlantic white-cedar) or codominated with *Acer rubrum* (red maple). Less frequent canopy associates include *Pinus rigida* (pitch pine), *Nyssa sylvatica* (blackgum), and *Magnolia virginiana* (sweetbay). The shrub layer is very dense and diverse with *Clethra alnifolia* (coastal sweet-pepperbush), *Ilex glabra* (inkberry or little gallberry), *Morella pensylvanica* (northern bayberry), *Gaylussacia frondosa* (dangleberry), *Leucothoe racemosa* (swamp doghobble), *Rhododendron viscosum* (swamp azalea), *Ilex verticillata* (common winterberry), *Photinia melanocarpa* (black chokeberry), and *Vaccinium corymbosum* (highbush blueberry). The herbaceous layer tends to be sparse or patchy and is limited to sunny openings with *Osmunda regalis* (royal fern), *Thelypteris palustris* (eastern marsh fern), *Woodwardia virginica* (Virginia chainfern), *Drosera* (sundew) spp., *Sarracenia purpurea* (purple pitcherplant), *Pogonia ophioglossoides* (rose pogonia), *Carex striata* var. *brevis* (northern peatland sedge), *Carex collinsii* (collins' sedge), *Carex atlantica* (prickly bog sedge), and *Smilax rotundifolia* (roundleaf greenbrier). The nonvascular layer includes several species of *Sphagnum* (peatmoss), commonly *Sphagnum fallax* (flat-top bogmoss), *Sphagnum flavicomans* (peatmoss), *Sphagnum magellanicum* (Magellan's peatmoss), *Sphagnum pulchrum* (beautiful peatmoss), *Sphagnum recurvum* (recurved peatmoss), and *Sphagnum palustre* (prairie peatmoss).

Noteworthy Associated Plant and/or Animal Species: *Narthecium americanum* (bog asphodel)

Characteristic Species: *Chamaecyparis thyoides* (Atlantic white-cedar), *Ilex glabra* (inkberry or little gallberry), *Rhododendron viscosum* (swamp azalea)

Management Concerns: Although naturally limited by the range of Atlantic white-cedar, it is likely that this community has declined from historic abundances as a result of logging and fire suppression.

Reference Sites: Brendan Byrne State Forest, NJ; Pemberton Branch in Sussex County, DE

Global and State Conservation Ranks and Reasons: G3 (10-Dec-1998). DE: SNR, NJ: S3. There are 100-200 estimated occurrences of this community covering perhaps 2500 to 7500 acres rangewide. The range is limited to the Atlantic Coastal Plain from Massachusetts to New Jersey and Delaware.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688211

References: Barrett 1996, Bowman 2000, Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Laderman 1989, McCormick 1979, Metzler and Barrett 1992, Metzler and Barrett 2001, Motzkin 1991, Olsson 1979, Rawinski 1984, Reschke 1990, Sperduto 2000b, Sperduto and Crowley 2002b, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Chamaecyparis thyoides</i> (Atlantic white-cedar)
Tree canopy	Broad-leaved deciduous tree	<i>Acer rubrum</i> (red maple)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Rhododendron viscosum</i> (swamp azalea)
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	<i>Ilex glabra</i> (inkberry or little gallberry)
Herb (field)	Fern or fern ally	<i>Osmunda regalis</i> (royal fern)

RED MAPLE / SEASIDE ALDER WOODLAND

Acer rubrum / *Alnus maritima* Woodland

Range: This community occupies 865 acres in the Prime Hook National Wildlife Refuge on the west side of Delaware Bay in Delaware.

Environmental Description: This community is a low-growing, partially open to open saturated woodland basin swamp that occurs alongside a freshwater creek in the Prime Hook National Wildlife Refuge in Delaware. It is almost completely dominated by *Acer rubrum* (red maple). The substrate is peat and muck characterized by hummock-and-hollow microtopography.



Photo by Robert Cox

Vegetation Description: The edges of the community alongside the creek and the understory are dominated by *Alnus maritima* (seaside alder).

Decodon verticillatus (swamp-loosestrife), *Clethra alnifolia* (coastal sweet-pepperbush), *Morella pensylvanica* (northern bayberry), and occasionally *Cephalanthus occidentalis* (common buttonbush) and *Leucothoe racemosa* (swamp doghobble) occur as associates in the shrub layer. *Toxicodendron radicans* (eastern poison-ivy) and *Smilax rotundifolia* (roundleaf greenbrier) are typical in the vine layer. The herbaceous layer grows densely on hummocks. Herbaceous species include *Osmunda regalis* (royal fern), *Triadenum virginicum* (Virginia marsh St. John's-wort), *Lobelia cardinalis* (cardinal-flower), *Carex seorsa* (weak stellate sedge), *Dulichium arundinaceum* (threeway sedge), and *Polygonum hydropiperoides* (swamp smartweed).

Noteworthy Associated Plant and/or Animal Species: *Alnus maritima* (seaside alder)

Characteristic Species: *Acer rubrum* (red maple), *Alnus maritima* (seaside alder)

Dynamics/Successional Trajectory: This woodland swamp occurs along a freshwater stream (Prime Hook Creek) that was historically tidally influenced but is no longer influenced by tidal forces due to the installation of a water control structure in the stream. Coastal storm surges may occasionally influence this community, as it is located approximately one mile from Delaware Bay.

Management Concerns: This association may be of artificial origin, as a result of damming.

Reference Sites: Prime Hook NWR, DE

Global and State Conservation Ranks and Reasons: GNR (5-Jan-2006). DE: SNR. 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.2.790558

References: Coxe 2005, Eastern Ecology Working Group n.d.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Acer rubrum</i> (red maple)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Alnus maritima</i> (seaside alder)
Shrub/sapling (tall & short)	Vine/Liana	<i>Toxicodendron radicans</i> (eastern poison-ivy)
Herb (field)	Fern or fern ally	<i>Osmunda regalis</i> (royal fern)

SOUTHERN RED MAPLE - BLACK GUM 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* (peatmoss)-covered hummocks, mucky depressions, and areas of exposed sand and gravel. 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* (southern wild raisin), *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 sweet-pepperbush) is a dominant shrub, while in New Jersey, *Chamaedaphne calyculata* (leatherleaf) and *Gaylussacia frondosa* (dangleberry) are present. Additional, less constant shrub associates are *Rhododendron viscosum* (swamp azalea), *Leucothoe racemosa* (swamp doghobble), *Chionanthus virginicus* (fringetree), *Viburnum dentatum* (southern arrow-wood), *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 (orange 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* (swamp-pink)

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* (orange 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* (southern wild raisin), *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: Widespread, NJ and DE, including Fort Dix, 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.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686944

References: Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002, Ehrenfeld and Gulick 1981, Fike 1999, Fleming et al. 2001, Fleming pers. comm., 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> (coastal sweet-pepperbush)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Vaccinium corymbosum</i> (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)

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

Summary: This system is comprised of hardwood swamps of seasonally flooded habitats, including relatively shallow groundwater-influenced depressions, stream headwaters and other topographic depressions. It ranges from Long Island, New York, south to Virginia. Although supporting some seepage indicators, they are 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, swamp-pink), *Hydrochus spangleri* (G1, Seth forest water scavenger beetle), *Juncus caesariensis* (G2, New Jersey rush), *Narthecium americanum* (G2, bog asphodel), *Scirpus longii* (G2G3, Long's bulrush), *Trillium pusillum* var. *virginianum* (G3T2, dwarf wakerobin)

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

Delaware Estuary Associations:

- Cape May Lowland Swamp
- Chesapeake Red Maple Swamp
- Coastal Loblolly Pine Wetland Forest
- Coastal Plain Calcareous Seepage Swamp
- Red Maple - Sweetgum Swamp
- Southern New England Red Maple Seepage Swamp
- Southern Red Maple - Black Gum Swamp Forest

CLASSIFIERS FOR ATLANTIC COASTAL PLAIN NORTHERN 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]

CAPE MAY LOWLAND SWAMP

Acer rubrum - *Nyssa sylvatica* - *Liquidambar styraciflua* - *Populus heterophylla* Forest

Range: This community is apparently restricted to the Cape May portion of New Jersey's Outer Coastal Plain.

Environmental Description: Typically this community occupies the headwaters of streams where occurrences probably receive groundwater discharge. Topography is gently rolling with a series of wet depressions alternating with drier islands.

Vegetation Description: Stands generally have high diversity; one occurrence was found to contain 20-25 species of trees and 40 species of shrubs. Typical canopy species include *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), *Fraxinus profunda* (pumpkin ash), and *Nyssa sylvatica* (blackgum). *Magnolia virginiana* (sweetbay) and *Ilex opaca* (American holly) are frequent subcanopy trees. Characteristic shrubs include *Clethra alnifolia* (coastal sweet-pepperbush), *Rhododendron*

viscosum (swamp azalea), *Lindera benzoin* (northern spicebush), and *Itea virginica* (Virginia-willow). In addition to these generally "acid-loving" species, a number of typical calcicoles occur in this community, including *Cirsium muticum* (swamp thistle), *Euphorbia purpurea* (glade spurge), and *Platanthera flava* var. *flava* (pale-green orchid). Several species with a more southern distribution are also found in this community, including *Quercus michauxii* (swamp chestnut oak), *Quercus phellos* (willow oak), *Quercus nigra* (water oak), *Triadenum walteri* (greater marsh-St. John's-wort), and *Populus heterophylla* (swamp cottonwood).

Noteworthy Associated Plant and/or Animal Species: *Euphorbia purpurea* (glade spurge), *Fraxinus profunda* (pumpkin ash), *Hottonia inflata* (featherfoil), *Listera australis* (southern twayblade), *Platanthera flava* var. *flava* (pale-green orchid), *Populus heterophylla* (swamp cottonwood), *Triadenum walteri* (greater marsh-St. John's-wort)

Characteristic Species: *Cirsium muticum* (swamp thistle), *Cypripedium reginae* (showy lady's-slipper), *Euphorbia purpurea* (glade spurge), *Itea virginica* (Virginia-willow), *Platanthera flava* var. *flava* (pale-green orchid), *Populus heterophylla* (swamp cottonwood)

Management Concerns: Cape May faces extensive development pressures as a popular vacation spot. Road networks also pose a threat to this community.

Reference Sites: Cape May Lowlands Swamp, NJ; Indian Trail, NJ; Fort Dix, NJ

Global and State Conservation Ranks and Reasons: G1 (18-Nov-1997). NJ: S1. This swamp forest community is confined to southern New Jersey, found only on Cape May. The habitat, stream headwaters of the Cape May geologic formation, is naturally of limited extent. There are only 3 known occurrences, with a low expectation for other discoveries. Occurrences range in size from 50-100 acres. Cape May faces extensive development pressures as a popular vacation spot.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687352

References: Bernard 1963, Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d.

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 profunda</i> (pumpkin ash)
Tree canopy	Broad-leaved deciduous tree	<i>Liquidambar styraciflua</i> (sweetgum)
Tree canopy	Broad-leaved deciduous tree	<i>Nyssa sylvatica</i> (blackgum)
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Clethra alnifolia</i> (coastal sweet-pepperbush)

CHESAPEAKE RED MAPLE SWAMP

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

Range: This red maple swamp community occurs in the Coastal Plain of the Chesapeake Bay region 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. The herbaceous layer is characterized by *Saururus cernuus* (lizard's-tail), *Peltandra virginica* (green arrow-arum), *Boehmeria cylindrica* (small-spike false nettle), *Triadenum walteri* (greater marsh-St. John's-wort), *Cinna arundinacea* (sweet woodreed), *Pilea pumila* (Canadian clearweed), *Impatiens capensis* (orange jewelweed), *Osmunda cinnamomea* (cinnamon fern), *Osmunda regalis* (royal fern), *Leersia oryzoides* (rice cutgrass), *Leersia virginica* (white cutgrass), *Glyceria striata* (fowl mannagrass), *Commelina virginica* (swamp dayflower), *Rumex verticillatus* (swamp dock), *Carex* (sedge) spp., and *Polygonum arifolium* (halberd-leaf tearthumb).

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

Reference Sites: Lizard Tail Swamp, 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

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 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 pensylvanicum* (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 pensylvanicum* (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

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)

COASTAL PLAIN CALCAREOUS SEEPAGE SWAMP

Acer rubrum - *Fraxinus pennsylvanica* / *Bidens laevis* - *Pilea fontana* Forest

Range: This calcareous seepage swamp occurs on the Virginia Coastal Plain and in New Jersey.

Environmental Description: This calcareous seepage swamp occurs on the Virginia Coastal Plain and in one documented location in New Jersey on groundwater-saturated stream bottoms in ravines that have cut into Tertiary shell deposits or limesands. Braided streams and hummock-and-hollow microtopography are characteristic of the environmental setting.

Vegetation Description: The tree canopy is characterized by *Fraxinus pennsylvanica* (green ash), *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), and others. The shrub layer is comprised of *Lindera benzoin* (northern spicebush), *Morella cerifera* (wax-myrtle), and *Cornus foemina* (stiff dogwood). Vines are abundant, characterized by *Decumaria barbara* (woodvamp). The herbaceous layer is characterized by *Carex bromoides* (brome-like sedge), *Packera aurea* (golden ragwort), *Scirpus lineatus* (drooping bulrush), *Thelypteris palustris* (eastern marsh fern), *Pedicularis lanceolata* (swamp lousewort), *Carex tetanica* (rigid sedge), *Liparis loeselii* (yellow wide-lip orchid), and *Carex granularis* (limestone meadow sedge) on drier hummocks, and *Saururus cernuus* (lizard's-tail), *Bidens laevis* (smooth

beggarticks), *Pilea fontana* (lesser clearweed), *Glyceria striata* (fowl mannagrass), and *Impatiens capensis* (orange jewelweed) in wetter hollows and seepage rivulets.

Noteworthy Associated Plant and/or Animal Species: *Helonias bullata* (swamp-pink)

Characteristic Species: *Bidens laevis* (smooth beggarticks), *Decumaria barbara* (woodvamp), *Fraxinus pennsylvanica* (green ash), *Pilea fontana* (lesser clearweed)

Reference Sites: Mantua Creek, NJ

Global and State Conservation Ranks and Reasons: GNR (15-Nov-2000). NJ: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687899

References: Eastern Ecology Working Group n.d., Fleming 2001, Fleming et al. 2001, Harrison 2004, 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)
Herb (field)	Vine/Liana	<i>Decumaria barbara</i> (woodvamp)
Herb (field)	Forb	<i>Bidens laevis</i> (smooth beggarticks)
Herb (field)	Forb	<i>Pilea fontana</i> (lesser clearweed)

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, New Jersey and Pennsylvania where it occurs in the Delaware Estuary.

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 blackgum), *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 sweet-pepperbush), *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* (greenish-white sedge), *Scirpus cyperinus* (woolgrass bulrush), *Juncus effusus* (soft rush), and *Polygonum* (smartweed, knotweed) spp.

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

Reference Sites: 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: GNR (1-Dec-1997). DE: SNR, NJ: S3, PA: SNR.

VegBank Link for Plot Data: 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 (tall & short)	Broad-leaved deciduous shrub	<i>Leucothoe racemosa</i> (swamp doghobble)

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 possibly Delaware in the Delaware Estuary.



Photo by Pennsylvania Natural Heritage Program

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 sweet-pepperbush), *Lindera benzoin* (northern spicebush), and less commonly *Vaccinium corymbosum* (highbush blueberry), *Lyonia ligustrina* (maleberry), *Toxicodendron vernix* (poison-sumac), *Viburnum dentatum* (southern arrow-wood), and *Viburnum nudum var. cassinoides* (northern wild raisin). 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 (orange jewelweed), *Carex stricta* (tussock sedge), *Veratrum viride* (American 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* (peatmoss) mosses are common on hummocks but do not in general form extensive carpets. Additional nonvascular species can include *Plagiomnium cuspidatum* 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 (25-Jun-1998). DE?:SNA, NJ: S3S5, PA: SNR.

VegBank Link for Plot Data: 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, Enser 1993, Golet et al. 1993, Harrison 2004, MENHP 1991, Metzler and Barrett 2001, 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 sweet-pepperbush)
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)

SOUTHERN RED MAPLE - BLACK GUM 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* (peatmoss)-covered hummocks, mucky depressions, and areas of exposed sand and gravel. 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* (southern wild raisin), *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 sweet-pepperbush) is a dominant shrub, while in New Jersey, *Chamaedaphne calyculata* (leatherleaf) and *Gaylussacia frondosa* (dangleberry) are present. Additional, less constant shrub

associates are *Rhododendron viscosum* (swamp azalea), *Leucothoe racemosa* (swamp doghobble), *Chionanthus virginicus* (fringetree), *Viburnum dentatum* (southern arrow-wood), *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* (orange 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* (swamp-pink)

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* (orange 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* (southern wild raisin), *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: Widespread, NJ and DE, including Fort Dix, 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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686944

References: Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002, Ehrenfeld and Gulick 1981, Fike 1999, Fleming et al. 2001, Fleming pers. comm., 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> (coastal sweet-pepperbush)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Vaccinium corymbosum</i> (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)

ECOLOGICAL SYSTEM: ATLANTIC COASTAL PLAIN NORTHERN BOG

Summary: This system is comprised of dwarf-shrub sphagnum bogs dominated by *Chamaedaphne calyculata* (leatherleaf) occurring on Cape Cod, Massachusetts; Long Island, New York; and the Coastal Plain of New Jersey. North of the glacial border, this system typically occurs in isolated glacial kettleholes and in New Jersey in similar isolated basins. This system occurs in regions of deep sands supporting a pine barrens landscape. The system is characterized by acidic, tannic water supporting a floating or grounded *Sphagnum* (peatmoss) mat over which *Chamaedaphne calyculata* (leatherleaf), *Gaylussacia dumosa* (dwarf huckleberry), and other dwarf-shrubs have rooted. Taller shrubs such as *Vaccinium corymbosum* (highbush blueberry) may occur at the periphery of the bog, and *Decodon verticillatus* (swamp-loosestrife) often forms a distinct zone adjacent to open water. Rooted hydromorphic plants such as *Nymphaea odorata* (white water-lily) occur in open water.

High-ranked Species: *Eupatorium resinosum* (G3, pine barren thoroughwort), *Papaipema sulphurata* (G2, decodon stem borer moth), *Scirpus longii* (G2G3, Long's bulrush)

Range: This system occurs on Cape Cod, Massachusetts; Long Island, New York; and the Coastal Plain of New Jersey. United States: MA, NJ, NY

Delaware Estuary Associations:

- Coastal Plain Atlantic White-cedar Swamp
- Pine Barrens Bog
- Pitch Pine Bog
- Water-lily Aquatic Wetland

CLASSIFIERS FOR ATLANTIC COASTAL PLAIN NORTHERN BOG

Primary Division: 203

Land Cover Class: Woody Wetland

Spatial Scale & Pattern: Small patch

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

Non-diagnostic Classifiers: Shrubland (Shrub-dominated); Depressional; Isolated Wetland [Partially Isolated];
Acidic Water

COASTAL PLAIN ATLANTIC WHITE-CEDAR SWAMP

Chamaecyparis thyoides / *Ilex glabra* - *Rhododendron viscosum* Forest

Range: This association occurs on the Atlantic Coastal Plain from Massachusetts to New Jersey and Delaware.

Environmental Description: This community generally occurs in basins overlying sand and gravel deposits or occasionally over glacial lake sediments. Water-saturated peat overlies mineral sediments. Standing water is usually present for at least half the growing season. Water and soil are nutrient-poor, especially low in nitrogen and phosphorus, and high in iron.

Vegetation Description: This Atlantic white-cedar swamp is dominated by *Chamaecyparis thyoides* (Atlantic white-cedar) or codominated with *Acer rubrum* (red maple). Less frequent canopy associates include *Pinus rigida* (pitch pine), *Nyssa sylvatica* (blackgum), and *Magnolia virginiana* (sweetbay). The shrub layer is very dense and diverse with *Clethra alnifolia* (coastal sweet-pepperbush), *Ilex glabra* (inkberry or little gallberry), *Morella pensylvanica* (northern bayberry), *Gaylussacia frondosa* (dangleberry), *Leucothoe racemosa* (swamp doghobble), *Rhododendron viscosum* (swamp azalea), *Ilex verticillata* (common winterberry), *Photinia melanocarpa* (black chokeberry), and *Vaccinium corymbosum*

(highbush blueberry). The herbaceous layer tends to be sparse or patchy and is limited to sunny openings with *Osmunda regalis* (royal fern), *Thelypteris palustris* (eastern marsh fern), *Woodwardia virginica* (Virginia chainfern), *Drosera* (sundew) spp., *Sarracenia purpurea* (purple pitcherplant), *Pogonia ophioglossoides* (rose pogonia), *Carex striata* var. *brevis* (northern peatland sedge), *Carex collinsii* (collins' sedge), *Carex atlantica* (prickly bog sedge), and *Smilax rotundifolia* (roundleaf greenbrier). The nonvascular layer includes several species of *Sphagnum* (peatmoss), commonly *Sphagnum fallax* (flat-top bogmoss), *Sphagnum flavicomans* (peatmoss), *Sphagnum magellanicum* (Magellan's peatmoss), *Sphagnum pulchrum* (beautiful peatmoss), *Sphagnum recurvum* (recurved peatmoss), and *Sphagnum palustre* (prairie peatmoss).

Noteworthy Associated Plant and/or Animal Species: *Narthecium americanum* (bog asphodel)

Characteristic Species: *Chamaecyparis thyoides* (Atlantic white-cedar), *Ilex glabra* (inkberry or little gallberry), *Rhododendron viscosum* (swamp azalea)

Management Concerns: Although naturally limited by the range of Atlantic white-cedar, it is likely that this community has declined from historic abundances as a result of logging and fire suppression.

Reference Sites: Brendan Byrne State Forest, NJ; Pemberton Branch in Sussex County, DE

Global and State Conservation Ranks and Reasons: G3 (10-Dec-1998). DE: SNR, NJ: S3. There are 100-200 estimated occurrences of this community covering perhaps 2500 to 7500 acres rangewide. The range is limited to the Atlantic Coastal Plain from Massachusetts to New Jersey and Delaware.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688211

References: Barrett 1996, Bowman 2000, Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Laderman 1989, McCormick 1979, Metzler and Barrett 1992, Metzler and Barrett 2001, Motzkin 1991, Olsson 1979, Rawinski 1984, Reschke 1990, Sperduto 2000b, Sperduto and Crowley 2002b, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Chamaecyparis thyoides</i> (Atlantic white-cedar)
Tree canopy	Broad-leaved deciduous tree	<i>Acer rubrum</i> (red maple)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Rhododendron viscosum</i> (swamp azalea)
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	<i>Ilex glabra</i> (inkberry or little gallberry)
Herb (field)	Fern or fern ally	<i>Osmunda regalis</i> (royal fern)

PINE BARRENS BOG

Chamaedaphne calyculata / *Carex striata* Dwarf-shrubland

Range: This community type occurs in the Pine Barrens of New Jersey.

Environmental Description: Pine barrens bog; "spung." This Pine Barrens bog or "spung" is associated with seasonally flooded sites, often covering entire shallow, circular depressions and swales, or it occurs along margins of intermittent ponds and streambanks.

Vegetation Description: Dense *Chamaedaphne calyculata* (leatherleaf) occurs over a continuous carpet of *Sphagnum* (peatmoss) spp. *Carex striata* (peatland sedge) is interspersed within the dwarf-shrubs or forms significant cover in wetter openings. Associated herbs of wetter openings include *Utricularia* (bladderwort) spp., *Rhynchospora* (beaksedge) spp., and *Drosera* (sundew) spp.

Characteristic Species: *Chamaedaphne calyculata* (leatherleaf)

Reference Sites: Belleplain Pond, NJ; Peaslee WMA, NJ; Brendan Byrne State Forest, NJ; Fort Dix, NJ

Global and State Conservation Ranks and Reasons: GNR (1-Dec-1997). NJ: S2S3.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688436

References: Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Chamaedaphne calyculata</i> (leatherleaf)
Herb (field)	Graminoid	<i>Carex striata</i> (peatland sedge)

PITCH PINE BOG

Pinus rigida / *Chamaedaphne calyculata* / *Sphagnum* spp. Woodland

Range: This association comprises pitch pine bogs of the northeastern United States. It is currently described from Maine, Vermont, New York, and New Jersey but possibly occurs sporadically within the Northeast. This community occurs in New Jersey Pine Barrens complex in the Delaware Estuary.



Photo by Andrew Windisch

Environmental Description: This association occurs in shallow, poorly drained depressions or basins that may have deep accumulation of peat or shallow peat over sandy mineral soil. This type is often found, but not exclusively, in proximity to upland sandplain pine barrens.

Vegetation Description: It is characterized by an open canopy of *Pinus rigida* (pitch pine) with an understory of ericaceous shrubs such as *Chamaedaphne calyculata* (leatherleaf). *Sphagnum* (peatmoss) mosses form a dense mat. Canopy associates include *Acer rubrum* (red maple), *Betula populifolia* (gray birch), and *Nyssa sylvatica* (blackgum). Other shrubs include *Vaccinium corymbosum* (highbush blueberry), *Kalmia angustifolia* (sheep laurel), *Photinia pyrifolia* (red chokeberry), *Vaccinium myrtilloides* (velvetleaf blueberry), and *Gaylussacia baccata* (black huckleberry). *Eriophorum* (cotton-grass) spp., *Scirpus* (bulrush) spp., *Calopogon tuberosus* (tuberous grass-pink), *Vaccinium macrocarpon* (large cranberry), *Rhynchospora alba* (white beaksedge), *Drosera rotundifolia* (roundleaf sundew), *Drosera intermedia* (water sundew), and *Carex trisperma* (three-seed sedge) are typical herbs. Other herbs are *Cornus canadensis* (Canadian bunchberry), *Gaultheria procumbens* (wintergreen), *Pteridium aquilinum* (bracken fern), *Osmunda cinnamomea* (cinnamon fern), *Maianthemum canadense* (Canada mayflower), and *Trientalis borealis* (starflower).

Characteristic Species: *Chamaedaphne calyculata* (leatherleaf), *Pinus rigida* (pitch pine)

Reference Sites: Brendan Byrne State Forest, NJ

Global and State Conservation Ranks and Reasons: G3G5 (1-Dec-1997). NJ: S3S4, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687571

References: Breden 1989, Breden et al. 2001, Cowardin et al. 1979, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Gawler 2001, Gawler 2002, Reschke 1990, Sperduto and Nichols 2004, Thompson 1996, Thompson and Sorenson 2000.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus rigida</i> (pitch pine)

WATER-LILY AQUATIC WETLAND

Nuphar lutea ssp. *advena* - *Nymphaea odorata* Herbaceous Vegetation

Range: This rooted aquatic community occupies shallow, quiet waters throughout the central and eastern United States, extending from Maine to Ontario and Minnesota, south to Oklahoma and east to Georgia. In the Delaware Estuary, this pond community occurs on the Inner Coastal Plain of Pennsylvania, New Jersey and Delaware.

Environmental Description: This community occupies shallow water depressions, oxbow ponds, and backwater sloughs of river floodplains, ponds, and small lakes.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: This community is dominated by rooted, floating-leaved aquatic species, with both submergent and emergent aquatics also present. *Nuphar lutea* ssp. *advena* (broadleaf pond-lily) and *Nymphaea odorata* (white water-lily) can be dominants. Other species present include *Brasenia schreberi* (watershield), various *Potamogeton* (pondweed) spp., *Polygonum amphibium* (water smartweed), *Sparganium* (bur-reed) spp., *Sagittaria latifolia* (broadleaf arrowhead), *Alisma* (water-plantain) spp., *Schoenoplectus tabernaemontani* (softstem bulrush), *Peltandra virginica* (green arrow-arum), and *Polygonum amphibium* var. *emersum* (water smartweed) (Anderson 1982). Submerged aquatic species more common in the southern part of the range include *Cabomba caroliniana* (Carolina fanwort), *Ceratophyllum demersum* (coontail), and *Heteranthera dubia* (grassleaf mud-plantain). This broadly conceived type may include ponds, or zones of ponds, dominated by *Nymphaea odorata* (white water-lily), with or without *Nuphar lutea* ssp. *advena* (broadleaf pond-lily).

Characteristic Species: *Nuphar lutea* ssp. *advena* (broadleaf pond-lily), *Nymphaea odorata* (white water-lily)

Management Concerns: This is not a rare or imperiled vegetation type, even though its occurrence is poorly documented. Stands may occur in natural lakes and ponds or in artificial impoundments.

Reference Sites: Swatara State Park, PA; Schuylkill County, PA

Global and State Conservation Ranks and Reasons: G4G5 (15-Oct-2002). DE: SNR, NJ: S4, PA: SNR. The dominant species in stands of this vegetation are widespread across the eastern and central United States and adjacent Canada.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686226

References: Ambrose 1990a, Anderson 1982, Breden et al. 2001, Clancy 1996, FNAI 1990, Fike 1999, Fleming et al. 2001, Foti et al. 1994, Gawler 2002, Harrison 2004, Hoagland 2000, INAI unpubl. data, Midwestern Ecology Working Group n.d., NAP pers. comm. 1998, NatureServe Ecology - Southeastern

U.S. unpubl. data, Peet et al. unpubl. data 2002, Penfound 1953, Rawinski 1984, Schafale and Weakley 1990, Schmalzer and DeSelm 1982, Schotz pers. comm., Sperduto and Nichols 2004, Swain and Kearsley 2001, TDNH unpubl. data, Thompson and Jenkins 1992, WINHIP unpubl. data, Zanoni et al. 1979

MOST ABUNDANT SPECIES

STRATUM	FLOATING AQUATIC
Lifeform	Aquatic herb (floating & submergent)
Species	<i>Nuphar lutea</i> ssp. <i>advena</i> (broadleaf pond-lily)

ECOLOGICAL SYSTEM: ATLANTIC COASTAL PLAIN NORTHERN DUNE AND MARITIME GRASSLAND

Summary: This system consists of vegetation of barrier islands and other coastal areas, ranging from northern 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. Shrublands resulting from succession from grasslands may occur in limited areas, but they are generally not natural components of this system in the southern part of its range (M. Schafale pers. comm.). Both upland and non-flooded wetland vegetation are also 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.

High-ranked Species: *Schizaea pusilla* (G3G4, curly-grass fern)

Range: This system ranges from northern North Carolina (Omernik ecoregion 63d) and southeastern Virginia to southern Maine. The southern limit is a transition zone from around Kitty Hawk, North Carolina, to the Virginia-North Carolina border. The northern limit is Merymeeting Bay, Maine. United States: CT, DE, MA, MD, ME, NC, NH, NJ, NY, RI, VA

Delaware Estuary Associations:

Atlantic Coast Interdune Swale	Beachgrass - Panicgrass Dune Grassland
Blueberry Wetland Thicket	Central Coast Beach Heather Dune Shrubland
Chesapeake Bay Tall Maritime Shrubland	Coastal Freshwater Marsh
Interdune Switchgrass Brackish Depression	Loblolly Pine Dune Woodland
Maritime Red-cedar Woodland	North Atlantic Coastal Plain Vine Dune
Northeastern Atlantic Brackish Interdunal Swale	Northern Bayberry Dune Shrubland
Northern Beachgrass Dune	Overwash Dune Grassland
Pitch Pine Dune Woodland	

Similar Ecological Systems in the Delaware Estuary:

- Northern Atlantic Coastal Plain Maritime Forest
- Northern Atlantic Coastal Plain Sandy Beach

CLASSIFIERS FOR ATLANTIC COASTAL PLAIN NORTHERN DUNE AND MARITIME GRASSLAND
Primary Division: 203
Land Cover Class: Mixed Upland and Wetland
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland; Wetland
Diagnostic Classifiers: Coast; Beach (Substrate); Graminoid; North Atlantic Coastal Plain
Non-diagnostic Classifiers: Herbaceous; Depressional; Isolated Wetland [Partially Isolated]

ATLANTIC COAST INTERDUNE 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 on maritime barrier islands and spits, usually on more protected backdunes, barrier flats and 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* (wax-myrtle). Other canopy associates include *Baccharis halimifolia* (groundsel-tree), *Morella pensylvanica* (northern bayberry) (from northern NC northward), *Juniperus virginiana* var. *silicicola* (coastal red-cedar) (from NC and possibly southern VA southward), and *Rhus copallinum* (winged sumac). The herbaceous layer is characterized by *Spartina patens* (saltmeadow cordgrass). Other ground flora associates include *Toxicodendron radicans* (eastern poison-ivy), *Panicum virgatum* (switchgrass), *Andropogon virginicus* (broomsedge bluestem), *Juncus dichotomus* (forked rush), *Solidago sempervirens* (seaside goldenrod), *Smilax* (greenbrier) spp., *Parthenocissus quinquefolia* (Virginia creeper), *Vitis* (grape) spp., and *Schoenoplectus pungens* (common threesquare). Small openings may have wetland graminoids, such as *Juncus roemerianus* (black needlerush), *Spartina patens* (saltmeadow cordgrass), *Fimbristylis castanea* (chestnut fimbry), *Andropogon glomeratus* var. *pumilus* (bushy broom-sedge), *Muhlenbergia filipes* (southern hairgrass), etc., and forbs, such as *Hydrocotyle bonariensis* (beach pennywort), *Sabatia stellaris* (rose-of-Plymouth), *Polygonum hydropiperoides* (swamp smartweed), *Eleocharis* (spikerush) spp., etc. In other cases, few herbs are present, because of the dense, thicket-like shrub layer.

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

Dynamics/Successional Trajectory: This community is not tidally flooded and occurs beyond the reach of most storm tides, but it is impacted by salt spray.

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

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

Global and State Conservation Ranks and Reasons: G3G4 (1-Feb-2005). DE: SNR, NJ: SNR. This association occurs in interdune flats on barrier islands and barrier spits from New Jersey south to Florida. 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

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)

BEACHGRASS - PANICGRASS DUNE GRASSLAND

Ammophila breviligulata - *Panicum amarum* var. *amarum* Herbaceous Vegetation

Range: This community occurs on maritime dunes from Long Island, New York, south to North Carolina. In New Jersey this community is more common on the Atlantic Coast where dunes are more developed. It occurs in patches on smaller dunes in on the Delaware Bayshore in New Jersey.



Photo by Kathleen Strakosch Walz

Environmental Description: This dune grassland community occurs almost exclusively on sandy, unstable, droughty substrates with no soil profile development. Aeolian processes cause active sand deposition and erosion. The sand substrate is usually visible, and litter accumulation from plant debris is nearly absent. This community generally occurs on foredunes that receive the force of wind and salt spray, but is beyond the influence of most storm tides.

Vegetation Description: This community is a maritime dune grassland dominated by *Ammophila breviligulata* (American beachgrass) and *Panicum amarum* (bitter panicgrass). Plant cover is variable, ranging from 10-75%, but is usually low. Other associated species characteristic of this community include *Solidago sempervirens* (seaside goldenrod), *Strophostyles helvula* (trailing wild bean), *Triplasis purpurea* (purple sandgrass), *Cenchrus tribuloides* (dune sandbur), *Chamaesyce polygonifolia* (northern seaside spurge), *Oenothera humifusa* (seaside evening-primrose) and *Spartina patens* (saltmeadow cordgrass) are common associates of this community and differentiate it from its northern beachgrass counterpart. This association contains several species characteristic to the *Cakile edentula* ssp. *edentula* (sea-rocket) sparsely vegetated association, but the *Ammophila breviligulata* - *Panicum amarum* Herbaceous Vegetation is differentiated by (1) its location beyond storm tide influence, (2) dominance by perennial rather than annual species, (3) greater plant cover on average, and (4) greater prevalence of *Solidago sempervirens* (seaside goldenrod).

Characteristic Species: *Ammophila breviligulata* (American beachgrass), *Panicum amarum* (bitter panicgrass)

Dynamics/Successional Trajectory: This association occurs on the shifting sands of active dune systems. Sand is wind-deposited and tends to accumulate where vegetation slows the surface wind velocity (Martin 1959b). Rhizomes of *Ammophila breviligulata* (American beachgrass) stabilize the dunes, growing upward through layers of sand deposition. *Ammophila breviligulata* (American beachgrass) tends to grow best where there is relatively rapid sand deposition; it can grow through one meter of sand accumulation (Zaremba and Leatherman 1984). Species diversity of this association tends to increase landward in more protected areas where the substrate is more stable.

Management Concerns: Many of the highest quality Element Occurrences are on public land, but they continue to be threatened by trampling, ORVs, and in some cases grazing by feral horses. Waterfront development along the beach is gradually eliminating this community. The use of four-wheel-drive and off-road vehicles is eroding and degrading parts of this habitat in Delaware. The association is highly fragile and does not recover well from these actions.

Reference Sites: Henlopen State Park, Sussex County, DE; Higbee Beach WMA, NJ

Global and State Conservation Ranks and Reasons: G2 (8-Oct-1998). DE: S2?, NJ: S1S2. Although 65-100 Element Occurrences are estimated to occur over the range, total acreage likely does not exceed 3000 acres for this small patch community. Many of the highest quality EOs are on public land, but they continue to be threatened by trampling, ORVs, and in some cases grazing by feral horses. The association is highly fragile and does not recover well from these actions.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684424

References: Bartgis 1986, Baumann 1978b, Berdine 1998, Boule 1979, Bowman 2000, Breden 1989, Breden et al. 2001, Clampitt 1991, Clancy 1993a, Clancy 1996, Eastern Ecology Working Group n.d., Egler 1962, Fender 1937, Fleming 2001, Fleming et al. 2001, Harrison 2004, Harvill 1965, Higgins et al. 1971, Hill 1986, Klotz 1986, Schafale 2000, Schafale 2003b, Schafale and Weakley 1990, Stalter and Lamont 1990

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Ammophila breviligulata</i> (American beachgrass)

BLUEBERRY WETLAND THICKET

Vaccinium corymbosum - *Rhododendron viscosum* - *Clethra alnifolia* Shrubland

Range: This type occurs from New Hampshire south to New Jersey, Delaware and possibly Pennsylvania. It has been confirmed in the New Jersey and Delaware portions of the Delaware Estuary.

Environmental Description: This community typically occurs on a shallow organic layer over sand.

Vegetation Description: This type is a tall-shrub swamp where the dominant shrubs include *Vaccinium corymbosum* (highbush blueberry), *Ilex verticillata* (common winterberry), and *Rhododendron viscosum* (swamp azalea). Scattered *Acer rubrum* (red maple) are not uncommon. Associated shrub species may include *Clethra alnifolia* (coastal sweet-pepperbush), *Chamaedaphne calyculata* (leatherleaf), *Ilex glabra* (inkberry or little gallberry), *Leucothoe racemosa* (swamp doghobble), *Lyonia ligustrina* (maleberry), *Decodon verticillatus* (swamp-loosestrife), *Cephalanthus occidentalis* (common buttonbush), *Kalmia angustifolia* (sheep laurel), and *Photinia* (redtip, chokeberry) spp. Herbaceous species commonly include *Osmunda cinnamomea* (cinnamon fern), *Osmunda regalis* (royal fern), *Lycopus uniflorus* (northern bugleweed), *Glyceria striata* (fowl mannagrass), and *Woodwardia virginica* (Virginia chainfern). *Sphagnum fimbriatum* (fringed bog moss), *Sphagnum rubellum* (red peatmoss), *Sphagnum magellanicum* (Magellan's peatmoss), *Sphagnum fallax* (flat-top bogmoss), and *Sphagnum viridum* (peatmoss) are characteristic.

Characteristic Species: *Rhododendron viscosum* (swamp azalea), *Sphagnum fallax* (flat-top bogmoss), *Sphagnum fimbriatum* (fringed bog moss), *Sphagnum magellanicum* (Magellan's peatmoss), *Sphagnum rubellum* (red peatmoss), *Sphagnum viridum* (peatmoss)

Dynamics/Successional Trajectory: This community is influenced by a strongly fluctuating water table with flooded conditions in spring and early summer followed by a drop in the water table below soil surface usually by late summer.

Reference Sites: Widespread in NJ and DE

Global and State Conservation Ranks and Reasons: GNR (14-Apr-1998). DE: SNR, NJ: S1S3, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685525

References: Breden et al. 2001, Conard 1935, Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Fike 1999, Gawler 2002, Golet 1973, Johnson 1981b, Lynn and Karlin 1985, Metzler and Barrett 2001, Niering and Egler 1966, Reschke 1990, Schall and Murley 1984, Sperduto 2000a, Sperduto and Nichols 2004

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Ilex verticillata</i> (common winterberry)
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Rhododendron viscosum</i> (swamp azalea)
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Vaccinium corymbosum</i> (highbush blueberry)
Herb (field)	Forb	<i>Calla palustris</i> (water arum)
Herb (field)	Forb	<i>Lycopus uniflorus</i> (northern bugleweed)
Herb (field)	Graminoid	<i>Glyceria striata</i> (fowl mannagrass)
Herb (field)	Fern or fern ally	<i>Osmunda cinnamomea</i> (cinnamon fern)
Herb (field)	Fern or fern ally	<i>Osmunda regalis</i> (royal fern)
Herb (field)	Fern or fern ally	<i>Woodwardia virginica</i> (Virginia chainfern)

CENTRAL COAST BEACH HEATHER DUNE SHRUBLAND

Hudsonia tomentosa / *Panicum amarum* var. *amarulum* Dwarf-shrubland

Range: The association is restricted to barrier beaches from Delaware and New Jersey to northern North Carolina.

Environmental Description: This community is largely confined to maritime interdunes. Influenced by wind-deposited sand, the substrate is unstable and supports no soil development and large patches of sparsely vegetated or unvegetated sand are common.

Vegetation Description: This community is a maritime dwarf-shrubland characterized by *Hudsonia tomentosa* (woolly beach-heather), a species adapted to sand burial. *Hudsonia tomentosa* (woolly beach-heather) is dominant, occurring as discrete patches that may coalesce into a dense mat on older, more stabilized dunes. A number of other shrubs, such as *Morella pensylvanica* (northern bayberry), *Morella cerifera* (wax-myrtle), *Pinus taeda* (loblolly pine) saplings, and *Prunus maritima* (beach plum), may occur but in low abundance and cover. *Schizachyrium littorale* (seaside bluestem), *Ammophila breviligulata* (American beachgrass), *Aristida tuberculosa* (seabeach three-awn), *Spartina patens* (saltmeadow cordgrass), and *Panicum amarum* (bitter panicgrass) are common grasses of this community, and *Toxicodendron radicans* is a common vine. Other herbaceous associates include *Lechea maritima* (beach pinweed), *Cyperus grayi* (Gray's flatsedge), *Artemisia stelleriana* (oldwoman), *Chamaesyce polygonifolia* (northern seaside spurge), *Solidago sempervirens* (seaside goldenrod), and *Diodia teres* (rough buttonweed).

Characteristic Species: *Hudsonia tomentosa* (woolly beach-heather)

Dynamics/Successional Trajectory: This association grades into *Ammophila breviligulata* (American beachgrass)-dominated dunes and into maritime shrub thickets.

Management Concerns: This association has likely declined substantially due to human development and remains threatened by continuing development of prime real estate.

Reference Sites: Cape Henlopen State Park, Sussex County, DE

Global and State Conservation Ranks and Reasons: G2 (14-Oct-1998). DE: S2, NJ: S1S2. Although there are an estimated 80 occurrences of this association rangewide, this small-patch community occupies fewer than 2500 total acres. The range is moderately restricted (New Jersey to northern North

Carolina), and the habitat requirements are also relatively restricted (large mid-Atlantic sand dunes). The rank was altered from G3 as reported in TNC (1995c) upon completion of more detailed ranking procedure.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686917

References: Bartgis 1986, Berdine 1998, Bowman 2000, Breden 1989, Breden et al. 2001, Clampitt 1991, Clancy 1993a, Collins and Anderson 1994, Eastern Ecology Working Group n.d., Fleming 2001, Fleming et al. 2001, Harrison 2004, Higgins et al. 1971, Hill 1986, Martin 1959b, TNC 1995c

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Hudsonia tomentosa</i> (woolly beach-heather)
Herb (field)	Vine/Liana	<i>Toxicodendron radicans</i> (eastern poison-ivy)
Herb (field)	Forb	<i>Lechea maritima</i> (beach pinweed)
Herb (field)	Forb	<i>Solidago sempervirens</i> (seaside goldenrod)
Herb (field)	Graminoid	<i>Aristida tuberculosa</i> (seabeach three-awn)
Herb (field) bluestem)	Graminoid	<i>Schizachyrium scoparium</i> ssp. <i>littorale</i> (seaside

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* (Canada serviceberry), *Sassafras albidum* (sassafras), *Photinia pyrifolia* (red chokeberry), and *Diospyros virginiana* (eastern persimmon) in varying proportions. *Pinus taeda* (loblolly pine) is a common associate in examples of this community south of New Jersey. *Morella 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* (whiteleaf 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.

Characteristic Species: *Morella cerifera* (wax-myrtle), *Prunus serotina* (black cherry), *Smilax rotundifolia* (roundleaf greenbrier)

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 and State Conservation Ranks and Reasons: G1G2 (18-Nov-1997). DE: SNR, NJ: S1. 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.

VegBank Link for Plot Data: 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)

COASTAL FRESHWATER MARSH

Schoenoplectus pungens var. *pungens* - *Juncus canadensis* Herbaceous Vegetation

Range: This association is known from Massachusetts and New Jersey but is likely to occur in other coastal states of the Northeast. It occurs in the New Jersey portion of the Delaware Estuary.

Environmental Description: This non-tidal freshwater marsh of the coastal Northeast occupies flooded depressions and swales in coastal dunes (and impoundments). This community can also occur at the mouth of large rivers, on hummocky islands in freshwater wetlands, and in transition zones. The substrate varies from sand to peat or muck, depending on hydrological regime. Water is present most of the year and does not typically exhibit a seasonal drawdown.

Vegetation Description: The vegetation is dominated by *Schoenoplectus pungens* var. *pungens* (common threesquare), in association with *Hibiscus moscheutos* ssp. *moscheutos* (eastern rosemallow), *Juncus canadensis* (Canadian rush), *Juncus effusus* (soft rush), *Eleocharis erythropoda* (bald spikerush), *Osmunda regalis* (royal fern), *Osmunda cinnamomea* (cinnamon fern), *Thelypteris palustris* (eastern marsh fern), and *Triadenum virginicum* (Virginia marsh St. John's-wort). *Typha latifolia* (broadleaf cattail) may be present but generally only occurs at low cover. A diverse range of other forbs may also be associated with this community. Shrubs may be present as sparsely distributed individuals, or more densely from the wetland edge. Typical shrubs include *Rosa palustris* (swamp rose), *Vaccinium corymbosum* (highbush blueberry), *Morella pensylvanica* (northern bayberry), and *Acer rubrum* (red maple).

Characteristic Species: *Juncus canadensis* (Canadian rush), *Schoenoplectus pungens* var. *pungens* (common threesquare)

Reference Sites: Monds Island (New Jersey Audubon Society), NJ; Raccoon Creek/Repaupo Creek, NJ; Route 44 at Birch Creek, Gloucester County, NJ; Oldman's Creek, NJ

Global and State Conservation Ranks and Reasons: GNR (8-Nov-2000). NJ: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685545

References: Eastern Ecology Working Group n.d., Martin 1959b

INTERDUNE SWITCHGRASS BRACKISH DEPRESSION

(*Morella cerifera*) - *Panicum virgatum* - *Spartina patens* Herbaceous Vegetation

Range: The community apparently occurs in New Jersey, Delaware, Maryland, and may extend to North Carolina, but the full range will require further study.

Environmental Description: This association occurs in interdunal swales, or seasonally flooded basins, landward of maritime backdunes. The water table is at or close to the surface in the spring. Freshwater maintains these depressions as saturated or seasonally flooded and somewhat poorly drained. Soils are characterized by a shallow organic layer (usually a few centimeters in depth) overlying loamy sand or sand.

Vegetation Description: This community is generally strongly dominated by *Panicum virgatum* (switchgrass) but can be variable in its expression. Associated species include *Spartina patens* (saltmeadow cordgrass), *Juncus canadensis* (Canadian rush), *Solidago sempervirens* (seaside goldenrod), *Eleocharis palustris* (marsh spikerush), *Toxicodendron radicans* (eastern poison-ivy), *Linum medium* (stiff yellow flax), *Carex longii* (Long's sedge), and *Euthamia caroliniana* (slender goldentop). This community is typically dominated by 40-85% cover of *Panicum virgatum* (switchgrass) and occurs in larger interdunal depressions (up to one-half hectare). Variability occurs in the cover of *Panicum virgatum* (switchgrass) and the richness of associated species. When *Panicum virgatum* (switchgrass) is not as dense, it is most often associated with an even mixture of *Schoenoplectus pungens* (common threesquare) or *Spartina patens* (saltmeadow cordgrass). In some cases, *Morella cerifera* (wax-myrtle) or *Baccharis halimifolia* (groundsel-tree) will constitute less than 10% shrub cover, but shrub coverage is usually much less or none and other herbs codominate.

Characteristic Species: *Panicum virgatum* (switchgrass)

Dynamics/Successional Trajectory: This association likely comprises an intermediate phase of interdunal swale vegetation succession; as sites become less wet, shrubs invade and the community may succeed to a shrubland. This association also has similarity to, and may be a southern analog of, *Panicum virgatum* - *Spartina patens* Herbaceous Vegetation (Brackish Meadow in this report), a brackish meadow association occurring from New Jersey northward. Freshwater interdunal swale wetlands occur in large dune systems that develop freshwater aquifers. Interdunal swale wetlands develop where the freshwater lens intersects the dune surface. The water table is a balance between input from precipitation and output from evapotranspiration or from drainage outlets. Perpetual drawdown tends to invoke successional shifts in vegetation from open water with or without submerged or floating aquatic plants, to emergent herbaceous vegetation to a series of shrubland associations as the duration of soil saturation decreases. *Salix* (willow) spp. are early pioneer shrubs, which can be displaced by other shrub species like *Morella* (bayberry) spp. as peat and or sediments accumulate.

Reference Sites: Broadkill Beach to Lewes, Sussex County, DE

Global and State Conservation Ranks and Reasons: G2G4 (19-Jan-2006). DE: SNR, NJ: SNR. This small-patch wetland community is restricted to the Coastal Plain of the mid-Atlantic.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684954

References: Berdine 1998, Bowman 2000, Breden et al. 2001, Eastern Ecology Working Group n.d., Fender 1937, Fleming 2001, Fleming et al. 2001, Harrison 2004, Harrison and Stango 2003, Heckscher et al. 1995, Higgins et al. 1971, Hill 1986, Metzler and Barrett 2001, Schafale 2000, Schafale 2003b, Schafale and Weakley 1990, Sneddon et al. 1996

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Panicum virgatum</i> (switchgrass)
Herb (field)	Graminoid	<i>Spartina patens</i> (saltmeadow cordgrass)

LOBLOLLY PINE DUNE WOODLAND

Pinus taeda / *Hudsonia tomentosa* Woodland

Range: This maritime woodland occurs on sand dunes of barrier islands in Delaware, Maryland, and Virginia.

Environmental Description: This community is a maritime woodland of sand dunes. Soils in this community are sandy and rapidly drained. This community often occurs directly adjacent to actively shifting foredune and is exposed to salt spray, winds, and storms. The community also occurs on unstable sands of protected backdunes.

Vegetation Description: This community is characterized by a very open canopy created by sparsely distributed *Pinus taeda* (loblolly pine). Hardwoods such as *Quercus falcata* (southern red oak), *Quercus phellos* (willow oak), and *Ilex opaca* (American holly) are frequent. Pines make up a sparse subcanopy. Tall shrubs are also sparse, although an occasional *Morella cerifera* (wax-myrtle), *Pinus taeda* (loblolly pine) sapling, or *Vaccinium corymbosum* (highbush blueberry) can be found. Sparse low shrubs of *Hudsonia tomentosa* (woolly beach-heather) are common. *Smilax glauca* (whiteleaf greenbrier) and *Toxicodendron radicans* (eastern poison-ivy) are typical vine species but make up less than 5% cover. Herbs are sparse, yet much varied. *Andropogon virginicus* (broomsedge bluestem) and *Smilax rotundifolia* (roundleaf greenbrier) are commonly present. The typical pattern of herb distribution is on dry open sand, in direct sunlight. Here, small patches of *Dichanthelium acuminatum* (tapered rosette grass), *Dichanthelium scoparium* (broom witchgrass), *Andropogon virginicus* (broomsedge bluestem), *Eupatorium rotundifolium* (roundleaf thoroughwort), *Erigeron* (fleabane) sp., *Euthamia caroliniana* (slender goldentop), *Solidago sempervirens* (seaside goldenrod), *Aristida tuberculosa* (seabeach three-awn), *Polygonella articulata* (coastal jointweed), and *Pseudognaphalium obtusifolium* are typically mixed with scattered *Hudsonia tomentosa* (woolly beach-heather) and *Smilax rotundifolia* (roundleaf greenbrier). In total, herb cover ranges from 5-40%, generally near the lower end of the scale.

Characteristic Species: *Pinus taeda* (loblolly pine)

Dynamics/Successional Trajectory: This community is exposed to salt spray, winds, and storms. In the denser woodlands, more pine duff accumulates and herb diversity and cover are generally higher. Where woodlands are more open and trees sparse, growing conditions are harsh, less duff accumulates, and vast areas of exposed white sand are characteristic.

Management Concerns: This community is threatened by many of the same threats common to coastal dune systems: dune stabilization, commercial and residential development, and road expansion.

Reference Sites: Cape Henlopen State Park, Sussex County, DE

Global and State Conservation Ranks and Reasons: G1G2 (2-Dec-1998). DE: S1?. This maritime woodland community is restricted to major coastal dune systems of the mid-Atlantic region. Only 10-20 occurrences are estimated or known from Maryland, Virginia, and Delaware. Size ranges from about an acre to perhaps 30 acres. The community occurs on a restricted habitat, on back dunes protected from the direct influence of wind and salt spray.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689830

References: Berdine 1998, Bowman 2000, Bratton and Davison 1987, Clampitt 1991, Clancy 1996, Eastern Ecology Working Group n.d., Fleming et al. 2001, Harrison 2004, Harrison and Stango 2003, Higgins et al. 1971, Hill 1986, Klotz 1986, Schafale and Weakley 1990, TNC 1995c

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus taeda</i> (loblolly pine)
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Hudsonia tomentosa</i> (woolly beach-heather)
Herb (field grass)	Graminoid	<i>Dichanthelium acuminatum</i> (tapered rosette grass)

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.



Photo by Robert Coxé

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 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

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 red-cedar	Needle-leaved tree	<i>Juniperus virginiana</i> var. <i>virginiana</i> (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 poison-ivy)
Herb (field)	Graminoid	<i>Schizachyrium scoparium</i> (little bluestem)

NORTH ATLANTIC COASTAL PLAIN VINE DUNE

Smilax glauca - *Toxicodendron radicans* Vine-Shrubland

Range: This type is likely to occur in New England south to Maryland and perhaps Virginia. In the Delaware Estuary, this community is found in Delaware.

Environmental Description: This community occurs on maritime sand dunes, generally of barrier beach systems, where vegetation is exposed to wind, salt spray and periodic overwash by storm tides. Vegetation is shallowly rooted in sand or draped over living or dead shrubs. Very little soil development occurs, and the water table is well below 1 m in depth (Martin 1959b).

Vegetation Description: The dominant species of any single dune may be one of several vine species such as *Smilax glauca* (whiteleaf greenbrier), *Smilax rotundifolia* (roundleaf greenbrier), *Vitis rotundifolia* (muscadine), *Parthenocissus quinquefolia* (Virginia creeper), or *Toxicodendron radicans* (eastern poison-ivy). In some cases, the vines are shallowly rooted in the sand or grow over older vine stems or other living or dead shrubs such as *Morella pensylvanica* (northern bayberry). Scattered dune grassland species may be present such as *Ammophila breviligulata* (American beachgrass), *Lechea maritima* (beach pinweed), *Solidago sempervirens* (seaside goldenrod), and *Hudsonia tomentosa* (woolly beach-heather).

Characteristic Species: *Smilax glauca* (whiteleaf greenbrier)

Dynamics/Successional Trajectory: Vegetation of this association stabilizes dunes. It also grades into maritime shrubland and dune grassland vegetation. The vegetation is exposed to wind, salt spray and periodic overwash by storm tides. The vegetation is generally low to the ground (less than half a meter tall) and generally covers 70-80% of the surface of the ground, the remainder being exposed sand.

Reference Sites: none identified

Global and State Conservation Ranks and Reasons: G1G2 (18-Jan-2006). DE: SNR, NJ: SNR. This small-patch community is restricted to coastal sand dunes of only four states. Total number of occurrences is 21-100, and total acreage is well less than 2000 acres.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686350

References: Berdine 1998, Bowman 2000, Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Harrison 2004, Harrison and Stango 2003, Martin 1959b, Rawinski 1984, Reschke 1990, Sneddon and Lundgren 2001, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Shrub/sapling (tall & short)	Vine/Liana	<i>Smilax glauca</i> (whiteleaf greenbrier)
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)

NORTHEASTERN ATLANTIC BRACKISH INTERDUNAL SWALE

Spartina patens - *Eleocharis parvula* Herbaceous Vegetation

Range: This association is currently described from Maryland, New Jersey, New York, Massachusetts, and New Hampshire. It also occurs in Delaware.

Environmental Description: This community occupies brackish interdunal swales and overwash flats between coastal sand dunes. Surface water is oligo- to mesohaline; the dune surface intersects the freshwater lens with salinity input from salt spray and/or storm tide overwash. Substrate is deep sand with or without a layer of surficial peat.

Vegetation Description: This association is dominated by graminoids, especially *Spartina patens* (saltmeadow cordgrass), *Eleocharis parvula* (dwarf spikerush), *Schoenoplectus pungens* (common threesquare), *Cyperus polystachyos* (many-spike flatsedge), and *Juncus articulatus* (jointleaf rush), although local dominance can change from year to year. Associated species depend on salinity and hydrology of a site and can include *Leptochloa fusca* ssp. *fascicularis* (maritime bearded sprangletop), *Schoenoplectus maritimus* (saltmarsh clubrush), *Juncus ambiguus* (seaside rush), *Juncus scirpoides* (needle-pod rush), *Ptilimnium capillaceum* (mock bishopweed), *Rumex maritimus* (golden dock), *Symphotrichum subulatum* (seaside American-aster), *Chenopodium rubrum* (red goosefoot), *Pluchea odorata* (sweetscent), *Hibiscus moscheutos* ssp. *moscheutos* (eastern rosemallow), *Polygonum ramosissimum* (yellow-flower knotweed), *Triglochin maritima* (seaside arrow-grass), *Panicum virgatum* (switchgrass), *Schoenoplectus robustus* (alkali bulrush), and *Argentina anserina* (silverweed). *Iva frutescens* (maritime marsh-elder) and *Baccharis halimifolia* (groundsel-tree) may occur on hummocks within the swale. Mats of blue-green and/or brown algae can proliferate across the soil surface.

Characteristic Species: *Eleocharis parvula* (dwarf spikerush), *Spartina patens* (saltmeadow cordgrass)

Dynamics/Successional Trajectory: Brackish swale vegetation can be ephemeral or can represent early stages of salt marsh or coastal salt pond development (Reschke 1990). Overwash flats can succeed into dune grasslands with sand accumulation and plant burial.

Management Concerns: *Phragmites australis* (common reed) can readily invade in this environmental setting.

Reference Sites: Blackbird Creek, New Castle County, DE

Global and State Conservation Ranks and Reasons: GNR (1-Dec-1997). DE: SNR, NJ: S1S2.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688128

References: Breden et al. 2001, Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Harrison 2004, Hunt 1997b, Lea 2002b, Lundgren 1998, Rawinski 1984, Reschke 1990, Sneddon and Lundgren 2001, Sperduto 2000b, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Eleocharis parvula</i> (dwarf spikerush)
Herb (field)	Graminoid	<i>Spartina patens</i> (saltmeadow cordgrass)

NORTHERN BAYBERRY DUNE SHRUBLAND

Morella pensylvanica - *Prunus maritima* Shrubland

Range: This association occurs from Maine to New Jersey. It occurs in New Jersey and Delaware portions of the Delaware Estuary.

Environmental Description: This association occurs on protected slopes and hollows of dry, stabilized maritime backdunes where the water table is greater than 1 m from the surface.

Vegetation Description: This shrubland vegetation is dominated by *Morella pensylvanica* (northern bayberry) and *Prunus maritima* (beach plum). Additional shrubs that are commonly present but with low cover can include *Rosa carolina* (Carolina rose),

Rosa rugosa (rugosa rose), *Baccharis halimifolia*

(groundsel-tree), or *Juniperus virginiana* (eastern red-cedar). The herbaceous layer tends to be sparse and can include dune grassland or adjacent upland species such as *Ammophila breviligulata* (American beachgrass), *Solidago sempervirens* (seaside goldenrod), *Hudsonia tomentosa* (woolly beach-heather), *Lechea maritima* (beach pinweed), *Juncus greenii* (greenie's rush), *Carex silicea* (beach sedge), *Polygonella articulata* (coastal jointweed), *Symphytotrichum subulatum* (seaside American-aster), *Solidago rugosa* (wrinkleleaf goldenrod), *Achillea millefolium* (common yarrow), *Oenothera parviflora* (northern evening-primrose), *Euthamia* (goldentop) spp., *Cyperus grayi* (Gray's flatsedge), *Cyperus polystachyos* (many-spike flatsedge), and others. Typical vine associates are *Toxicodendron radicans* (eastern poison-ivy) and *Smilax* (greenbrier) spp.

Characteristic Species: *Morella pensylvanica* (northern bayberry), *Prunus maritima* (beach plum)

Dynamics/Successional Trajectory: This vegetation can be a probable intermediate in succession between beach dune and sunken forest; further dune development and protection from salt spray allow development of sunken forest vegetation (Art 1976). Large patches of open unvegetated or sparsely vegetated sand are present in some examples. Depending on exposure, these shrublands range from over 2 m tall in sheltered areas to less than 1 m tall in areas with greater exposure to winds and storms.



Photo by Kathleen Strakosch Walz

Reference Sites: dunes on DE Bay eastern shore; Bowers Beach south to Broadkill Beach, DE; Bowers Beach south to Lewes, DE; Kent County, DE; Higbee Beach, NJ

Global and State Conservation Ranks and Reasons: G4 (1-Dec-1997). DE: SNR, NJ: S1S2.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685486

References: Art 1976, Breden 1989, Breden et al. 2001, Chrysler 1930, Conard 1935, Dunlop and Crow 1985, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Gawler 2001, Gawler 2002, Lundgren 2000, Martin 1959b, McDonnell 1979, Metzler and Barrett 2001, Metzler and Barrett 2004, Moul 1969, Nelson and Fink 1980, Nichols 1920, Rawinski 1984, Reschke 1990, Sneddon and Lundgren 2001, Sperduto 1997b, Sperduto 2000a, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Prunus maritima</i> (beach plum)
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	<i>Morella pensylvanica</i> (northern bayberry)
Herb (field)	Graminoid	<i>Ammophila breviligulata</i> (American beachgrass)

NORTHERN BEACHGRASS DUNE

Ammophila breviligulata - *Lathyrus japonicus* Herbaceous Vegetation

Range: This association occurs along the northern Atlantic Coast from Maine to New Jersey and Delaware.

Environmental Description: This association primarily occurs on active maritime dunes, on both foredunes that are exposed to onshore winds and salt spray as well as more protected interdunes. This grassland generally occurs beyond the influence of storm tides. Substrate is sand with no soil profile development.

Vegetation Description: This association is characterized and dominated by *Ammophila breviligulata* (American beachgrass), which can occur monotypically, especially on foredunes or other areas of active and rapid sand deposition. *Lathyrus japonicus* (beach pea) is the most common associate and can be codominant in most examples of this community; however, it is not common in Delaware. Other associated species include *Solidago sempervirens* (seaside goldenrod), *Lechea maritima* (beach pinweed), *Aristida tuberculosa* (seabeach three-awn), *Schizachyrium scoparium* (little bluestem), *Carex silicea* (beach sedge), *Polygonella articulata* (coastal jointweed), and *Artemisia stelleriana* (oldwoman). Dwarf-shrubs, such as *Hudsonia tomentosa* (woolly beach-heather), *Rosa rugosa* (rugosa rose), *Morella pensylvanica* (northern bayberry), or stunted *Prunus maritima* (beach plum), can occur sporadically and form locally dominant patches within the grassland.



Photo by Kathleen Strakosch Walz

Characteristic Species: *Ammophila breviligulata* (American beachgrass)

Dynamics/Successional Trajectory: This association occurs on the shifting sands of active dune systems. Sand is wind-deposited and tends to accumulate where vegetation slows the surface wind velocity (Martin 1959b). Rhizomes of *Ammophila breviligulata* (American beachgrass) stabilize the dunes, growing upward through layers of sand deposition. *Ammophila breviligulata* (American beachgrass) tends to grow best where there is relatively rapid sand deposition; it can grow through one meter of sand

accumulation (Zaremba and Leatherman 1984). Species diversity of this association tends to increase landward in more protected areas where the substrate is more stable. This dune grassland can merge into beach strand vegetation seaward and maritime heath communities landward.

Reference Sites: Cape May, NJ, and north along Delaware Bayshore - Higbee Beach, Townsend Beach, Norbury Landing, NJ

Global and State Conservation Ranks and Reasons: G4? (1-Dec-1997). DE: SNR, NJ: S2S3.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685381

References: Breden 1989, Breden et al. 2001, Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Gawler 2001, Gawler 2002, Johnson 1981b, Johnson 1985b, Martin 1959b, Metzler and Barrett 2001, Moul 1969, Nelson and Fink 1980, Rawinski 1984, Reschke 1990, Sperduto 1997a, Swain and Kearsley 2001, Zaremba and Leatherman 1984

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Ammophila breviligulata</i> (American beachgrass)

OVERWASH DUNE GRASSLAND

Spartina patens - *Schoenoplectus pungens* - *Solidago sempervirens* Herbaceous Vegetation

Range: This community is an upland dune grassland of mid-Atlantic barrier islands from New Jersey to North Carolina. Examples of this type occur in Delaware in the Delaware Estuary.

Environmental Description: This community is an upland dune grassland of mid-Atlantic barrier islands on embryo dunes forming from overwash terraces. The plants of this community are influenced by water-deposited sand caused by storm surges. They differ ecologically from dune grasslands dominated by *Ammophila breviligulata* (American beachgrass) or *Uniola paniculata* (sea-oats), which are primarily impacted by wind-deposited sand. Storm overwash is a prevalent natural disturbance to this community.

Vegetation Description: *Spartina patens* (saltmeadow cordgrass) is dominant, ranging from quite sparse (25% cover) to dense, and can be monotypic in early successional expressions. As the vegetation develops, common associated species can include *Schoenoplectus pungens* (common threesquare) or *Solidago sempervirens* (seaside goldenrod). Less common associates can include *Cyperus grayi* (Gray's flatsedge), *Cenchrus tribuloides* (dune sandbur), *Setaria parviflora* (yellow foxtail grass), *Festuca rubra* (red fescue), and occasional scattered individuals of *Toxicodendron radicans* (eastern poison-ivy) and seedlings of *Baccharis halimifolia* (groundsel-tree). *Ammophila breviligulata* (American beachgrass) or *Uniola paniculata* (sea-oats) may invade from the surrounding dunes. This community is characterized by upland maritime dune grassland vegetation. *Spartina patens* (saltmeadow cordgrass), and sometimes *Schoenoplectus pungens* (common threesquare), or both are dominant on dunes or overwash terraces. Total vegetation cover is variable, ranging from quite sparse (25% cover) to dense. Bare sand is often visible through the vegetation, and there is no soil profile development. Species diversity is variable; although it may be quite low and confined to the nominate species in the northern part of the range, it may be of greater diversity, including *Strophostyles helvula* (trailing wild bean), *Solidago sempervirens* (seaside goldenrod), *Cenchrus tribuloides* (dune sandbur), *Setaria parviflora* (yellow foxtail grass), *Distichlis spicata* (saltgrass), *Sabatia stellaris* (rose-of-Plymouth), *Ammophila breviligulata* (American beachgrass), *Suaeda linearis* (southern sea-blite), *Bassia hirsuta* (hairy smotherweed), *Atriplex patula* (halberd-leaf orache), *Fimbristylis castanea* (chestnut fimbry), and *Cakile edentula* ssp. *edentula* (sea-rocket).

Characteristic Species: *Schoenoplectus pungens* (common threesquare), *Spartina patens* (saltmeadow cordgrass)

Dynamics/Successional Trajectory: This association forms a drier, later successional phase of an overwash community begun from water-deposited sand of storm overwash; it appears to be a successional step between interdunal herbaceous wetlands and interdunal herbaceous/shrub uplands. Undisturbed water-deposited sand is colonized by *Spartina patens* (saltmeadow cordgrass) and/or *Schoenoplectus pungens* (common threesquare) plus additional associates like *Suaeda linearis* (southern sea-blite), *Bassia hirsuta* (hairy smotherweed), *Atriplex patula* (halberd-leaf orache), and *Fimbristylis castanea* (chestnut fimbry) that have low percent cover. This wetter, early successional phase is currently covered by *Spartina patens* - *Eleocharis parvula* Herbaceous Vegetation (CEGL006342). With time since overwash, sand movement, plant burial, and dune formation rates increase, but are not so high as to form *Ammophila breviligulata* (American beachgrass)-dominated primary dunes. However, this association can be found as a fringe around the lower, outer edge of those dunes.

Management Concerns: As part of a dynamic system, the community is in a sense ephemeral, being buried over time by sand deposition, and being formed anew in other areas subjected to overwash. Because of the dynamic forces structuring the community, it requires sufficient area in large dune systems to accommodate this shifting mosaic. This community is threatened by a number of activities, including dune stabilization and outright destruction of habitat through human activities.

Reference Sites: Great Marsh, Sussex County, DE

Global and State Conservation Ranks and Reasons: G2G3 (4-Nov-1998). DE: S2S3, NJ: SNR. This dune grassland community is restricted to overwash areas of major maritime dune systems. It is typically small in extent, not usually more than a few acres in size. It is best developed on barrier islands of Delaware, Maryland, Virginia, and North Carolina; it extends sporadically farther north to Massachusetts. Although not extremely rare (an estimated 100-200 occurrence exist rangewide), the community is restricted to a specialized habitat.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686121

References: Baumann 1978b, Berdine 1998, Boule 1979, Bowman 2000, Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fleming et al. 2001, Harrison 2004, Harrison and Stango 2003, Higgins et al. 1971, Hill 1986, Klotz 1986, Lea 2002b, Reschke 1990, Schafale 2000, Schafale 2003b, Schafale and Weakley 1990, TNC 1995c, Travis and Godfrey 1976, Zaremba and Leatherman 1984

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Forb	<i>Solidago sempervirens</i> (seaside goldenrod)
Herb (field)	Graminoid	<i>Schoenoplectus pungens</i> (common threesquare)

PITCH PINE DUNE WOODLAND

Pinus rigida / *Hudsonia tomentosa* Woodland

Range: This association occurs along the north Atlantic coast from southern Maine to Cape Henlopen, Delaware.

Environmental Description: The community occurs on backdunes that are more stabilized than foredunes. It occurs on stabilized, parabolic dunes. The substrate is wind- and wave-deposited sand which is characteristically excessively well-drained and nutrient-poor.

Vegetation Description: There is generally significant cover of bare sand, but where more stabilized, species diversity tends to increase. *Pinus rigida* (pitch pine) dominates the canopy and averages 10-15 m

in height, but is quite variable, ranging from 1 m in an unusual shrub form in Delaware to over 20 m. Canopy associates are few but include *Juniperus virginiana* (eastern red-cedar), and occasionally *Sassafras albidum* (sassafras), with scattered individuals of *Quercus velutina* (black oak) in the northern part of the range, and *Quercus falcata* (southern red oak) and *Pinus virginiana* (Virginia pine) to the south. At Cape Henlopen, the subcanopy is sparse but may also include *Quercus marilandica* (blackjack oak), *Quercus stellata* (post oak), *Nyssa sylvatica* (blackgum), and *Prunus serotina* (black cherry). The shrub layer, if present, may include *Hudsonia tomentosa* (woolly beach-heather), *Morella pensylvanica* (northern bayberry), *Gaylussacia baccata* (black huckleberry), *Gaylussacia frondosa* (dangleberry), *Vaccinium pallidum* (hillside blueberry), and occasionally *Hudsonia ericoides* (pine barren golden-heather), or *Viburnum nudum var. cassinoides* (northern wild raisin). Vines may be present but scarce and include *Smilax rotundifolia* (roundleaf greenbrier), *Smilax glauca* (whiteleaf greenbrier), *Parthenocissus quinquefolia* (Virginia creeper), and *Toxicodendron radicans* (eastern poison-ivy). The herbaceous layer is sparse but can include *Aralia nudicaulis* (wild sarsaparilla), *Dichantherium ovale var. addisonii* (eggleaf rosette grass), *Solidago odora* (anise-scented goldenrod), *Chimaphila maculata* (striped pipsissewa), *Lechea maritima* (beach pinweed), *Pteridium aquilinum* (bracken fern), and *Trientalis borealis* (starflower), *Maianthemum canadense* (Canada mayflower), *Deschampsia flexuosa* (wavy hairgrass), *Carex lucorum* (Blue Ridge sedge), and *Arctostaphylos uva-ursi* (bearberry) in the north. Lichens are common; at Cape Henlopen State Park, Delaware, species included *Cladonia strepsilis* (olive cladonia), *Cladina terrae-novae* (reindeer lichen), *Lepraria incana* (dust lichen), and *Cladonia squamosa* (dragon cladonia).

Noteworthy Associated Plant and/or Animal Species: *Carex silicea* (beach sedge)

Characteristic Species: *Hudsonia tomentosa* (woolly beach-heather), *Morella pensylvanica* (northern bayberry), *Pinus rigida* (pitch pine)

Dynamics/Successional Trajectory: Active sand movement occurs with storm activity, causing the boundaries of the community to migrate over time. Maritime occurrences are subjected to a number of environmental stresses such as high winds, "sand-blasting" by salt spray, shifting substrate, and both water and nutrient stress. All of these factors appear to be important in structuring the form and composition of the community.

Management Concerns: This community is threatened by a host of threats common to coastal dune systems in general: dune stabilization, residential and commercial development, and road expansion.

Reference Sites: Cape Henlopen State Park, Sussex County, DE

Global and State Conservation Ranks and Reasons: G2 (8-Dec-1998). DE: S1, NJ: S1?. This maritime woodland community is restricted to major coastal sand dune systems. It ranges from southern Maine to Cape Henlopen, Delaware; it does not occur in Connecticut or Rhode Island. Occurrences are generally small, ranging from 5 or 10 acres to a few hundred acres at maximum. 25-30 occurrences covering 1000-1200 acres are estimated rangewide.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687760

References: Art 1976, Bennett et al. 1998, Bowman 2000, Breden 1989, Breden et al. 2001, Clancy 1996, DNHP 1998, Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Gawler 2001, Gawler 2002, Godfrey et al. 1978, Johnson 1985b, MENHP 1991, Martin 1959b, McDonnell 1979, Motzkin and Foster 2002, Nelson and Fink 1980, RINHP n.d., Rawinski 1984, Reschke 1990, Swain and Kearsley 2001, Trudeau et al. 1977

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus rigida</i> (pitch pine)
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Hudsonia tomentosa</i> (woolly beach-heather)

ECOLOGICAL SYSTEM: ATLANTIC COASTAL PLAIN NORTHERN 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 brevifolia* (pinebarren sandreed) 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.

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)

Range: Best developed in the New Jersey Pine Barrens. United States: NJ

Delaware Estuary Associations:

- Highbush Blueberry Bog Thicket
- Pine Barrens Bog
- Pine Barrens Floodplain Forest
- Pine Barrens Sandreed Savanna
- Pitch Pine - Reedgrass Savanna
- Pitch Pine Bog
- Pitch Pine Lowland
- Pitch Pine Subhydric Lowland
- Southern Red Maple - Black Gum Swamp Forest
- Upper South Switchgrass Wet Prairie

CLASSIFIERS FOR ATLANTIC COASTAL PLAIN NORTHERN PITCH PINE LOWLAND

Primary Division: 203

Land Cover Class: Woody Wetland

Spatial Scale & Pattern: Large patch

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

Non-diagnostic Classifiers: Woody-Herbaceous; Extensive Wet Flat

HIGHBUSH BLUEBERRY BOG THICKET

Vaccinium corymbosum / *Sphagnum* spp. Shrubland

Range: This association occurs from Pennsylvania and New Jersey north to New Hampshire and Maine and possibly Vermont.

Environmental Description: This tall-shrub bog thicket occurs on oligotrophic to weakly minerotrophic peat soils, commonly as a border thicket around more open dwarf heath shrub peatlands or within small, isolated basins. Significant seasonal water level fluctuation can occur, especially in isolated basins without inlet or outlet streams.

Vegetation Description: A tall-shrub layer is characterized by abundant *Vaccinium corymbosum* (highbush blueberry) plus *Gaylussacia baccata* (black huckleberry), *Chamaedaphne calyculata* (leatherleaf), *Kalmia angustifolia* (sheep laurel), *Rhododendron canadense* (rhodora), *Lyonia ligustrina* (maleberry), and *Nemopanthus mucronatus* (catberry) in more northern or cooler microclimates, and *Ilex verticillata* (common winterberry) and *Rhododendron viscosum* (swamp azalea) in the south. In locally wetter areas, *Cephalanthus occidentalis* (common buttonbush) or *Decodon verticillatus* (swamp-loosestrife) can occur. Sparse, scattered trees may occur, including *Acer rubrum* (red maple), *Picea mariana* (black spruce), *Larix laricina* (tamarack), *Pinus strobus* (eastern white pine), *Pinus rigida* (pitch pine), *Betula populifolia* (gray birch), or *Nyssa sylvatica* (blackgum), with species dependent on environmental setting. The herbaceous layer tends to be sparse, although can be locally abundant. Common herbs include *Osmunda cinnamomea* (cinnamon fern), *Woodwardia virginica* (Virginia chainfern), *Carex trisperma* (three-seed sedge), *Sarracenia purpurea* (purple pitcherplant), *Thelypteris palustris* (eastern marsh fern), *Triadenum virginicum* (Virginia marsh St. John's-wort), and *Maianthemum trifolium* (threeleaf false Solomon's-seal). *Sphagnum* (peatmoss) mosses blanket well-developed hummocks and hollows, including *Sphagnum magellanicum* (Magellan's peatmoss), *Sphagnum centrale* (peatmoss), *Sphagnum rubellum* (red peatmoss), *Sphagnum capillifolium* (northern peatmoss), *Sphagnum fimbriatum* (fringed bog moss), and *Sphagnum fuscum* (brown peatmoss).

Characteristic Species: *Vaccinium corymbosum* (highbush blueberry)

Reference Sites: Brendan Byrne State Forest, NJ

Global and State Conservation Ranks and Reasons: G3G5 (31-Dec-1997). NJ: S1S3, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684554

References: Breden 1989, Breden et al. 2001, CAP pers. comm. 1998, Conard 1935, Damman and French 1987, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Fike 1999, Gawler 2002, Johnson 1981b, Karlin and Lynn 1988, Kearsley 1999a, Lundgren et al. 2000, Lynn and Karlin 1985, Metzler and Barrett 1982, Metzler and Barrett 2001, Radis 1986, Rawinski 1984, Rozsa and Metzler n.d., Sperduto 2000a, Sperduto and Nichols 2004, Swain and Kearsley 2000, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Vaccinium corymbosum</i> (highbush blueberry)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Gaylussacia baccata</i> (black huckleberry)
Herb (field)	Fern or fern ally	<i>Osmunda cinnamomea</i> (cinnamon fern)

PINE BARRENS BOG

Chamaedaphne calyculata / *Carex striata* Dwarf-shrubland

Range: This community type occurs in the Pine Barrens of New Jersey.

Environmental Description: Pine barrens bog; "spung." This Pine Barrens bog or "spung" is associated with seasonally flooded sites, often covering entire shallow, circular depressions and swales, or it occurs along margins of intermittent ponds and streambanks.

Vegetation Description: Dense *Chamaedaphne calyculata* (leatherleaf) occurs over a continuous carpet of *Sphagnum* (peatmoss) spp. *Carex striata* (peatland sedge) is interspersed within the dwarf-shrubs or forms significant cover in wetter openings. Associated herbs of wetter openings include *Utricularia* (bladderwort) spp., *Rhynchospora* (beaksedge) spp., and *Drosera* (sundew) spp.

Characteristic Species: *Chamaedaphne calyculata* (leatherleaf)

Reference Sites: Belleplains Pond, NJ; Peaslee WMA, NJ; Brendan Byrne State Forest, NJ; Fort Dix, NJ

Global and State Conservation Ranks and Reasons: GNR (1-Dec-1997). NJ: S2S3.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688436

References: Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Chamaedaphne calyculata</i> (leatherleaf)
Herb (field)	Graminoid	<i>Carex striata</i> (peatland sedge)

PINE BARRENS FLOODPLAIN FOREST

Fraxinus pennsylvanica - *Juglans nigra* - *Ulmus americana* / *Cornus amomum* / *Onoclea sensibilis* Forest

Range: This floodplain forest occurs in the New Jersey Pine Barrens in the Delaware Estuary.

Environmental Description: This is a temporarily flooded floodplain forest associated with small streams that occurs on the Coastal Plain.

Vegetation Description: This is a floodplain forest community in which the canopy is codominated by *Fraxinus pennsylvanica* (green ash), *Juglans nigra* (black walnut), and *Ulmus americana* (American elm). The shrub stratum is dominated by *Cornus amomum* (silky dogwood), in association with *Alnus serrulata* (smooth alder) and exotics, such as *Ligustrum vulgare* (European privet), *Rosa multiflora* (multiflora rose), and *Lonicera tatarica* (Tatarian honeysuckle). The herbaceous layer is dominated by *Onoclea sensibilis* (sensitive fern).

Characteristic Species: *Cornus amomum* (silky dogwood), *Juglans nigra* (black walnut)

Dynamics/Successional Trajectory: Fire frequency as well as floodplain hydrology have a profound influence on the vegetation.

Management Concerns: The shrub layer contains a number of exotics, including *Ligustrum vulgare* (European privet), *Rosa multiflora* (multiflora rose), and *Lonicera tatarica* (Tatarian honeysuckle). The herbaceous layer may contain exotics, such as *Allium vineale* (wild garlic) and *Microstegium vimineum* (Japanese stiltgrass).

Reference Sites: Brendan Byrne State Forest, NJ

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685560

References: Eastern Ecology Working Group n.d.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Fraxinus pennsylvanica</i> (green ash)
Tree canopy	Broad-leaved deciduous tree	<i>Juglans nigra</i> (black walnut)
Tree canopy	Broad-leaved deciduous tree	<i>Ulmus americana</i> (American elm)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Cornus amomum</i> (silky dogwood)
Herb (field)	Fern or fern ally	<i>Onoclea sensibilis</i> (sensitive fern)

PINE BARRENS SANDREED SAVANNA

Gaylussacia dumosa / *Calamovilfa brevipilis* Shrub Herbaceous Vegetation

Range: This type occurs in the New Jersey Pine Barrens.

Environmental Description: This is a saturated wetland community of the New Jersey Pine Barrens.

Vegetation Description: *Calamovilfa brevipilis* (pinebarren sandreed) dominates the wetland. Other herbaceous associates include *Gentiana autumnalis* (pine barren gentian), *Symphotrichum dumosum* (rice button American-aster), *Solidago* (goldenrod) spp., and others. Shrubs are widely scattered, the most characteristic being *Gaylussacia dumosa* (dwarf huckleberry). Other shrubs may include *Vaccinium corymbosum* (highbush blueberry), *Lyonia mariana* (piedmont staggerbush), *Chamaedaphne calyculata* (leatherleaf), *Gaylussacia baccata* (black huckleberry), *Gaylussacia frondosa* (dangleberry), and *Kalmia angustifolia* (sheep laurel). *Sphagnum* (peatmoss) mosses make up the bryophyte layer.

Noteworthy Associated Plant and/or Animal Species: *Calamovilfa brevipilis* (pinebarren sandreed)

Characteristic Species: *Calamovilfa brevipilis* (pinebarren sandreed), *Gaylussacia dumosa* (dwarf huckleberry)

Management Concerns: This vegetation is maintained by frequent fire and is currently maintained by active ordnance explosions and burning on a military range. This vegetation is fire-dependent and is currently best-developed on an arsenal range that is subjected to fires caused by frequent munitions explosions. Although the community is located on a military range where personnel have been educated about the community's rarity, an increase in bombing beyond the current frequency and other military activities may degrade the community.

Reference Sites: Fort Dix, NJ

Global and State Conservation Ranks and Reasons: G1 (12-Nov-1998). NJ: S1. This community is dominated by the rare grass pine barrens sandreed. Although the grass is known from Virginia and North Carolina, the community is limited to the New Jersey pine barrens, where it occupies approximately 200-400 acres in total in two distinct occurrences.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684200

References: Breden et al. 2001, Eastern Ecology Working Group n.d., Windisch 1995b

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Calamovilfa brevipilis</i> (pinebarren sandreed)

PITCH PINE - REEDGRASS SAVANNA

Pinus rigida / *Gaylussacia dumosa* / *Calamovilfa brevipilis* Woodland

Range: This woodland is known to date only from the New Jersey Pine Barrens.

Environmental Description: This pitch pine saturated woodland is currently only known from the New Jersey Pine Barrens.

Vegetation Description: The community is characterized by an open canopy (10-50%) of *Pinus rigida* (pitch pine) with a scattered shrub layer characterized by *Gaylussacia dumosa* (dwarf huckleberry), in association with *Gaylussacia baccata* (black huckleberry), *Kalmia angustifolia* (sheep laurel), *Ilex glabra* (inkberry or little gallberry), *Vaccinium corymbosum* (highbush blueberry), and *Chamaedaphne calyculata* (leatherleaf). *Sphagnum* (peatmoss) mosses are common. The herbaceous is characterized by high cover of *Calamovilfa brevipilis* (pinebarren sandreed). Associated herbs are varied in cover and

frequency but may include *Andropogon glomeratus* (bushy broom-sedge), *Gentiana autumnalis* (pine barren gentian), *Muhlenbergia torreyana* (New Jersey muhly), and *Amphicarpum purshii* (blue maiden-cane).

Noteworthy Associated Plant and/or Animal Species: *Agrotis buchholzi* (buchholz's dart moth), *Calamovilfa brevipilis* (pinebarren sandreed), *Crambus daeckellus* (daecke's pyralid moth), *Spartiniphaga carterae* (a noctuid moth)

Characteristic Species: *Calamovilfa brevipilis* (pinebarren sandreed), *Gaylussacia dumosa* (dwarf huckleberry), *Pinus rigida* (pitch pine)

Reference Sites: Fort Dix, NJ

Global and State Conservation Ranks and Reasons: G1 (22-Mar-1999). NJ: S1.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689833

References: Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Windisch 1995b

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus rigida</i> (pitch pine)
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Gaylussacia dumosa</i> (dwarf huckleberry)
Herb (field)	Graminoid	<i>Calamovilfa brevipilis</i> (pinebarren sandreed)

PITCH PINE BOG

Pinus rigida / *Chamaedaphne calyculata* / *Sphagnum* spp. Woodland

Range: This association comprises pitch pine bogs of the northeastern United States. It is currently described from Maine, Vermont, New York, and New Jersey but possibly occurs sporadically within the Northeast. This community occurs in New Jersey Pine Barrens complex in the Delaware Estuary.

Environmental Description: This association occurs in shallow, poorly drained depressions or basins that may have deep accumulation of peat or shallow peat over sandy mineral soil. This type is often found, but not exclusively, in proximity to upland sandplain pine barrens.



Photo by Andrew Windisch

Vegetation Description: It is characterized by an open canopy of *Pinus rigida* (pitch pine) with an understory of ericaceous shrubs such as *Chamaedaphne calyculata* (leatherleaf). *Sphagnum* (peatmoss) mosses form a dense mat. Canopy associates include *Acer rubrum* (red maple), *Betula populifolia* (gray birch), and *Nyssa sylvatica* (blackgum). Other shrubs include *Vaccinium corymbosum* (highbush blueberry), *Kalmia angustifolia* (sheep laurel), *Photinia pyrifolia* (red chokeberry), *Vaccinium myrtilloides* (velvetleaf blueberry), and *Gaylussacia baccata* (black huckleberry). *Eriophorum* (cotton-grass) spp., *Scirpus* (bulrush) spp., *Calopogon tuberosus* (tuberous grass-pink), *Vaccinium macrocarpon* (large cranberry), *Rhynchospora alba* (white beaksedge), *Drosera rotundifolia* (roundleaf sundew), *Drosera intermedia* (water sundew), and *Carex trisperma* (three-seed sedge) are typical herbs. Other herbs are *Cornus canadensis* (Canadian bunchberry), *Gaultheria procumbens* (wintergreen), *Pteridium aquilinum*

(bracken fern), *Osmunda cinnamomea* (cinnamon fern), *Maianthemum canadense* (Canada mayflower), and *Trientalis borealis* (starflower).

Characteristic Species: *Chamaedaphne calyculata* (leatherleaf), *Pinus rigida* (pitch pine)

Reference Sites: Brendan Byrne State Forest, NJ

Global and State Conservation Ranks and Reasons: G3G5 (1-Dec-1997). NJ: S3S4, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687571

References: Breden 1989, Breden et al. 2001, Cowardin et al. 1979, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Gawler 2001, Gawler 2002, Reschke 1990, Sperduto and Nichols 2004, Thompson 1996, Thompson and Sorenson 2000

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus rigida</i> (pitch pine)

PITCH PINE LOWLAND

Pinus rigida / *Vaccinium corymbosum* - *Leucothoe racemosa* / *Sphagnum* spp. Woodland

Range: This association is restricted to the New Jersey Pine Barrens.

Environmental Description: This association is described as hydric, with a saturated hydrology.

Vegetation Description: The open canopy is dominated by *Pinus rigida* (pitch pine), with *Acer rubrum* (red maple), *Nyssa sylvatica* (blackgum), and *Amelanchier arborea* (common serviceberry) being infrequent associates. The shrub layer may be quite dense and is characterized by *Vaccinium corymbosum* (highbush blueberry), *Leucothoe racemosa* (swamp doghobble), *Gaylussacia frondosa* (dangleberry), *Gaylussacia baccata* (black huckleberry), *Kalmia angustifolia* (sheep laurel), and *Ilex glabra* (inkberry or little gallberry). The herbaceous layer is not well-developed. *Sphagnum* (peatmoss) species are common in the bryophyte layer.

Characteristic Species: *Gaylussacia baccata* (black huckleberry), *Gaylussacia frondosa* (dangleberry), *Ilex glabra* (inkberry or little gallberry), *Kalmia angustifolia* (sheep laurel), *Leucothoe racemosa* (swamp doghobble), *Vaccinium corymbosum* (highbush blueberry)

Reference Sites: Brendan Byrne State Forest, NJ

Global and State Conservation Ranks and Reasons: G3 (10-Dec-1998). NJ: S3S4. Despite the fact that this association is a narrow endemic, restricted to the New Jersey Pine Barrens, there are 100 to 200 occurrences covering an estimated 15,000 to 50,000 acres in total. However, further evaluation of acreage is needed.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689926

References: Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus rigida</i> (pitch pine)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Vaccinium corymbosum</i> (highbush blueberry)

PITCH PINE SUBHYDRIC LOWLAND

Pinus rigida / *Gaylussacia baccata* - *Kalmia angustifolia* Woodland

Range: This type is found in New Jersey.

Environmental Description: This pitch pine lowland of New Jersey is characterized by "subhydric" conditions. Soils are saturated sands, but the water table is below the soil surface in most cases.



Photo by Andrew Windisch

Vegetation Description: *Pinus rigida* (pitch pine) forms an open canopy, with a well-developed shrub layer of *Gaylussacia baccata* (black huckleberry), *Gaylussacia frondosa* (dangleberry), and *Kalmia angustifolia* (sheep laurel), with other less frequent associates such as *Ilex glabra*

(inkberry or little gallberry), *Lyonia mariana* (piedmont staggerbush), *Vaccinium corymbosum* (highbush blueberry), and *Leiophyllum buxifolium* (sand-myrtle). The ground cover is characterized by *Pteridium aquilinum* (bracken fern), *Pyxidantha barbulata* (pyxie-moss), *Xerophyllum asphodeloides* (eastern turkeybeard), *Calamovilfa brevipilis* (pinebarren sandreed), and *Schizachyrium scoparium* (little bluestem).

Characteristic Species: *Calamovilfa brevipilis* (pinebarren sandreed), *Pteridium aquilinum* (bracken fern), *Pyxidantha barbulata* (pyxie-moss), *Xerophyllum asphodeloides* (eastern turkeybeard)

Reference Sites: Brendan Byrne State Forest, NJ

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684840

References: Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Windisch 1995b

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus rigida</i> (pitch pine)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Gaylussacia baccata</i> (black huckleberry)
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Kalmia angustifolia</i> (sheep laurel)

SOUTHERN RED MAPLE - BLACK GUM 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* (peatmoss)-covered hummocks, mucky depressions, and areas of exposed sand and gravel. 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* (southern wild raisin), *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 sweet-pepperbush) is a dominant shrub, while in New Jersey, *Chamaedaphne calyculata* (leatherleaf) and *Gaylussacia frondosa* (dangleberry) are present. Additional, less constant shrub associates are *Rhododendron viscosum* (swamp azalea), *Leucothoe racemosa* (swamp doghobble), *Chionanthus virginicus* (fringetree), *Viburnum dentatum* (southern arrow-wood), *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* (orange 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* (swamp-pink)

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* (orange 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* (southern wild raisin), *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: Widespread, NJ and DE, including Fort Dix, 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.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686944

References: Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002, Ehrenfeld and Gulick 1981, Fike 1999, Fleming et al. 2001, Fleming pers. comm., 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> (coastal sweet-pepperbush)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Vaccinium corymbosum</i> (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)

UPPER SOUTH SWITCHGRASS WET PRAIRIE

Panicum virgatum Seasonally Flooded Herbaceous Vegetation

Range: This vegetation is found in Kentucky and possibly Tennessee. It, or a closely related type, has also been found in the New Jersey Pine Barrens.

Environmental Description: In New Jersey, this community occurs on sandy soils and in areas associated with Coastal Plain pondshores. This broadly defined type represents prairie-related, seasonally flooded herbaceous vegetation dominated by *Panicum virgatum* (switchgrass).

Vegetation Description: This seasonally flooded herbaceous vegetation community is dominated by *Panicum virgatum* (switchgrass).

Characteristic Species: *Panicum virgatum* (switchgrass)

Management Concerns: This type is placed here to represent vegetation which may be virtually extinct, persisting as remnant populations of *Panicum virgatum* (switchgrass) in ditches and swales. More inventory is needed to determine the relationship of the New Jersey and southern variants of this type.

Reference Sites: Brendan Byrne State Forest, NJ

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687290

References: Southeastern Ecology Working Group n.d., TDNH unpubl. data

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Panicum virgatum</i> (switchgrass)

ECOLOGICAL SYSTEM: ATLANTIC COASTAL PLAIN NORTHERN PONDSHORE

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* (Virginia meadowbeauty), *Cyperus dentatus* (bulblet flatsedge), *Gratiola aurea* (golden hedge-hyssop), *Panicum verrucosum* (warty panicgrass), *Euthamia caroliniana* (slender goldentop), *Carex striata* (peatland sedge), *Juncus pelocarpus* (brown-fruit rush), *Rhynchospora capillacea* (limestone beaksedge), *Rhynchospora macrostachya* (tall horned beaksedge), *Xyris difformis* (bog yellow-eyed-grass), *Fimbristylis autumnalis* (slender fimbry), *Scleria reticularis* (netted nutrush), *Sabatia kennedyana* (Plymouth 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* (creeping rush), *Muhlenbergia torreyi* (ring muhly), *Rhynchospora oligantha* (feather-bristle beaksedge), *Rhynchospora cephalantha* (bunched beaksedge), *Rhynchospora chalarocephala* (loose-head 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 blackgum). The vegetation is characterized by many of the species from New England, New York and New Jersey and also includes *Juncus repens* (creeping rush), *Boltonia asteroides* (white doll's-daisy), *Fimbristylis perpusilla* (Harper's fimbry), *Coelorachis rugosa* (wrinkled jointgrass), *Dichantherium spretum* (Eaton's witchgrass), *Saccharum giganteum* (giant 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 hirsitii* (G1, hirsits' rosette grass), *Eulimnadia agassizii* (G1G2, agassiz clam shrimp), *Eupatorium leucolepis* var. *novae-angliae* (G5T1, white-bract boneset), *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. John's-wort), *Lobelia boykinii* (G2G3, boykin's lobelia), *Lycopodiella margueritiae* (G2, northern prostrate clubmoss), *Lycopodiella subappressa* (G2, northern appressed clubmoss), *Oxypolis canbyi* (G2, canby's cowbane), *Papaipema sulphurata* (G2, decodon stem borer moth), *Rhexia aristosa* (G3, awned meadowbeauty), *Rhynchospora inundata* (G3G4, narrow-fruit horned beaksedge), *Sabatia kennedyana* (G3, plymouth gentian), *Sagittaria teres* (G3, slender arrowhead), *Schoenoplectus etuberculatus* (G3G4, swamp bulrush), *Scirpus ancistrochaetus* (G3, barbed-bristle 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

Delaware Estuary Associations:

- Blueberry Wetland Thicket
- Buttonbush Coastal Plain Pond
- Cape May - Delmarva Depression Meadow
- Coastal Plain Muck Pondshore
- Coastal Plain Pond
- Coastal Plain Pondshore
- Creeping Lovegrass Coastal Plain Pond
- Deep Muck Coastal Plain Pond
- Northern Peatland Sedge Coastal Plain Pond
- Panicgrass Pondshore
- Pine Barrens Floodplain Forest
- Red Maple - Sweetgum Swamp
- Swamp-loosestrife Coastal Plain Pond
- Upper South Switchgrass Wet Prairie
- Water-willow Shrub Swamp

CLASSIFIERS FOR ATLANTIC COASTAL PLAIN NORTHERN PONDSHORE

Primary Division: 203

Land Cover Class: Herbaceous Wetland

Spatial Scale & Pattern: Small patch

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

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

BLUEBERRY WETLAND THICKET

Vaccinium corymbosum - *Rhododendron viscosum* - *Clethra alnifolia* Shrubland

Range: This type occurs from New Hampshire south to New Jersey, Delaware and possibly Pennsylvania. It has been confirmed in the New Jersey and Delaware portions of the Delaware Estuary.

Environmental Description: This community typically occurs on a shallow organic layer over sand.

Vegetation Description: This type is a tall-shrub swamp where the dominant shrubs include *Vaccinium corymbosum* (highbush blueberry), *Ilex verticillata* (common winterberry), and *Rhododendron viscosum* (swamp azalea). Scattered *Acer rubrum* (red maple) are not uncommon. Associated shrub species may include *Clethra alnifolia* (coastal sweet-pepperbush), *Chamaedaphne calyculata* (leatherleaf), *Ilex glabra* (inkberry or little gallberry), *Leucothoe racemosa* (swamp doghobble), *Lyonia ligustrina* (maleberry), *Decodon verticillatus* (swamp-loosestrife), *Cephalanthus occidentalis* (common buttonbush), *Kalmia angustifolia* (sheep laurel), and *Photinia* (redtip, chokeberry) spp.. Herbaceous species commonly include *Osmunda cinnamomea* (cinnamon fern), *Osmunda regalis* (royal fern), *Lycopus uniflorus* (northern bugleweed), *Glyceria striata* (fowl mannagrass), and *Woodwardia virginica* (Virginia chainfern). *Sphagnum fimbriatum* (fringed bog moss), *Sphagnum rubellum* (red peatmoss), *Sphagnum magellanicum* (Magellan's peatmoss), *Sphagnum fallax* (flat-top bogmoss), and *Sphagnum viridum* (peatmoss) are characteristic.

Characteristic Species: *Rhododendron viscosum* (swamp azalea), *Sphagnum fallax* (flat-top bogmoss), *Sphagnum fimbriatum* (fringed bog moss), *Sphagnum magellanicum* (Magellan's peatmoss), *Sphagnum rubellum* (red peatmoss), *Sphagnum viridum* (peatmoss)

Dynamics/Successional Trajectory: This community is influenced by a strongly fluctuating water table with flooded conditions in spring and early summer followed by a drop in the water table below soil surface usually by late summer.

Reference Sites: Widespread in NJ and DE

Global and State Conservation Ranks and Reasons: GNR (14-Apr-1998). DE: SNR, NJ: S1S3, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685525

References: Breden et al. 2001, Conard 1935, Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Fike 1999, Gawler 2002, Golet 1973, Johnson 1981b, Lynn and Karlin 1985, Metzler and Barrett 2001, Niering and Egler 1966, Reschke 1990, Schall and Murley 1984, Sperduto 2000a, Sperduto and Nichols 2004

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Ilex verticillata</i> (common winterberry)
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Rhododendron viscosum</i> (swamp azalea)
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Vaccinium corymbosum</i> (highbush blueberry)
Herb (field)	Forb	<i>Calla palustris</i> (water arum)
Herb (field)	Forb	<i>Lycopus uniflorus</i> (northern bugleweed)
Herb (field)	Graminoid	<i>Glyceria striata</i> (fowl mannagrass)
Herb (field)	Fern or fern ally	<i>Osmunda cinnamomea</i> (cinnamon fern)
Herb (field)	Fern or fern ally	<i>Osmunda regalis</i> (royal fern)
Herb (field)	Fern or fern ally	<i>Woodwardia virginica</i> (Virginia chainfern)

BUTTONBUSH COASTAL PLAIN POND

Cephalanthus occidentalis / *Polygonum hydropiperoides* - *Panicum verrucosum* Shrubland

Range: The known range of this community includes the central Atlantic Coastal Plain of Delaware, Maryland and Virginia, with an uncertain northward extension to Rhode Island and Massachusetts.

Environmental Description: Habitats are relatively small basin wetlands that draw down entirely during dry years, exposing some bare substrate by the end of the growing season. Soils typically have a shallow organic layer overlying silt loam or clay loam.

Vegetation Description: Physiognomy of stands varies from sparse to rather dense shrublands dominated by *Cephalanthus occidentalis* (common buttonbush). In the Coastal Plain, *Decodon verticillatus* (swamp-loosestrife) may be present or even codominant. Characteristic herbs in the main, Coastal Plain part of the range include *Dulichium arundinaceum* (threeway sedge), *Polygonum hydropiperoides* (swamp smartweed), *Torreyochloa pallida* (pale false mannagrass), *Rhexia virginica* (Virginia meadowbeauty), and *Panicum hemitomon* (maidencane). More irregular herbaceous associates of the compositionally variable stands include *Bidens frondosa* (devil's pitchfork), *Scirpus cyperinus* (woolgrass bulrush), *Proserpinaca palustris* (marsh mermaidweed), *Triadenum virginicum* (Virginia marsh St. John's-wort), *Dichantheium spretum* (Eaton's witchgrass), *Scleria reticularis* (netted nutrush), and *Fimbristylis autumnalis* (slender fimbry).

Noteworthy Associated Plant and/or Animal Species: *Eleocharis melanocarpa* (black-fruit spikerush), *Helenium virginicum* (Virginia sneezeweed), *Scirpus ancistrochaetus* (barbed-bristle bulrush)

Characteristic Species: *Cephalanthus occidentalis* (common buttonbush), *Dulichium arundinaceum* (threeway sedge), *Panicum hemitomon* (maidencane), *Polygonum hydropiperoides* (swamp smartweed), *Rhexia virginica* (Virginia meadowbeauty), *Torreyochloa pallida* (pale false mannagrass)

Dynamics/Successional Trajectory: Most of the Coastal Plain ponds are believed to be sinkhole features that formed through dissolution of underlying carbonate-rich shell marl deposits. The marl deposits are too deep to influence soil or water chemistry of the ponds, which are strongly acidic in most examples. Ponds supporting this community type have mineral soil substrates and a regime of relatively deep and/or long seasonal flooding.

Management Concerns: The community is threatened by groundwater alteration and by agricultural runoff.

Reference Sites: Upper tributary of Blackbird Creek, near Townsend, DE

Global and State Conservation Ranks and Reasons: G3? (14-Dec-1998). DE: SNR. Although there may be 100-200 occurrences of this community, the acreage is very small, probably fewer than 2000 acres rangewide.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684722

References: Bartgis 1986, Berdine and Gould 1999, Bowman 2000, Buhlmann et al. 1999, Eastern Ecology Working Group n.d., Fleming and Coulling 2001, Fleming and Van Alstine 1999, Fleming et al. 2001, Harrison 2004, McAvoy and Clancy 1994, Rawinski 1997, Sneddon 1994, Tyndall et al. 1990

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Cephalanthus occidentalis</i> (common buttonbush)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Decodon verticillatus</i> (swamp-loosestrife)

CAPE MAY - DELMARVA DEPRESSION MEADOW

Cladium mariscoides - *Coelorachis rugosa* Herbaceous Vegetation

Range: This wetland occurs in southern New Jersey and Delaware.

Environmental Description: This seasonally flooded, depressional wetland occurs in the Coastal Plain of southern New Jersey and Delaware. The substrate is sandy loam over sandy clay loam.

Vegetation Description: The vegetation is diverse, with *Cladium mariscoides* (twig-rush) arguably the most characteristic species. Herbaceous associates may include *Dichanthelium spretum* (Eaton's witchgrass), *Coelorachis rugosa* (wrinkled jointgrass), *Boltonia asteroides* (white doll's-daisy), *Eryngium aquaticum* (rattlesnake-master), *Rhexia virginica* (Virginia meadowbeauty), *Fimbristylis autumnalis* (slender fimbry), *Scleria reticularis* (netted nutrush), *Sclerolepis uniflora* (pink bogbutton), and others. Additional species at a site in Delaware include *Panicum hemitomon* (maidencane), *Rhynchospora chalarocephala* (loose-head beaksedge), *Scleria reticularis* (netted nutrush), *Proserpinaca pectinata* (combleaf mermaidweed), *Fimbristylis autumnalis* (slender fimbry), *Dichanthelium hirstii* (hirsts' rosette grass), *Rhexia aristosa* (awned meadowbeauty), *Sabatia difformis* (lanceleaf rose-gentian), and *Xyris smalliana* (Small's yellow-eyed-grass).



Photo by Delaware Natural Heritage Program

Noteworthy Associated Plant and/or Animal Species: *Boltonia asteroides* var. *asteroides* (white doll's-daisy), *Dichanthelium hirstii* (hirsts' rosette grass), *Eryngium aquaticum* (rattlesnake-master),

Hypericum adpressum (creeping St. John's-wort), *Muhlenbergia torreyana* (New Jersey muhly), *Panicum hemitomon* (maidencane), *Rhexia aristosa* (awned meadowbeauty), *Rhynchospora filifolia* (threadleaf beaksedge)

Characteristic Species: *Cladium mariscoides* (twig-rush)

Dynamics/Successional Trajectory: One of the three known occurrences is threatened by altered hydrology caused by an adjacent gravel pit.

Reference Sites: Bennett's Bog, NJ (1/2 mile east of Estuary boundary); Huckleberry Pond, Sussex County, DE

Global and State Conservation Ranks and Reasons: G1 (18-Nov-1997). DE: SNR, NJ: S1. This coastal plain pond community is restricted to a small subset of seasonally flooded basins of southern New Jersey and Delaware. Only three occurrences are known.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687945

References: Bowman 2000, Breden et al. 2001, Eastern Ecology Working Group n.d.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Cladium mariscoides</i> (twig-rush)

COASTAL PLAIN MUCK POND SHORE

Rhexia virginica - *Panicum verrucosum* Herbaceous Vegetation

Range: This Coastal Plain pondshore community commonly occurs in coastal Massachusetts discontinuously south to Delaware.

Environmental Description: This Coastal Plain pondshore community commonly occurs in coastal Massachusetts discontinuously south to Delaware. It occurs on the broad margins of shallow groundwater basins but also occurs on the protected shoreline inlets of deeper ponds in New York. The substrate is variable, ranging from loamy sand, sandy loam, or sand with an organic layer from 0 to greater than 20 cm in depth.



Photo by Kathleen Strakosch Walz

Vegetation Description: Characteristic species include *Rhexia virginica* (Virginia meadowbeauty), *Cyperus dentatus* (bulblet flatsedge), *Juncus canadensis* (Canadian rush), *Viola lanceolata* (bog white violet), *Juncus pelocarpus* (brown-fruit rush), *Gratiola aurea* (golden hedge-hyssop), *Rhynchospora capitellata* (northern beaksedge), *Euthamia caroliniana* (slender goldentop), *Drosera intermedia* (water sundew), *Hypericum mutilum* (dwarf St. John's-wort), *Coreopsis rosea* (pink tickseed), *Scleria reticularis* (netted nutrush), *Panicum verrucosum* (warty panicgrass), *Xyris torta* (slender yellow-eyed-grass), *Lachnanthes caroliniana* (redroot), *Rhynchospora scirpoides* (longbeak beaksedge), *Fuirena squarrosa* (hairy umbrella-sedge), and *Rhynchospora macrostachya* (tall horned beaksedge).

Noteworthy Associated Plant and/or Animal Species: *Coreopsis rosea* (pink tickseed), *Dichanthelium hirstii* (hirsts' rosette grass), *Nymphoides cordata* (little floatingheart), *Rhexia aristosa* (awned meadowbeauty), *Rhynchospora macrostachya* (tall horned beaksedge)

Characteristic Species: *Panicum verrucosum* (warty panicgrass), *Rhexia virginica* (Virginia meadowbeauty)

Management Concerns: Many occurrences of this community have likely been lost because they occupied shallow basins that dried out in late summer, so provided little recreation (swimming or fishing) and were likely filled in to add agricultural land or to suppress mosquito breeding. On the mid-Atlantic Coastal Plain, agriculture has caused the greatest loss, either through filling or draining, or has caused indirect degradation through fertilizer runoff.

Reference Sites: Wheatland Pond Complex, NJ

Global and State Conservation Ranks and Reasons: G2G3 (14-Dec-1998). DE: SNR, NJ: S1S3. This Coastal Plain pondshore community is restricted to shallow seasonally flooded basins of the Atlantic Coastal Plain from Massachusetts to Delaware.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687006

References: Bartgis 1986, Berdine and Gould 1999, Breden et al. 2001, Cowardin et al. 1979, Eastern Ecology Working Group n.d., Metzler and Barrett 2001, Rawinski 1984, Swain and Kearsley 2001, Thompson 1996, Thompson and Sorenson 2000, Tyndall et al. 1990

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Forb	<i>Rhexia virginica</i> (Virginia meadowbeauty)
Herb (field)	Graminoid	<i>Panicum verrucosum</i> (warty panicgrass)

COASTAL PLAIN POND

Nymphaea odorata - *Eleocharis robbinsii* Herbaceous Vegetation

Range: This association is limited to the Atlantic Coastal Plain from southern New England to Maryland.

Environmental Description: This hydromorphic Coastal Plain pond community ranges from southern New England to Maryland. It occurs in standing water in all but exceptionally dry years. The substrate is most often deep muck, but in oligotrophic ponds an organic layer may be absent or much reduced, and the vegetation occurs on sand or mucky sand.

Vegetation Description: Characteristic species include *Nymphaea odorata* (white water-lily), *Nymphoides cordata* (little floatingheart), and *Eleocharis robbinsii* (Robbins' spikerush), with frequent associates including *Scleria reticularis* (netted nutrush), *Gratiola aurea* (golden hedge-hyssop), *Proserpinaca pectinata* (combleaf mermaidweed), *Utricularia juncea* (southern bladderwort), *Brasenia schreberi* (watershield), *Pontederia cordata* (pickerelweed), *Ludwigia* (seedbox) spp., *Utricularia* (bladderwort) spp., and *Eriocaulon aquaticum* (seven-angle pipewort).



Photo by Nancy Lee Adamson

Characteristic Species: *Eleocharis robbinsii* (Robbins' spikerush), *Nymphaea odorata* (white water-lily), *Nymphoides cordata* (little floatingheart)

Management Concerns: Coastal Plain ponds in general are threatened by hydrologic alteration (groundwater depletion), agricultural runoff, and recreation activities.

Reference Sites: Possibly at Prime Hook NWR, Sussex County, DE; Confirmed at Pierce's Pond, NJ and Deep Run Powerline, NJ

Global and State Conservation Ranks and Reasons: G2 (7-Dec-1998). DE: SNR, NJ: S1S2. This Coastal Plain pond association has an estimated 100-150 occurrences rangewide, but it is a small-patch community that totals fewer than 1000 acres.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689522

References: Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Harrison 2004, Rawinski 1984, Sneddon 1994, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Eleocharis robbinsii</i> (Robbins' spikerush)
Floating aquatic	Aquatic herb (floating & submergent)	<i>Nymphaea odorata</i> (white water-lily)
Floating aquatic	Aquatic herb (floating & submergent)	<i>Nymphoides cordata</i> (little floatingheart)

COASTAL PLAIN POND SHORE

Dulichium arundinaceum - *Juncus canadensis* - *Juncus pelocarpus* Herbaceous Vegetation

Range: This Coastal Plain pondshore community occurs in Delaware, New Jersey, and Maryland.

Environmental Description: This community occurs along the pondshores of coastal plains.

Vegetation Description: The vegetation is dominated by *Dulichium arundinaceum* (threeway sedge) and *Juncus canadensis* (Canadian rush). Other associated species include *Scirpus cyperinus* (woolgrass bulrush), *Polygonum punctatum* (dotted smartweed), *Utricularia* (bladderwort) spp., *Triadenum virginicum* (Virginia marsh St. John's-wort), and *Scirpus cyperinus* (woolgrass bulrush).

Characteristic Species: *Dulichium arundinaceum* (threeway sedge), *Juncus canadensis* (Canadian rush)

Reference Sites: Seasonal Pond Townsend One in the Blackbird Creek drainage, DE

Global and State Conservation Ranks and Reasons: GNR (15-Nov-2000). DE: SNR, NJ: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684603

References: Bowman 2000, Eastern Ecology Working Group n.d., Rawinski 1997

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Dulichium arundinaceum</i> (threeway sedge)

CREEPING LOVEGRASS COASTAL PLAIN POND

Eragrostis hypnoides - *Ludwigia sphaerocarpa* - *Polygonum hydropiperoides* Herbaceous Vegetation

Range: This Coastal Plain pond community occurs in New Jersey and possibly Delaware.

Environmental Description: This seasonally flooded, depressional wetland of the central Atlantic Coastal Plain occupies the lowest portion of the basin and is flooded for the longest period relative to adjacent vegetation zones. The substrate is an organic layer over black clay loam.

Vegetation Description: The vegetation is dominated by small-statured herbs, including *Eragrostis hypnoides* (creeping lovegrass), *Polygonum hydropiperoides* (swamp smartweed), *Polygonum amphibium* (water smartweed), *Ludwigia sphaerocarpa* (globe-fruit seedbox), *Oldenlandia uniflora* (clustered mille grains), *Cyperus strigosus* (straw-colored flatsedge), *Bidens frondosa* (devil's pitchfork), *Fimbristylis autumnalis* (slender fimbry), *Juncus pelocarpus* (brown-fruit rush), *Gratiola aurea* (golden hedge-hyssop), and *Lindernia dubia* (yellowseed false pimpernel). Other species of taller stature may be present, including seedlings or small saplings of *Cephalanthus occidentalis* (common buttonbush) and herbaceous species *Panicum rigidulum* (redtop panicgrass), *Carex striata* (peatland sedge), *Carex gigantea* (giant sedge), and *Torreyochloa* (false mannagrass) sp.

Characteristic Species: *Eragrostis hypnoides* (creeping lovegrass), *Ludwigia sphaerocarpa* (globe-fruit seedbox), *Polygonum hydropiperoides* (swamp smartweed)

Dynamics/Successional Trajectory: In years of high rainfall resulting in incomplete drawdown, many species of this association persist in the seedbank below standing water.

Reference Sites: Supawna Meadows NWR, Salem County, NJ

Global and State Conservation Ranks and Reasons: GNR (17-Apr-2000). NJ: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689603

References: Bartgis 1986, Berdine and Gould 1999, Coulling 2002, Eastern Ecology Working Group n.d., Fleming et al. 2001, Harrison 2004, Rawinski 1997

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Forb	<i>Ludwigia sphaerocarpa</i> (globe-fruit seedbox)
Herb (field)	Forb	<i>Polygonum hydropiperoides</i> (swamp smartweed)
Herb (field)	Graminoid	<i>Eragrostis hypnoides</i> (creeping lovegrass)

DEEP MUCK COASTAL PLAIN POND

Eleocharis flavescens - *Xyris difformis* Herbaceous Vegetation

Range: This Coastal Plain pond community occurs in Delaware and in New Jersey.

Environmental Description: This type comprises herbaceous vegetation of deep muck often associated with Coastal Plain ponds. This vegetation may only appear during the latter part of the growing season when water levels have dropped, and may not appear at all during years of particularly high rainfall.

Vegetation Description: This community includes low, graminoid-dominated vegetation of deep muck often associated with Coastal Plain ponds. Characteristic species include *Eleocharis flavescens* (yellow spikerush), *Eleocharis olivacea* (bright-green spikerush), *Eleocharis microcarpa* (small-fruit spikerush), *Eleocharis robbinsii* (Robbins' spikerush), *Eleocharis tricostata* (three-angle spikerush), *Eleocharis tuberculosa* (cone-cup spikerush), *Juncus pelocarpus* (brown-fruit rush), *Drosera intermedia* (water sundew), *Eriocaulon aquaticum* (seven-angle pipewort), *Fimbristylis autumnalis* (slender fimbry), *Rhynchospora scirpoides* (longbeak beaksedge), *Scleria reticularis* (netted nutrush), *Xyris difformis* var. *difformis* (bog yellow-eyed-grass), and *Xyris smalliana* (Small's yellow-eyed-grass), as well as occasional individuals of aquatic species such as *Nymphaea odorata* (white water-lily).

Characteristic Species: *Eleocharis flavescens* (yellow spikerush), *Xyris difformis* var. *difformis* (bog yellow-eyed-grass)

Reference Sites: Prime Hook NWR, DE; Wheatland Pond Complex, NJ; Steelmantown Road South Pond, Cape May, NJ; Odd Pond, NJ

Global and State Conservation Ranks and Reasons: GNR (1-Dec-1997). DE: SNR, NJ: S2. (Note: in NJ this is an S2 association.)

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.683317

References: Eastern Ecology Working Group n.d., Rawinski 1984, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Eleocharis flavescens</i> (yellow spikerush)

NORTHERN PEATLAND SEDGE COASTAL PLAIN POND

Carex striata var. *brevis* Herbaceous Vegetation

Range: Examples are known from the Coastal Plain in New York, Maryland and Delaware and in the New Jersey Pine Barrens. The nominal taxon ranges south to South Carolina (Kartesz 1999), and the association could also be found in the Coastal Plain of Virginia and the Carolinas.

Environmental Description: This vegetation occupies Coastal Plain depression meadows around the perimeter of Coastal Plain ponds. The substrate is typically composed of sand and gravel, but some community types may occur on organic muck.

Vegetation Description: Stands are dominated by *Carex striata* var. *brevis* (northern peatland sedge), which usually occurs in dense stands with few other associates. These may include seedlings of *Cephalanthus occidentalis* (common buttonbush) and *Acer rubrum* (red maple), as well as *Cladium mariscoides* (twig-rush), *Rhexia virginica* (Virginia meadowbeauty), *Bidens frondosa* (devil's pitchfork), *Rhynchospora macrostachya* (tall horned beaksedge), *Rhynchospora chalarocephala* (loose-head beaksedge), *Fimbristylis autumnalis* (slender fimbry), *Juncus canadensis* (Canadian rush), *Dulichium arundinaceum* (threeway sedge), *Hypericum mutilum* (dwarf St. John's-wort), and *Panicum hemitomon* (maidencane). *Sphagnum* (peatmoss) is often abundant.

Characteristic Species: *Carex striata* var. *brevis* (northern peatland sedge)

Management Concerns: These isolated wetlands are vulnerable to dredging, filling, pesticide or fertilizer runoff, and other human disturbances.

Reference Sites: Steelmantown Pond Road South Pond, NJ; Wheatland Pond Complex, NJ; Slab Branch Pond, NJ

Global and State Conservation Ranks and Reasons: G3G4 (19-Jan-2006). DE: SNR, NJ: S1S3. This small-patch wetland community is restricted to the Coastal Plain of four mid-Atlantic states and may range southward discontinuously to South Carolina.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687457

References: Bartgis 1986, Berdine and Gould 1999, Bowman 2000, Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Fleming et al. 2001, Harrison 2004, Kartesz 1999, Nelson 1986, Tyndall et al. 1990

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Carex striata</i> var. <i>brevis</i> (northern peatland sedge)

PANICGRASS PONDSHORE

Panicum hemitomon - *Panicum verrucosum* Herbaceous Vegetation

Range: This intermittent Coastal Plain pond community occurs in New Jersey within the Delaware Estuary.

Environmental Description: This seasonally flooded wetland occurs in small topographically isolated basins in the central Atlantic Coastal Plain. This vegetation usually occurs on the relatively higher, outer margin of the basin, occurring on loamy sands.

Vegetation Description: *Panicum hemitomon* (maidencane) is the dominant species, often occurring in monotypic stands. Associates that may occur at low cover include *Cladium mariscoides* (twig-rush), *Dulichium arundinaceum* (threeway sedge), *Panicum verrucosum* (warty panicgrass), *Dichanthelium spretum* (Eaton's witchgrass), *Carex striata* (peatland sedge), *Juncus repens* (creeping rush), and *Eleocharis quadrangulata* (squarestem spikerush). Occasional seedlings of *Liquidambar styraciflua* (sweetgum), *Acer rubrum* (red maple), and *Diospyros virginiana* (eastern persimmon) also may occur.



Photo by Nancy Lee Adamson

Characteristic Species: *Panicum hemitomon* (maidencane)

Reference Sites: Peasley Pond, Peaslee WMA, NJ; Belleplain SF, NJ; Odd Pond, NJ; Steelmantown Road South Pond, NJ

Global and State Conservation Ranks and Reasons: GNR (28-Aug-1997). DE: SNR, NJ: S1S2.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689661

References: Bartgis 1986, Berdine and Gould 1999, Bowman 2000, Breden et al. 2001, Eastern Ecology Working Group n.d., Harrison 2004

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Panicum hemitomon</i> (maidencane)

PINE BARRENS FLOODPLAIN FOREST

Fraxinus pennsylvanica - *Juglans nigra* - *Ulmus americana* / *Cornus amomum* / *Onoclea sensibilis* Forest

Range: This floodplain forest occurs in the New Jersey Pine Barrens in the Delaware Estuary.

Environmental Description: This is a temporarily flooded floodplain forest associated with small streams that occurs on the Coastal Plain.

Vegetation Description: This is a floodplain forest community in which the canopy is codominated by *Fraxinus pennsylvanica* (green ash), *Juglans nigra* (black walnut), and *Ulmus americana* (American elm).

The shrub stratum is dominated by *Cornus amomum* (silky dogwood), in association with *Alnus serrulata* (smooth alder) and exotics, such as *Ligustrum vulgare* (European privet), *Rosa multiflora* (multiflora rose), and *Lonicera tatarica* (Tatarian honeysuckle). The herbaceous layer is dominated by *Onoclea sensibilis* (sensitive fern).

Characteristic Species: *Cornus amomum* (silky dogwood), *Juglans nigra* (black walnut)

Dynamics/Successional Trajectory: Fire frequency as well as floodplain hydrology have a profound influence on the vegetation.

Management Concerns: The shrub layer contains a number of exotics, including *Ligustrum vulgare* (European privet), *Rosa multiflora* (multiflora rose), and *Lonicera tatarica* (Tatarian honeysuckle). The herbaceous layer may contain exotics, such as *Allium vineale* (wild garlic) and *Microstegium vimineum* (Japanese stiltgrass).

Reference Sites: Brendan Byrne State Forest, NJ

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685560

References: Eastern Ecology Working Group n.d.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Fraxinus pennsylvanica</i> (green ash)
Tree canopy	Broad-leaved deciduous tree	<i>Juglans nigra</i> (black walnut)
Tree canopy	Broad-leaved deciduous tree	<i>Ulmus americana</i> (American elm)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Cornus amomum</i> (silky dogwood)
Herb (field)	Fern or fern ally	<i>Onoclea sensibilis</i> (sensitive fern)

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, New Jersey and Pennsylvania where it occurs in the Delaware Estuary.

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 blackgum), *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 sweet-pepperbush), *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* (greenish-white sedge), *Scirpus cyperinus* (woolgrass bulrush), *Juncus effusus* (soft rush), and *Polygonum* (smartweed, knotweed) spp.

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

Reference Sites: 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: GNR (1-Dec-1997). DE: SNR, NJ: S3, PA: SNR.

VegBank Link for Plot Data: 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 (tall & short)	Broad-leaved deciduous shrub	<i>Leucothoe racemosa</i> (swamp doghobble)

SWAMP-LOOSESTRIFE COASTAL PLAIN POND

Decodon verticillatus / *Triadenum virginicum* Shrubland

Range: This association occurs in southern New England, New Jersey and Delaware.

Environmental Description: This wetland vegetation of mucky substrates occurs in coastal plains of the the northeastern U.S. It often completely covers small seasonally flooded basins or occurs in a patchy zone on the periphery of larger permanent water bodies.

Vegetation Description: The vegetation is dominated by *Decodon verticillatus* (swamp-loosestrife). Although the flooding regime is typified by a longer hydroperiod than many other Coastal Plain pondshore vegetation types as evidenced by moderately deep to deep muck, water levels in dry years drop below the surface, exposing substrate that supports Coastal Plain species such as *Drosera intermedia* (water sundew), *Hypericum mutilum* (dwarf St. John's-wort), and *Viola lanceolata* (bog white violet). Typical associates include *Triadenum virginicum* (Virginia marsh St. John's-wort), *Leersia oryzoides* (rice cutgrass), *Lycopus uniflorus* (northern bugleweed), *Lycopus virginicus* (Virginia water-horehound), *Bidens connata* (purple-stem beggarticks), *Lysimachia terrestris* (swamp-candles), *Juncus canadensis* (Canadian rush), *Galium palustre* (common marsh bedstraw), and *Woodwardia virginica* (Virginia chainfern).



Photo by Nancy Lee Adamson

Characteristic Species: *Decodon verticillatus* (swamp-loosestrife), *Triadenum virginicum* (Virginia marsh St. John's-wort)

Dynamics/Successional Trajectory: Although the flooding regime is typified by a longer hydroperiod than many other Coastal Plain pondshore vegetation types as evidenced by moderately deep to deep

muck, water levels in dry years drop below the surface, exposing substrate that supports Coastal Plain species.

Reference Sites: Several millponds in Sussex County, DE

Global and State Conservation Ranks and Reasons: GNR (21-Apr-2004). DE: SNR, NJ: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.721909

References: Eastern Ecology Working Group n.d., Sneddon et al. 1999

UPPER SOUTH SWITCHGRASS WET PRAIRIE

Panicum virgatum Seasonally Flooded Herbaceous Vegetation

Range: This vegetation is found in Kentucky and possibly Tennessee. It has also been found in the New Jersey Pine Barrens. It, or a closely related type, has also been found in the New Jersey Pine Barrens.

Environmental Description: In New Jersey, this community occurs on sandy soils and in areas associated with Coastal Plain pondshores. This broadly defined type represents prairie-related, seasonally flooded herbaceous vegetation dominated by *Panicum virgatum* (switchgrass).

Vegetation Description: This seasonally flooded herbaceous vegetation community is dominated by *Panicum virgatum* (switchgrass).

Characteristic Species: *Panicum virgatum* (switchgrass)

Management Concerns: This type is placed here to represent vegetation which may be virtually extinct, persisting as remnant populations of *Panicum virgatum* (switchgrass) in ditches and swales. More inventory is needed to determine the relationship of the New Jersey and southern variants of this type.

Reference Sites: Brendan Byrne State Forest, NJ

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687290

References: Southeastern Ecology Working Group n.d., TDNH unpubl. data

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Panicum virgatum</i> (switchgrass)

WATER-WILLOW SHRUB SWAMP

Decodon verticillatus Semipermanently Flooded Shrubland

Range: This community occurs in the New Jersey portion of the Delaware Estuary and may also occur in Delaware.

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

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* (white water-lily), *Peltandra virginica* (green arrow-arum), *Pontederia cordata* (pickerelweed), *Utricularia* (bladderwort) spp., and *Potamogeton* (pondweed) spp.

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

Reference Sites: (NJ and DE - no sites identified)

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

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: ATLANTIC COASTAL PLAIN SMALL BROWNWATER RIVER FLOODPLAIN FOREST

Summary: This system encompasses the floodplains of small to medium brownwater rivers of the Atlantic Coastal Plain which are intermediate between the smaller streams and the largest rivers. Brownwater rivers originate in clayey areas and carry substantial amounts of mineral sediment, creating well-developed deposition alluvial landforms and fertile soils. Vegetation is a mosaic of cypress and gum swamps, oak-dominated bottomland hardwoods, and mixed levee forests, with only local non-forested communities.

Range: Throughout the Atlantic Coastal Plain, from Delaware to Georgia. United States: DE, GA, MD, NC, SC, VA

Delaware Estuary Associations:

- Alluvial Alder Swamp Coastal Plain Oak Floodplain Swamp
- Coastal Plain Streamside Forest Southern Coastal Plain Cottonwood - Willow Riverfront Forest
- Successional Sweetgum Floodplain Forest

CLASSIFIERS FOR ATLANTIC COASTAL PLAIN SMALL BROWNWATER RIVER FLOODPLAIN FOREST

Primary Division: 203

Land Cover Class: Woody Wetland

Spatial Scale & Pattern: Linear

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

Diagnostic Classifiers: Riverine / Alluvial [Brownwater]

Non-diagnostic Classifiers: Forest and Woodland (Treed)

ALLUVIAL ALDER SWAMP

Cornus amomum - *Alnus serrulata* Shrubland

Range: This Coastal Plain alluvial shrubland occurs in the Chesapeake Bay Lowlands and along the Christina River in Delaware in the Delaware Estuary.

Environmental Description: This Coastal Plain alluvial shrubland occurs in the Chesapeake Bay Lowlands on the non-tidal portions of rivers and non-tidal bay mouths.

Vegetation Description: The shrub canopy is characterized by *Cornus amomum* (silky dogwood) with other associates including *Alnus serrulata* (smooth alder), *Cephalanthus occidentalis* (common buttonbush), and *Viburnum* (viburnum) spp., as well as saplings of *Acer rubrum* (red maple), *Fraxinus pennsylvanica* (green ash), and *Salix nigra* (black willow). Herbaceous associates include *Osmunda regalis* (royal fern), *Decodon verticillatus* (swamp-loosestrife), *Utricularia* (bladderwort) spp., *Limnobiium spongia* (American spongeplant), and *Cicuta bulbifera* (bulb-bearing water-hemlock).

Characteristic Species: *Cornus amomum* (silky dogwood)

Reference Sites: Lewden-Green Park in New Castle County, DE, on the Christina River

Global and State Conservation Ranks and Reasons: GNR (10-Oct-2000). DE: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.683138

References: Eastern Ecology Working Group n.d., Harrison 2004, Tiner 1985a

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Alnus serrulata</i> (smooth alder)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Cornus amomum</i> (silky dogwood)
Herb (field)	Fern or fern ally	<i>Osmunda regalis</i> (royal fern)

COASTAL PLAIN OAK FLOODPLAIN SWAMP

Quercus (palustris, phellos) - Acer rubrum / Cinna arundinacea Forest

Range: This community is found in the Chesapeake Bay region north to the southern Coastal Plain of New Jersey and Pennsylvania.

Environmental Description: This floodplain swamp community of the Chesapeake Bay region and environs occurs in topographic depressions within alluvial floodplains. It occurs in pockets of saturated soils in, or at the edges of, depressions within a larger floodplain forest with annual flooding. Soils are poorly drained loams or clay loams.

Vegetation Description: The tree canopy is dominated by *Quercus palustris* (pin oak), *Quercus phellos* (willow oak), *Acer rubrum* (red maple), and *Liquidambar styraciflua* (sweetgum). The shrub layer is of relatively low cover and comprised of *Viburnum dentatum* (southern arrow-wood), *Viburnum prunifolium* (smooth blackhaw), and *Ilex verticillata* (common winterberry). *Vaccinium corymbosum* (highbush blueberry) is a less frequent shrub layer associate. Typical vines include *Toxicodendron radicans* (eastern poison-ivy), *Parthenocissus quinquefolia* (Virginia creeper), and *Smilax rotundifolia* (roundleaf greenbrier). The herb layer is characterized by *Cinna arundinacea* (sweet woodreed), *Boehmeria cylindrica* (small-spike false nettle), *Symphytotrichum lateriflorum* var. *lateriflorum* (calico aster), and *Carex* (sedge) spp., with less frequent associates including *Arisaema triphyllum* (Jack-in-the-pulpit), *Eurybia divaricata* (white wood-aster), *Lycopus virginicus* (Virginia water-horehound), *Ranunculus abortivus* (kidneyleaf buttercup), *Euonymus americanus* (American strawberry-bush), *Chasmanthium laxum* (slender spikegrass), and *Glyceria striata* (fowl mannagrass).

Characteristic Species: *Boehmeria cylindrica* (small-spike false nettle), *Cinna arundinacea* (sweet woodreed), *Quercus palustris* (pin oak)

Dynamics/Successional Trajectory: This floodplain forest is subject to annual flooding.

Reference Sites: Cape May, NJ, and potentially Cedar Swamp WMA, New Castle County, DE

Global and State Conservation Ranks and Reasons: GNR (27-Mar-2000). DE?:SNA, NJ?:SNA, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689632

References: Eastern Ecology Working Group n.d., Fleming et al. 2001, Harrison 2004, Harrison and Stango 2003, Patterson pers. comm., Thomson et al. 1999

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>Quercus palustris</i> (pin oak)
Tree canopy	Broad-leaved deciduous tree	<i>Quercus phellos</i> (willow oak)
Herb (field)	Graminoid	<i>Cinna arundinacea</i> (sweet woodreed)

COASTAL PLAIN STREAMSIDE FOREST

Platanus occidentalis - (*Liquidambar styraciflua*, *Liriodendron tulipifera*) / *Asimina triloba* Forest

Range: This forest is found in the Inner Coastal Plain of the Chesapeake Bay region, in the Upper Coastal Plain and Piedmont of Delaware, and in New Jersey. In the Delaware Estuary, this community occurs in New Jersey and possibly Pennsylvania and Delaware.

Environmental Description: This Inner Coastal Plain streamside forest of the Mid-Atlantic region occurs along braided and intermittent streams on active and former stream channels. Flooding frequency is annual, and soils are alluvial clay loams or sandy clay loams.



Photo by Linda Kelly

Vegetation Description: The tree canopy is dominated by *Platanus occidentalis* (sycamore), *Liquidambar styraciflua* (sweetgum), *Betula nigra* (river birch), *Liriodendron tulipifera* (tuliptree), and *Acer rubrum* (red maple). Less frequent associates may include *Quercus michauxii* (swamp chestnut oak), *Ulmus americana* (American elm), and *Quercus phellos* (willow oak). The subcanopy is of variable cover and is characterized by *Asimina triloba* (common pawpaw), *Carpinus caroliniana* (American hornbeam), *Lindera benzoin* (northern spicebush), and *Ilex opaca* (American holly), with *Cornus florida* (flowering dogwood) found less frequently. Typical vines include *Toxicodendron radicans* (eastern poison-ivy), *Parthenocissus quinquefolia* (Virginia creeper), and *Smilax rotundifolia* (roundleaf greenbrier). The most abundant herbs are *Boehmeria cylindrica* (small-spike false nettle) and *Arisaema triphyllum* (Jack-in-the-pulpit). Other herbaceous associates include *Geum virginianum* (cream avens), *Carex debilis* (white-edge sedge), *Lycopus virginicus* (Virginia water-horehound), *Impatiens capensis* (orange jewelweed), *Pilea pumila* (Canadian clearweed), *Claytonia virginica* (Virginia springbeauty), *Ranunculus abortivus* (kidneyleaf buttercup), and *Cardamine concatenata* (cutleaf toothwort). The vine *Campsis radicans* (trumpetvine) may also be present. *Asimina triloba* (common pawpaw) does not occur in New Jersey examples of this site; however, all of the other species listed are typical.

Characteristic Species: *Arisaema triphyllum* (Jack-in-the-pulpit), *Asimina triloba* (common pawpaw), *Boehmeria cylindrica* (small-spike false nettle), *Platanus occidentalis* (sycamore)

Reference Sites: Brandywine Creek, DE?; Rancocas State Park, NJ

Global and State Conservation Ranks and Reasons: G3G4 (21-Mar-2000). DE: SNR, NJ: SNR, PA?: SNA. This community is newly proposed and requires further evaluation. Global based on state rank.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686841

References: Bartgis 1986, Eastern Ecology Working Group n.d., Fleming et al. 2001, Harrison 2004, Thomson et al. 1999

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Betula nigra</i> (river birch)
Tree canopy	Broad-leaved deciduous tree	<i>Liquidambar styraciflua</i> (sweetgum)
Tree canopy	Broad-leaved deciduous tree	<i>Liriodendron tulipifera</i> (tuliptree)
Tree canopy	Broad-leaved deciduous tree	<i>Platanus occidentalis</i> (sycamore)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Carpinus caroliniana</i> (American hornbeam)
Shrub/sapling (tall & short)	Vine/Liana	<i>Toxicodendron radicans</i> (eastern poison-ivy)
Herb (field)	Forb	<i>Arisaema triphyllum</i> (Jack-in-the-pulpit)
Herb (field)	Forb	<i>Boehmeria cylindrica</i> (small-spike false nettle)

SOUTHERN COASTAL PLAIN COTTONWOOD - WILLOW RIVERFRONT FOREST

Populus deltoides - *Salix nigra* / *Mikania scandens* Forest

Range: This forest occurs in the southeastern Coastal Plain of the United States. The status in the lower Piedmont is undetermined. It, or a closely related community, also occurs in New Jersey's portion of the Delaware Estuary.

Environmental Description: This forest occurs in the southeastern Coastal Plain along the fronts and banks of large rivers and on islands where sediment accretes. This community is found on the fronts or banks of major rivers which are better-drained than areas farther from the watercourse. It can also be found on relatively newly accreted soil at the ends of islands and stream bars. Soils are coarser-textured than those of most other bottomland communities because the heavier soil particles drop out of flood waters first; silts and clays stay suspended longer and are deposited farther from the watercourse. This community may establish itself in either Zone III or Zone IV. If it occurs in Zone III, soil accretion will move the community into Zone IV. Zone III communities experience semipermanently inundated or saturated soil from surface or groundwater during >25% of the growing season; flooding is typical during winter and spring with a 51-100% frequency, but the soil is not saturated approximately 60% of the year. Zone IV communities experience seasonal inundation or groundwater saturation for approximately 12.5-25% of the year, usually during spring and early summer with a frequency of 51-100%.

Vegetation Description: Stands of this forest are dominated by *Populus deltoides* (eastern cottonwood) and *Salix nigra* (black willow). These two species combined contribute at least 75% of the canopy cover with each contributing 25-75% of the total and a variety of other bottomland species contributing the rest. In addition to the above-listed species, *Acer rubrum* (red maple), *Acer negundo* (box-elder), *Fraxinus pennsylvanica* (green ash), *Betula nigra* (river birch), *Celtis occidentalis* (common hackberry), *Ulmus americana* (American elm), *Liquidambar styraciflua* (sweetgum), *Juglans nigra* (black walnut), and *Acer saccharinum* (silver maple) all may be present within their ranges. *Ilex opaca* var. *opaca* (American holly), *Carpinus caroliniana* (American hornbeam), and *Lindera benzoin* (northern spicebush) may be present in the subcanopy. Depending on the maturity of the occurrence, physiognomy varies. The herb layer is sparse to dense.

Characteristic Species: *Populus deltoides* (eastern cottonwood), *Salix nigra* (black willow)

Dynamics/Successional Trajectory: This community experiences frequent flooding of short duration. Very heavy siltation can kill enough individuals of *Populus deltoides* (eastern cottonwood) to convert the community to one dominated almost exclusively by *Salix nigra* (black willow). This forest often succeeds to a forest dominated by some combination of *Celtis laevigata* (sugarberry), *Ulmus americana* (American elm), *Platanus occidentalis* (sycamore), *Fraxinus pennsylvanica* (green ash), and *Liquidambar styraciflua* (sweetgum). Regardless, succession in this community occurs relatively swiftly.

Management Concerns: Management may require removal of exotics to maintain the quality of occurrences. It is important to maintain the natural hydrology of the associated river. More inventory is needed to determine the relationship between the New Jersey community and the more southern variants of this community.

Reference Sites: Palmyra Cove, NJ

Global and State Conservation Ranks and Reasons: G4G5 (2-Sep-1999). NJ: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.683975

References: Allard 1990, Ambrose 1990a, Burns and Honkala 1990b, Clark and Benforado 1981, Dickson and Segelquist 1978, Eyre 1980, Faulkner and Patrick n.d., Foti et al. 1994, Klimas 1988b, Klimas et al. 1981, McWilliams and Rosson 1990, Oberholster 1993, Putnam 1951, Putnam et al. 1960, Schotz pers. comm., Smith 1996a, Smith and Linnartz 1980, Southeastern Ecology Working Group n.d., TDNH unpubl. data, Van Auken and Bush 1988, Wharton 1978, Wharton et al. 1982, Wieland 1994b, Wieland 2000b

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Celtis laevigata</i> (sugarberry)
Tree canopy	Broad-leaved deciduous tree	<i>Platanus occidentalis</i> (sycamore)
Tree canopy	Broad-leaved deciduous tree	<i>Populus deltoides</i> (eastern cottonwood)
Tree canopy	Broad-leaved deciduous tree	<i>Salix nigra</i> (black willow)
Shrub/sapling (tall & short)	Vine/Liana	<i>Apios americana</i> (groundnut)
Shrub/sapling (tall & short)	Vine/Liana	<i>Brunnichia ovata</i> (ladies' eardrops)
Shrub/sapling (tall & short)	Vine/Liana	<i>Campsis radicans</i> (trumpetvine)
Shrub/sapling (tall & short)	Vine/Liana	<i>Mikania scandens</i> (climbing hempvine)
Shrub/sapling (tall & short)	Vine/Liana	<i>Toxicodendron radicans</i> (eastern poison-ivy)
Herb (field)	Forb	<i>Boehmeria cylindrica</i> (small-spike false nettle)
Herb (field)	Forb	<i>Laportea canadensis</i> (Canadian wood-nettle)
Herb (field)	Forb	<i>Phytolacca americana</i> (American pokeweed)

SUCCESSIONAL SWEETGUM FLOODPLAIN FOREST

Liquidambar styraciflua - (*Liriodendron tulipifera*) Temporarily Flooded Forest

Range: This association is known from the Piedmont, Interior Low Plateau, Inner South Atlantic Coastal Plain, and possibly other provinces. It occurs in New Jersey's portion of the Delaware Estuary.

Environmental Description: This association occurs on disturbed sites such as wetland old fields. This is a successional community that develops following clearcutting or other disturbance along floodplains of major creeks and other temporarily flooded areas. These are productive stream terraces subject to occasional flooding (Jones et al. 1981b).

Vegetation Description: The canopy of this association is dominated by *Liquidambar styraciflua* (sweetgum) but can be dominated by *Liriodendron tulipifera* (tuliptree) in some cases. *Acer rubrum* (red maple) may be a major component of the canopy and subcanopy and may even partially dominate in some instances (TNC 1998a). In more mature examples, other canopy/subcanopy species which may occur to a lesser extent and often as scattered emergents are *Quercus alba* (white oak), *Quercus phellos* (willow oak), *Quercus nigra* (water oak), *Fraxinus americana* (white ash), *Carya* (hickory) spp., *Nyssa sylvatica* (blackgum), and *Cornus florida* (flowering dogwood). Stands in the Inner Coastal Plain of South Carolina typically contain *Persea palustris* (swampbay) and *Magnolia virginiana* (sweetbay) (Jones et al. 1981b). The shrub layer contains *Carpinus caroliniana* (American hornbeam), *Itea virginica* (Virginia-willow), *Vitis rotundifolia* (muscadine), *Parthenocissus quinquefolia* (Virginia creeper), *Smilax rotundifolia* (roundleaf greenbrier), and *Rubus* (blackberry) sp., in addition to canopy/subcanopy species. The herbaceous layer may include *Chasmanthium laxum* (slender spikegrass), *Carex* (sedge) spp., *Boehmeria cylindrica* (small-spike false nettle), and *Botrychium biternatum* (sparse-lobe grapefern), sometimes growing on hummocks in standing water. Various *Carex* (sedge) species may be present.

Characteristic Species: *Liquidambar styraciflua* (sweetgum)

Dynamics/Successional Trajectory: This is a successional community which develops following clearcutting or other disturbance along floodplains of major creeks and other temporarily flooded areas.

Management Concerns: *Lonicera japonica* (Japanese honeysuckle) is often abundant in the understory. On disturbed sites, the shrub layer is often dominated by *Ligustrum sinense* (Chinese privet), and the ground layer is typically solid *Microstegium vimineum* (Japanese stiltgrass).

Reference Sites: Supawna Meadows NWR, NJ; Mount Laurel, Pemberton, NJ

Global and State Conservation Ranks and Reasons: GNA (ruderal) (8-Aug-2000). NJ: SNA. This is a successional community which develops following clearcutting or other disturbance along floodplains of major creeks and other temporarily flooded areas.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689938

References: Jones et al. 1981b, NatureServe Ecology - Southeastern U.S. unpubl. data, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data, TNC 1998a

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

ECOLOGICAL SYSTEM: CENTRAL APPALACHIAN DRY OAK-PINE FOREST

Summary: These oak and oak-pine forests cover large areas in the low- to mid-elevation central Appalachians and middle Piedmont. The topography and landscape position range from rolling hills to steep slopes, with occasional occurrences on more level, ancient alluvial fans. The soils are coarse and infertile; they may be deep (on glacial deposits in the northern part of the system's range), or more commonly shallow, on rocky slopes of acidic rock (shale, sandstone, other acidic igneous or metamorphic rock). The well-drained soils and exposure create dry conditions. The forest is mostly closed-canopy but can include more open woodlands. It is dominated by a variable mixture of dry-site oak and pine species, most typically *Quercus prinus* (chestnut oak), *Pinus virginiana* (Virginia pine), and *Pinus strobus* (eastern white pine), but sometimes *Quercus alba* (white oak) and/or *Quercus coccinea* (scarlet oak). The system may include areas of oak forest, pine forest (usually small), and mixed oak-pine forest. Heath shrubs such as *Vaccinium pallidum* (hillside blueberry), *Gaylussacia baccata* (black huckleberry), and *Kalmia latifolia* (mountain laurel) are common in the understory and often form a dense layer. Embedded submesic ravines and concave landforms support slightly more diverse forests characterized by mixtures of oaks, several hickories, *Cornus florida* (flowering dogwood), and sometimes *Liriodendron tulipifera* (tuliptree). Small hillslope pockets with impeded drainage may support small isolated wetlands with *Acer rubrum* (red maple) and *Nyssa sylvatica* (blackgum) characteristic. Disturbance agents include fire, windthrow, and ice damage. Increased site disturbance generally leads to secondary forest vegetation with a greater proportion of *Pinus virginiana* (Virginia pine) and weedy hardwoods such as *Acer rubrum* (red maple).

Range: This system is found from central New England through Pennsylvania and south to central Virginia. United States: CT, MD, ME, NH, NJ, NY, PA, RI, VA, VT, WV

Delaware Estuary Associations:

- Appalachian Low-Elevation Mixed Pine / Hillside Blueberry Forest
- Black Locust Successional Forest
- Central Appalachian / Northern Piedmont Low-Elevation Chestnut Oak Forest
- Central Appalachian Forested Acid Seep
- Northeastern Modified Successional Forest
- Pitch Pine - Scarlet Oak Low- to Mid-Elevation Ridgetop
- Ridgetop Scrub Oak Barrens
- Virginia Pine Successional Forest
- White Pine - Oak Forest

CLASSIFIERS FOR CENTRAL APPALACHIAN DRY OAK-PINE FOREST

Primary Division: 202

Land Cover Class: Forest and Woodland

Spatial Scale & Pattern: Matrix

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

Diagnostic Classifiers: Forest and Woodland (Treed); Ridge/Summit/Upper Slope; Acidic Soil; *Pinus* (*strobus*, *rigida*, *echinata*, *virginiana*) - *Quercus prinus*

Non-diagnostic Classifiers: Lowland; Sideslope; Oligotrophic Soil; Mineral: W/ A-Horizon <10 cm; Loam Soil

Texture; Sand Soil Texture; Ustic; F-Patch/Medium Intensity; W-Patch/Low Intensity; Needle-Leaved Tree;

Broad-Leaved Tree

APPALACHIAN LOW-ELEVATION MIXED PINE / HILLSIDE BLUEBERRY FOREST

Pinus virginiana - *Pinus (rigida, echinata)* - (*Quercus prinus*) / *Vaccinium pallidum* Forest

Range: This community occurs primarily in the Appalachian region of the United States, ranging from central Pennsylvania, south and west through the Ridge and Valley, Blue Ridge, and Cumberland Plateau to northern Georgia and Alabama, extending westward to scattered areas in the Interior Low Plateau and eastward into the upper Piedmont. It is reported from the states of Georgia, North Carolina, South Carolina, Tennessee, Kentucky, Pennsylvania, Indiana, Ohio, and is probably in Maryland, Virginia, and West Virginia. It occurs in Pennsylvania's portion of the Delaware Estuary.

Environmental Description: Stands of this forest occur on narrow ridges and knobs, steep upper slopes, bluff and clifftops, and other exposed sites throughout the range of the type. The community is found primarily on south-, southeast- or southwest-facing aspects on excessively drained, shallow soils. In the Blue Ridge Escarpment region, the western margin of the Blue Ridge, and west into the Ridge and Valley and Cumberland Mountains, this xeric forest occurs on convex slopes and ridges below 610 m (2000 feet) elevation, over soils classed as Inceptisols, typically Lithic Dystrochrepts originating from sandstone, shale and other noncalcareous parent material. Occurrences in rugged parts of the western Piedmont are also likely. Its environmental situation in the western Alleghenies is not known. In the Interior Low Plateau of Kentucky, Tennessee, and Indiana, this association occurs in edaphically extreme situations, including blufftops and narrow ridges in thin soils weathered from relatively acidic caprocks with southern and western aspects, as well as other similar slopes, over cherty limestone, siltstones, sandstones, and shales. In particular, in the Knobstone Escarpment Subsection (a few Indiana counties just north of Louisville, Kentucky), it occurs in gladelike situations on steep slopes with thin soils.

Vegetation Description: This community is a needle-leaved evergreen forest with a somewhat open to closed canopy. A deciduous subcanopy may be present, especially in areas where fire has been excluded. The shrub layers can be sparse to very dense and are composed of tall and short shrubs, predominantly ericaceous species. Herb cover is sparse, and leaf litter often dominates the ground layer. *Pinus virginiana* (Virginia pine) and/or *Pinus rigida* (pitch pine) are the canopy dominants throughout the range of the type. Within its range, *Pinus pungens* (Table Mountain pine) may be present as a very minor component. *Quercus prinus* (chestnut oak), *Quercus coccinea* (scarlet oak), *Quercus alba* (white oak), *Quercus velutina* (black oak), *Acer rubrum* (red maple), and *Nyssa sylvatica* (blackgum) are common in the canopy, subcanopy and sapling strata, particularly in areas where fire has been excluded. Common shrub dominants include *Quercus ilicifolia* (bear oak), *Vaccinium angustifolium* (northern lowbush blueberry), *Vaccinium pallidum* (hillside blueberry), *Vaccinium stamineum* (deerberry), and *Kalmia latifolia* (mountain laurel). Other typical shrubs can include *Gaylussacia baccata* (black huckleberry) and *Sassafras albidum* (sassafras). *Smilax glauca* (whiteleaf greenbrier) and *Smilax rotundifolia* (roundleaf greenbrier) can be common vines. Characteristic herbaceous species include *Chimaphila maculata* (striped pipsissewa), *Danthonia spicata* (poverty oatgrass), *Deschampsia flexuosa* (wavy hairgrass), *Carex communis* (fibrous-root sedge), *Carex rosea* (rosy sedge), *Hieracium venosum* (rattlesnake-weed), *Epigaea repens* (trailing arbutus), *Pteridium aquilinum* (bracken fern), and *Schizachyrium scoparium* (little bluestem).

Characteristic Species: *Chimaphila maculata* (striped pipsissewa), *Epigaea repens* (trailing arbutus), *Pinus rigida* (pitch pine), *Pinus virginiana* (Virginia pine), *Pteridium aquilinum* (bracken fern), *Schizachyrium scoparium* (little bluestem)

Dynamics/Successional Trajectory: This xeric evergreen forest community will be maintained on sites where local soil conditions, topographic extremes, or occasional fire function to retard hardwood invasion. Throughout most of its range, this community occurs as linear features along ridgetops and may be adjacent to or grade into xeric forests dominated by *Quercus coccinea* (scarlet oak) or *Quercus prinus* (chestnut oak) or more mesic forests dominated by *Quercus alba* (white oak), *Quercus rubra* (northern

red oak), *Quercus velutina* (black oak), *Carya glabra* (pignut hickory), and *Carya alba* (mockernut hickory).

Management Concerns: It is important that this community be managed as part of a physiognomic complex with related communities and that natural processes are allowed to occur. Infestations of southern pine beetle (*Dendroctonus frontalis*) are a problem in portions of the range.

Reference Sites: No reference sites identified.

Global and State Conservation Ranks and Reasons: G4? (11-Feb-2001). PA: SNR. This xeric evergreen forest community will be maintained on sites where local soil conditions, topographic extremes, or occasional fire function to retard hardwood invasion. Infestations of southern pine beetle (*Dendroctonus frontalis*) can cause mortality of canopy trees. Examples affected by southern pine beetle in the Great Smoky Mountains can have up to 80-90% standing dead pine.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688719

References: Allard 1990, Ambrose 1990a, Barden 1977, Burns and Honkala 1990a, CAP pers. comm. 1998, Cooper 1963, Core 1966, Evans 1991, Eyre 1980, Fike 1999, Gettman 1974, Harrison 2004, Homoya pers. comm., Malter 1977, NatureServe Ecology - Southeastern U.S. unpubl. data, Nelson 1986, Patterson et al. 1999, Peet et al. unpubl. data 2002, Pyne 1994, Racine 1966, Rawinski 1992, Schafale 1998b, Schafale and Weakley 1990, Schmalzer and DeSelm 1982, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data, Walton et al. 1997, Whittaker 1956

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus virginiana</i> (Virginia pine)
Tall shrub/sapling	Broad-leaved evergreen shrub	<i>Kalmia latifolia</i> (mountain laurel)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Gaylussacia baccata</i> (black huckleberry)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Vaccinium pallidum</i> (hillside blueberry)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Vaccinium stamineum</i> (deerberry)

BLACK LOCUST SUCCESSIONAL FOREST

Robinia pseudoacacia Forest

Range: This black locust semi-natural forest is found locally throughout the eastern United States. Its distribution is not completely known because many state ecologists have not developed lists of semi-natural types in their state. It occurs in New Jersey, Pennsylvania and Delaware in the Delaware Estuary.

Environmental Description: This type often establishes on old fields abandoned after agricultural cropping.

Vegetation Description: The vegetation is dominated by *Robinia pseudoacacia* (black locust).

Characteristic Species: *Robinia pseudoacacia* (black locust)

Dynamics/Successional Trajectory: Uncertain. This is an early-successional forest type dominated by black locust. Overtime the black locust will be replaced by other, more shade-tolerant species (species composition will depend on available local species pool). The understory of this



Photo by Pennsylvania Natural Heritage Program

community is typically dominated by a dense growth of non-native invasive species which may retard colonization by mid- and late-successional forest species.

Management Concerns: This is a disturbed forest type and is not typically managed for conservation purposes.

Reference Sites: Not a conservation target; reference sites not provided.

Global and State Conservation Ranks and Reasons: GNA (ruderal) (24-Oct-2002). DE: SNA, NJ: SNA, PA: SNA. Although *Robinia pseudoacacia* is a native species found in the Central Appalachian and Ozark Mountains, it does not typically become a dominant species in these natural habitats (Elias 1980). It is now widespread in the eastern U.S. in disturbed habitats. This forest represents early successional vegetation and is thus not of conservation concern and does not receive a conservation status rank.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684159

References: Baalman 1965, CAP pers. comm. 1998, Elias 1980, Fleming and Coulling 2001, Gaertner 1955, Hoagland 2000, INAI unpubl. data, McDonald 1938, Rawinski et al. 1996, Southeastern Ecology Working Group n.d., TDNH unpubl. data

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Robinia pseudoacacia</i> (black locust)

CENTRAL APPALACHIAN / NORTHERN PIEDMONT LOW-ELEVATION CHESTNUT OAK FOREST

Quercus prinus - (*Quercus coccinea*, *Quercus velutina*) / *Kalmia latifolia* / *Vaccinium pallidum* Forest

Range: This association is currently described from the northern Piedmont and central Appalachians in Pennsylvania, Virginia, Maryland and West Virginia. It occurs in the Pennsylvania portion of the Delaware Estuary.

Environmental Description: This association is found on acidic, infertile soils on low-elevation (mostly <900 m), mid and upper slopes (occasionally on lower slopes). Site moisture potential is typically subxeric to xeric. Some exposed bedrock is often present.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: The canopy is strongly dominated by *Quercus prinus* (chestnut oak). The most frequent canopy associate is *Quercus coccinea* (scarlet oak), which varies from sparse to codominant. *Quercus coccinea* (scarlet oak), *Quercus alba* (white oak), and *Quercus velutina* (black oak) are frequent associates or codominants in the canopy. Minor associates frequently include *Quercus velutina* (black oak) plus *Quercus alba* (white oak), *Quercus rubra* (northern red oak), *Nyssa sylvatica* (blackgum), and *Sassafras albidum* (sassafras). *Acer rubrum* (red maple) and *Nyssa sylvatica* (blackgum) are usually abundant in the understory tree layers. Tall shrubs *Kalmia latifolia* (mountain laurel) (usually dominant), *Viburnum acerifolium* (mapleleaf viburnum), and *Rhododendron periclymenoides* (pink azalea) are often associated, sometimes at low cover. The dwarf- or short-shrub layer is well-developed and includes *Vaccinium pallidum* (hillside blueberry), *Vaccinium stamineum* (deerberry), and *Gaylussacia baccata* (black huckleberry), any one of which can exhibit patch-dominance. The herb layer generally has sparse cover and includes *Aureolaria laevigata*

(entireleaf yellow false foxglove), *Chimaphila maculata* (striped pipsissewa), *Comandra umbellata* (bastard toadflax), *Cypripedium acaule* (pink lady's-slipper), *Danthonia spicata* (poverty oatgrass), *Epigaea repens* (trailing arbutus), *Hieracium venosum* (rattlesnake-weed), *Lysimachia quadrifolia* (whorled yellow loosestrife), *Medeola virginiana* (Indian cucumber-root), *Monotropa uniflora* (Indian-pipe), *Pteridium aquilinum* (bracken fern), and *Uvularia puberula* (mountain bellwort). Strong dominance of *Quercus prinus* (chestnut oak) in the canopy, frequent and sometimes abundant *Rhododendron periclymenoides* (pink azalea) in the tall-shrub layer, and *Vaccinium pallidum* (hillside blueberry) present and often abundant as a dwarf-shrub are diagnostics for this type.

Noteworthy Associated Plant and/or Animal Species: *Tsuga caroliniana* (Carolina hemlock)

Characteristic Species: *Quercus prinus* (chestnut oak), *Rhododendron periclymenoides* (pink azalea), *Vaccinium pallidum* (hillside blueberry)

Dynamics/Successional Trajectory: Windthrow, fire, and ice storms are common natural disturbances in these habitats. Evidence of past fires is present at many sites, and periodic fire appears to be an important ecological factor in oak regeneration. Development of *Acer rubrum* (red maple)-dominated understories in these forests is widely considered to be the result of drastic reductions of fire frequencies or exclusion of fire altogether. *Castanea dentata* (American chestnut) was formerly an important canopy species in these forests prior to chestnut blight.

Management Concerns: The applicability of utilizing prescribed fire as a restoration technique for this association should be evaluated on a site-specific basis.

Reference Sites: Blue Mountain, State Game Lands 110, PA

Global and State Conservation Ranks and Reasons: G5 (29-Jan-2004). PA: SNR. Abundant examples occur in Virginia, Maryland, and West Virginia.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.728821

References: Allard and Leonard 1943, Eastern Ecology Working Group n.d., Fleming 2002a, Fleming and Coulling 2001, Fleming and Moorhead 1996, Fleming and Moorhead 2000, Fleming et al. 2001, Lea 2003, Rawinski et al. 1994, Rawinski et al. 1996

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
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 prinus</i> (chestnut oak)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Viburnum acerifolium</i> (mapleleaf viburnum)
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	<i>Kalmia latifolia</i> (mountain laurel)

CENTRAL APPALACHIAN FORESTED ACID SEEP

Acer rubrum - *Nyssa sylvatica* High Allegheny Plateau, Central Appalachian Forest

Range: This acidic deciduous swamp occurs in the central Appalachian Mountains north of the Cumberland drainage in the Central Appalachians and High Allegheny ecoregions, as well as the adjacent Cumberlands and Western Allegheny Plateau. This seep community occurs in the Pennsylvania portion of the Delaware Estuary.

Environmental Description: This community occurs on substrates which are saturated for extended periods during the growing season but which rarely have standing water, including forested seeps, hillsides, streamheads, floodplain edges, and poorly drained depressions. Occurrences tend to be small.

Vegetation Description: Characteristic trees are *Acer rubrum* (red maple) and *Nyssa sylvatica* (blackgum), with other associates including *Tsuga canadensis* (eastern hemlock) and *Betula alleghaniensis* (yellow birch). The shrub stratum includes *Alnus serrulata* (smooth alder), *Photinia pyrifolia* (red chokeberry), *Ilex verticillata* (common winterberry), *Vaccinium corymbosum* (highbush blueberry), *Rhododendron maximum* (great laurel), and *Rubus hispidus* (bristly dewberry). Characteristic herbs include *Osmunda cinnamomea* (cinnamon fern), *Osmunda regalis* (royal fern), *Carex folliculata* (northern long sedge), *Carex trisperma* (three-seed sedge), *Carex intumescens* (greater bladder sedge), *Carex stricta* (tussock sedge), and *Poa trivialis* (rough bluegrass). *Sphagnum* (peatmoss) spp. are typical.

Characteristic Species: *Acer rubrum* (red maple), *Nyssa sylvatica* (blackgum), *Osmunda cinnamomea* (cinnamon fern)

Reference Sites: none identified

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689039

References: Anderson et al. 1998, CAP pers. comm. 1998, Eastern Ecology Working Group n.d., Fike 1999, Harrison 2004

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>Nyssa sylvatica</i> (blackgum)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Alnus serrulata</i> (smooth alder)

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.

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.



Photo by Pennsylvania Natural Heritage Program

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 red-cedar), *Acer negundo* (box-elder), *Acer saccharinum* (silver maple), *Ailanthus altissima* (tree-of-heaven), *Ulmus americana* (American elm), *Quercus* (oak) spp., *Betula lenta* (sweet birch), *Amelanchier* (serviceberry) spp., 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*

(blackberry) spp. 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* (hawthorn) spp., *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: *Acer rubrum* (red maple), *Fraxinus americana* (white ash), *Liriodendron tulipifera* (tuliptree), *Prunus serotina* (black cherry), *Robinia pseudoacacia* (black locust)

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* (hawthorn) spp., *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 restoration.

Global and State Conservation Ranks and Reasons: GNA (ruderal) (29-Nov-2004). NJ: SNA, PA: SNA. 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

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 subcanopy	Broad-leaved deciduous tree	<i>Acer rubrum</i> (red maple)
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Carpinus caroliniana</i> (American hornbeam)
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Lindera benzoin</i> (northern spicebush)

PITCH PINE - SCARLET OAK LOW- TO MID-ELEVATION RIDGETOP

Pinus rigida - *Quercus coccinea* / *Vaccinium angustifolium* Woodland

Range: It occurs in the Central Appalachian ecoregion in Pennsylvania.

Environmental Description: This open oak-pine woodland community type occurs on well-drained, nutrient-poor shallow soils on dry ridges and bedrock ledges. It is closely associated with pine barrens communities and typically intergrades with pitch pine/heath communities. It occurs in the Central Appalachian ecoregion in Pennsylvania.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: This community type occurs on dry, sandy, acidic soils. *Pinus rigida* (pitch pine) contributes between 25 and 75% relative cover. *Pinus pungens* (Table Mountain pine) or *Pinus resinosa* (red pine) may also occur on some sites. Hardwood associates include *Quercus prinus* (chestnut oak), *Quercus coccinea* (scarlet oak), *Quercus velutina* (black oak), *Nyssa sylvatica* (blackgum), *Sassafras albidum* (sassafras), *Betula lenta* (sweet birch), *Betula populifolia* (gray birch), and *Acer rubrum* (red maple). The shrub layer may be entirely composed of low shrubs, including *Vaccinium corymbosum* (highbush blueberry), *Vaccinium pallidum* (hillside blueberry), *Comptonia peregrina* (sweet-fern), and *Gaylussacia baccata* (black huckleberry), or may have an additional layer of taller shrubs such as *Kalmia latifolia* (mountain laurel), *Vaccinium corymbosum* (highbush blueberry), and *Quercus ilicifolia* (bear oak). Herbaceous species include *Pteridium aquilinum* (bracken fern), *Deschampsia flexuosa* (wavy hairgrass), *Danthonia spicata* (poverty oatgrass), *Epigaea repens* (trailing arbutus), *Gaultheria procumbens* (wintergreen), *Melampyrum lineare* (narrowleaf cow-wheat), *Carex pennsylvanica* (Pennsylvania sedge), *Carex communis* (fibrous-root sedge), *Oryzopsis* (mountain-ricegrass) spp., and *Aralia nudicaulis* (wild sarsaparilla). Lichens, such as *Cladonia* (cup lichen) spp. and *Cladina* (reindeer lichen) spp., are abundant in some areas.

Characteristic Species: *Pinus rigida* (pitch pine), *Pteridium aquilinum* (bracken fern), *Quercus coccinea* (scarlet oak), *Vaccinium corymbosum* (highbush blueberry)

Dynamics/Successional Trajectory: Windthrow, fire and ice storms are common natural disturbances in these habitats. Evidence of past fires is present at many sites, and periodic fire appears to be an important ecological factor in maintaining the structure and composition of this association. Establishment of *Acer rubrum* (red maple) and *Pinus strobus* (eastern white pine) in these woodlands is considered to be the result of drastic reductions of fire frequencies or exclusion of fire altogether.

Management Concerns: The applicability of utilizing prescribed fire as a restoration technique for this association should be evaluated on a site-specific basis.

Reference Sites: Weiser State Forest and Locust Lake State Park, Schuylkill County, PA

Global and State Conservation Ranks and Reasons: GNR (8-Jul-1999). PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688348

References: Eastern Ecology Working Group n.d., Fike 1999

MOST ABUNDANT SPECIES

STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus rigida</i> (pitch pine)
Tree canopy	Broad-leaved deciduous tree	<i>Quercus coccinea</i> (scarlet oak)
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	<i>Kalmia latifolia</i> (mountain laurel)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Vaccinium corymbosum</i> (highbush blueberry)

RIDGETOP SCRUB OAK BARRENS

Quercus ilicifolia - *Prunus pumila* Shrubland

Range: Within the Delaware Estuary, this association likely occurs only in high-elevation portions of the Blue, First, and Second mountains in Schuylkill County in Pennsylvania.

Environmental Description: This shrubland occurs on extremely shallow, stable acidic soils over bedrock. Open bedrock is common. Periodic fires can help maintain this association in a shrubland state.

Vegetation Description: This shrubland is dominated by *Quercus ilicifolia* (bear oak), which occurs with variable cover depending on site conditions. Associated shrubs include *Vaccinium angustifolium* (northern lowbush blueberry), *Vaccinium pallidum* (hillside blueberry), *Comptonia peregrina* (sweet-fern), *Kalmia angustifolia* (sheep laurel), *Gaylussacia baccata* (black huckleberry), *Photinia melanocarpa* (black chokeberry), *Quercus prinoides* (dwarf chinquapin oak), *Gaultheria procumbens* (wintergreen), and *Prunus pumila* var. *susquehanae* (Susquehanna cherry). Herbaceous species are generally sparse but include *Danthonia spicata* (poverty oatgrass), *Schizachyrium scoparium* (little bluestem), *Pteridium aquilinum* (bracken fern), *Deschampsia flexuosa* (wavy hairgrass), *Carex pennsylvanica* (Pennsylvania sedge), *Comandra umbellata* (bastard toadflax), *Melampyrum lineare* (narrowleaf cow-wheat), *Hypericum gentianoides* (pineweed), *Corydalis sempervirens* (rock harlequin), *Sibbaldiopsis tridentata* (mountain-cinquefoil), plus *Andropogon gerardii* (big bluestem) at some sites. Scattered trees are common and include species from the surrounding ridgetop forests, such as *Quercus prinus* (chestnut oak), *Quercus rubra* (northern red oak), *Quercus alba* (white oak), *Pinus rigida* (pitch pine), *Populus tremuloides* (quaking aspen), *Betula populifolia* (gray birch), and *Carya* (hickory) spp.



Photo by Pennsylvania Natural Heritage Program

Noteworthy Associated Plant and/or Animal Species: *Prunus pumila* var. *susquehanae* (Susquehanna cherry)

Characteristic Species: *Prunus pumila* var. *susquehanae* (Susquehanna cherry), *Quercus ilicifolia* (bear oak)

Dynamics/Successional Trajectory: This shrubland is influenced by the extremely thin soils over acidic bedrock, with fire as a secondary influence.

Management Concerns: The applicability of utilizing prescribed fire as a restoration technique for this association should be evaluated on a site-specific basis.

Reference Sites: Weiser State Forest and Locust Lake State Park, Schuylkill County, PA

Global and State Conservation Ranks and Reasons: GNR (10-May-2002). PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689771

References: Eastern Ecology Working Group n.d., Fike 1999, Metzler and Barrett 2001, Swain and Kearsley 2000

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Shrub/sapling (tall & short)	Broad-leaved deciduous tree	<i>Quercus ilicifolia</i> (bear oak)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Prunus pumila</i> var. <i>susquehanae</i> (Susquehanna cherry)
Short shrub/sapling (blueberry)	Broad-leaved deciduous shrub	<i>Vaccinium angustifolium</i> (northern lowbush blueberry)
Herb (field)	Graminoid	<i>Danthonia spicata</i> (poverty oatgrass)
Herb (field)	Graminoid	<i>Schizachyrium scoparium</i> (little bluestem)

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 portion of the Delaware Estuary.



Photo by Pennsylvania Natural Heritage Program

Environmental Description: This community occurs in areas where canopy removal has created open 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* (blueberry) spp., *Gaylussacia* (huckleberry) spp., *Kalmia latifolia* (mountain laurel), and *Rhododendron* (azalea, rhododendron) spp.

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: (Note: more inventory needs to be done to confirm that this type is in the Delaware Estuary.

Global and State Conservation Ranks and Reasons: GNA (ruderal) (13-Jun-2000). NJ: SNA, PA: SNA. 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

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 red-cedar)
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>Cornus florida</i> (flowering dogwood)
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>Cornus florida</i> (flowering dogwood)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Oxydendrum arboreum</i> (sourwood)
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> (Japanese honeysuckle)
Herb (field)	Vine/Liana	<i>Smilax glauca</i> (whiteleaf greenbrier)
Herb (field)	Vine/Liana	<i>Toxicodendron radicans</i> (eastern poison-ivy)

WHITE PINE - OAK FOREST

Pinus strobus - *Quercus* (*rubra*, *velutina*) - *Fagus grandifolia* Forest

Range: This association occurs in New England south and west to Pennsylvania, West Virginia and possibly New Jersey.

Environmental Description: This mixed white pine - oak forest is a ridge and valley community that occurs on dry-mesic to mesic, acidic, nutrient-poor, sandy loam to sandy soils along mid and lower slopes, and along the unglaciated plateau on rolling topography underlain by sandstone. In the northern glaciated portion of the range, the forest occurs on outwash plains or moraines, as well as along mid and lower slopes and within protected ravines, and on protected ridges of shale, sandstone, or other sedimentary rock, occasionally underlain by metamorphic or igneous rock. It occurs at elevations below 915 m (3000 feet) throughout the range.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: The tree canopy is dominated by *Pinus strobus* (eastern white pine) with a mixture of oaks, including *Quercus velutina* (black oak), *Quercus rubra* (northern red oak), *Quercus alba* (white oak), *Quercus prinus* (chestnut oak), and in the southern portions of the range *Quercus coccinea* (scarlet oak). Oak species drop out at the northern extreme of the type's range, leaving only *Quercus rubra* (northern red oak). *Fagus grandifolia* (American beech) is characteristic but not always present. Other less frequent canopy associates may include *Acer rubrum* (red maple), *Carya alba* (mockernut hickory), *Populus tremuloides* (quaking aspen), *Tsuga canadensis* (eastern hemlock), and *Populus grandidentata* (bigtooth aspen). The variable subcanopy may include *Hamamelis virginiana* (American witch-hazel); other species, such as *Carpinus caroliniana* (American hornbeam), *Cornus florida* (flowering dogwood), and *Nyssa sylvatica* (blackgum), may be present in the central and southern portions of the range. The stand can contain a moderately dense to dense tall-shrub layer of *Pinus strobus* (eastern white pine) saplings. The sparse to well-developed, generally ericaceous short-shrub layer includes *Gaylussacia* (huckleberry) spp., *Kalmia latifolia* (mountain laurel), *Vaccinium* (blueberry) spp., as well as *Rubus* (blackberry) spp., *Corylus americana* (American hazelnut), *Gaultheria procumbens* (wintergreen), *Sassafras albidum* (sassafras), and *Viburnum prunifolium* (smooth blackhaw). The herb layer ranges from sparse to moderately dense cover, with species including *Aralia nudicaulis* (wild sarsaparilla), *Ageratina altissima* (white snakeroot), *Amphicarpaea bracteata* (American hog-peanut), *Brachyelytrum erectum* (bearded shorthusk), *Carex communis* (fibrous-root sedge), *Carex pensylvanica* (Pennsylvania sedge), *Carex lucorum* (Blue Ridge sedge), *Melampyrum lineare* (narrowleaf cow-wheat), *Pteridium aquilinum* (bracken fern), *Trientalis borealis* (starflower), *Chimaphila maculata* (striped pipsissewa), *Desmodium nudiflorum* (naked-flower tick-trefoil), *Goodyera pubescens* (downy rattlesnake-plantain), *Hieracium venosum* (rattlesnake-weed), *Maianthemum racemosum* (feathery false lily-of-the-valley), *Maianthemum canadense* (Canada mayflower), *Medeola virginiana* (Indian cucumber-root), *Mitchella repens* (partridgeberry), *Monotropa uniflora* (Indian-pipe), *Poa cuspidata* (early bluegrass), *Polygonatum biflorum* (smooth Solomon's-seal), *Polystichum acrostichoides* (Christmas fern), and/or *Viola hastata* (halberd-leaf yellow violet). The bryophyte layer is not well-documented but supports *Leucobryum* (leucobryum moss) sp. and *Polytrichum* (haircap moss) sp.

Characteristic Species: *Fagus grandifolia* (American beech), *Gaylussacia baccata* (black huckleberry), *Pinus strobus* (eastern white pine), *Quercus rubra* (northern red oak), *Vaccinium angustifolium* (northern lowbush blueberry), *Vaccinium pallidum* (hillside blueberry)

Reference Sites: near Adams Creek and much of the escarpment on the Pennsylvania side of the Delaware Water Gap National Recreation Area

Global and State Conservation Ranks and Reasons: G5 (1-Dec-1997). NJ?: SNA, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688827

References: Breden et al. 2001, CAP pers. comm. 1998, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1993, Eyre 1980, Fike 1999, Gawler 2002, Kuchler 1956, Lundgren 2001, Moore and Taylor 1927, Rawinski 1984, Sperduto 2000a, Sperduto and Nichols 2004, Swain and Kearsley 2001, Thompson 1996, Thompson and Jenkins 1992, Thompson and Sorenson 2000

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus strobus</i> (eastern white pine)
Tree canopy	Broad-leaved deciduous tree	<i>Quercus alba</i> (white oak)
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)
Tree canopy	Broad-leaved deciduous tree	<i>Quercus velutina</i> (black oak)
Tree subcanopy	Broad-leaved deciduous tree	<i>Prunus serotina</i> (black cherry)
Shrub/sapling (tall & short)	Needle-leaved shrub	<i>Pinus strobus</i> (eastern white pine)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Hamamelis virginiana</i> (American witch-hazel)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Gaylussacia baccata</i> (black huckleberry)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Vaccinium angustifolium</i> (northern lowbush blueberry)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Vaccinium pallidum</i> (hillside blueberry)
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Kalmia latifolia</i> (mountain laurel)
Herb (field)	Forb	<i>Aralia nudicaulis</i> (wild sarsaparilla)
Herb (field)	Forb	<i>Maianthemum canadense</i> (Canada mayflower)
Herb (field)	Forb	<i>Trientalis borealis</i> (starflower)
Herb (field)	Graminoid	<i>Carex pensylvanica</i> (Pennsylvania sedge)

ECOLOGICAL SYSTEM: CENTRAL APPALACHIAN FLOODPLAIN

Summary: This system encompasses floodplains from southern New England to Virginia. Mostly forested, these occur on floodplains of medium to large rivers where topography and process have resulted in the development of a relatively flat floodplain with a complex of upland and wetland temperate alluvial vegetation. This complex includes floodplain forests in which *Acer saccharinum* (silver maple), *Populus deltoides* (eastern cottonwood), and *Platanus occidentalis* (sycamore) are characteristic, as well as herbaceous sloughs and shrub wetlands. 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, although there is a history of deposition in the floodplain formation.

High-ranked Species: *Arabis georgiana* (G1, georgia rock-cress), *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), *Gymnoderma lineare* (G2, rock gnome lichen), *Hasteola suaveolens* (G3, false Indian-plantain), *Hygrohypnum closteri* (G3, closter's brook-hypnum), *Lejeunea blomquistii* (G1G2, blomquist leafy liverwort), *Lysimachia fraseri* (G2, Fraser's 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 spiraea)

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 Associations:

Alluvial Alder Swamp	Box-elder Floodplain Forest
Coastal Plain Oak Floodplain Swamp	Floodplain Pool
Green Ash - Mixed Hardwood Floodplain Forest	• Mid-Atlantic Terrace Hardwood Floodplain Forest
Northeastern Buttonbush Shrub Swamp	Northeastern Temperate Cobble Scour Rivershore
Red Maple - Green Ash Forested Swamp	River Birch Low Floodplain Forest
Silver Maple - Elm Forest	Small River Red Maple - Elm Floodplain Forest
• Water-willow Rocky Bar and Shore	

Similar Ecological Systems in the Delaware Estuary:

- Central Appalachian Riparian

CLASSIFIERS FOR CENTRAL APPALACHIAN 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

ALLUVIAL ALDER SWAMP

Cornus amomum - *Alnus serrulata* Shrubland

Range: This Coastal Plain alluvial shrubland occurs in the Chesapeake Bay Lowlands and along the Christina River in Delaware in the Delaware Estuary.

Environmental Description: This Coastal Plain alluvial shrubland occurs in the Chesapeake Bay Lowlands on the non-tidal portions of rivers and non-tidal bay mouths.

Vegetation Description: The shrub canopy is characterized by *Cornus amomum* (silky dogwood) with other associates including *Alnus serrulata* (smooth alder), *Cephalanthus occidentalis* (common buttonbush), and *Viburnum* spp. (viburnum). as well as saplings of *Acer rubrum* (red maple), *Fraxinus pennsylvanica* (green ash), and *Salix nigra* (black willow). Herbaceous associates include *Osmunda regalis* (royal fern), *Decodon verticillatus* (swamp-loosestrife), *Utricularia* (bladderwort) spp., *Limnobium spongia* (American spongeplant), and *Cicuta bulbifera* (bulb-bearing water-hemlock).

Characteristic Species: *Cornus amomum* (silky dogwood)

Reference Sites: Lewden-Green Park in New Castle County, DE, on the Christina River

Global and State Conservation Ranks and Reasons: GNR (10-Oct-2000). DE: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.683138

References: Eastern Ecology Working Group n.d., Harrison 2004, Tiner 1985a

MOST ABUNDANT SPECIES

STRATUM	LIFEFORM	SPECIES
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Alnus serrulata</i> (smooth alder)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Cornus amomum</i> (silky dogwood)
Herb (field)	Fern or fern ally	<i>Osmunda regalis</i> (royal fern)

BOX-ELDER FLOODPLAIN FOREST

Acer negundo Forest

Range: This *Acer negundo* (box-elder) floodplain forest is found sporadically on floodplains in the southern, eastern, and midwestern United States, ranging from Maryland west to Iowa (and possibly

southeastern South Dakota), south to Louisiana and possibly Texas, and east to Georgia. It occurs in the Piedmont region in Pennsylvania and in the Coastal Plain and Piedmont regions in New Jersey and Delaware.

Environmental Description: Stands occur on large rivers in the active floodplain and on sandbars, and may form farther from the riverfront following disturbance. They are typically temporarily flooded in the spring. In Kentucky, these forests may also occur in old fields.

Vegetation Description: These early-successional forests are dominated by *Acer negundo* (box-elder). Other characteristic species include *Platanus occidentalis* (sycamore), *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), *Acer saccharinum* (silver maple), *Ulmus americana* (American elm), *Carpinus caroliniana* (American hornbeam), *Morus rubra* (red mulberry), and *Populus deltoides* (eastern cottonwood). The shrub and herb layers range from sparse to relatively lush, and the vine component often is heavy. The range, dynamics and variability of this type are complicated by the "weedy" nature of *Acer negundo* (box-elder), often with *Dichanthelium clandestinum* (deer-tongue witchgrass) and *Carex* (sedge) spp. in the ground layer.

Characteristic Species: *Acer negundo* (box-elder)

Dynamics/Successional Trajectory: This type is an early-successional community that arises from natural and cultural disturbances on floodplains. Stands also occur where occasional flash floods create extensive open alluvial deposits that may be colonized by this type.

Management Concerns: This community type is not considered a desired target community for restoration in the Delaware Estuary. Some stands may develop following disturbance of other natural bottomland communities.

Reference Sites: No reference sites were identified because this community type is not considered a desired community for restoration in the Delaware Estuary.

Global and State Conservation Ranks and Reasons: G4G5 (28-Mar-2003). DE: SNR, NJ: SNR, PA: SNR. As currently defined this is a broad-ranging community type. However, the range, dynamics, and variability of this type is complicated by the "weedy" nature of *Acer negundo*. More information may be needed to clarify the extent to which this type represents purely natural vegetation. Some stands may develop following disturbance of other natural bottomland communities.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686021

References: Blair 1938, Campbell pers. comm., Fleming et al. 2001, Foti pers. comm., Harrison 2004, Hoagland 2000, INAI unpubl. data, Leahy pers. comm., Patterson and DeSelm 1989, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data, Zollner pers. comm.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Acer negundo</i> (box-elder)

COASTAL PLAIN OAK FLOODPLAIN SWAMP

Quercus (palustris, phellos) - Acer rubrum / Cinna arundinacea Forest

Range: This community is found in the Chesapeake Bay region north to the southern Coastal Plain of New Jersey and Pennsylvania.

Environmental Description: This floodplain swamp community of the Chesapeake Bay region and environs occurs in topographic depressions within alluvial floodplains. It occurs in pockets of saturated soils in, or at the edges of, depressions within a larger floodplain forest with annual flooding. Soils are poorly drained loams or clay loams.

Vegetation Description: The tree canopy is dominated by *Quercus palustris* (pin oak), *Quercus phellos* (willow oak), *Acer rubrum* (red maple), and *Liquidambar styraciflua* (sweetgum). The shrub layer is of relatively low cover and comprised of *Viburnum dentatum* (southern arrow-wood), *Viburnum prunifolium* (smooth blackhaw), and *Ilex verticillata* (common winterberry). *Vaccinium corymbosum* (highbush blueberry) is a less frequent shrub layer associate. Typical vines include *Toxicodendron radicans* (eastern poison-ivy), *Parthenocissus quinquefolia* (Virginia creeper), and *Smilax rotundifolia* (roundleaf greenbrier). The herb layer is characterized by *Cinna arundinacea* (sweet woodreed), *Boehmeria cylindrica* (small-spike false nettle), *Symphytotrichum lateriflorum* var. *lateriflorum* (calico aster), and *Carex* (sedge) spp., with less frequent associates including *Arisaema triphyllum* (Jack-in-the-pulpit), *Eurybia divaricata* (white wood-aster), *Lycopus virginicus* (Virginia water-horehound), *Ranunculus abortivus* (kidneyleaf buttercup), *Euonymus americanus* (American strawberry-bush), *Chasmanthium laxum* (slender spikegrass), and *Glyceria striata* (fowl mannagrass).

Characteristic Species: *Boehmeria cylindrica* (small-spike false nettle), *Cinna arundinacea* (sweet woodreed), *Quercus palustris* (pin oak)

Dynamics/Successional Trajectory: This floodplain forest is subject to annual flooding.

Reference Sites: Cape May, NJ, and potentially Cedar Swamp WMA, New Castle County, DE

Global and State Conservation Ranks and Reasons: GNR (27-Mar-2000). DE?: SNA, NJ?: SNA, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689632

References: Eastern Ecology Working Group n.d., Fleming et al. 2001, Harrison 2004, Harrison and Stango 2003, Patterson pers. comm., Thomson et al. 1999

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>Quercus palustris</i> (pin oak)
Tree canopy	Broad-leaved deciduous tree	<i>Quercus phellos</i> (willow oak)
Herb (field)	Graminoid	<i>Cinna arundinacea</i> (sweet woodreed)

FLOODPLAIN POOL

Peltandra virginica - *Saururus cernuus* - *Carex crinita* / *Climacium americanum* Herbaceous Vegetation

Range: This association is found in the Piedmont, Southern Blue Ridge and related ecoregions, as well as the Coastal Plain in New Jersey, Delaware, and Pennsylvania. Its possible range is from Connecticut to Delaware and Maryland south to Tennessee and North Carolina.

Environmental Description: This vegetation typically occurs in Piedmont and mountain floodplains. These depressions are usually abandoned channel segments or swales behind natural levees in which water is ponded for all or much of the year. Water may be supplied primarily by stream flooding or by rainfall.

Vegetation Description: Emergent vegetation may include *Peltandra virginica* (green arrow-arum), *Dulichium arundinaceum* (threeway sedge), and *Polygonum* (smartweed, knotweed) spp. The vascular plant species vary widely among examples. *Carex crinita* (fringed sedge) or some other wetland *Carex* (sedge) species are almost always present, and *Climacium americanum* (tree moss) is often abundant on the landward side. Larger examples may have pad-leaved aquatic species such as *Brasenia schreberi* (watershield) or *Nymphaea odorata* (white water-lily). Piedmont examples may also have *Saururus cernuus* (lizard's-tail) and *Boehmeria cylindrica* (small-spike false nettle). Some examples have wetland

shrubs on edges or in shallow portions, including *Cornus amomum* (silky dogwood) and *Cephalanthus occidentalis* (common buttonbush).

Characteristic Species: *Carex crinita* (fringed sedge)

Management Concerns: Many sites for this community have been lost to clearing for agriculture, ditching and draining, hydrologic alteration, and development. These sites are important for amphibian breeding.

Reference Sites: No reference sites identified.

Global and State Conservation Ranks and Reasons: G2? (14-Dec-1998). DE: SNR, NJ: SNR, PA: SNR. This community is apparently quite rare. Individual occurrences are small, generally less than an acre.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684674

References: Breden et al. 2001, Fleming et al. 2001, Harrison 2004, Metzler and Barrett 2001, Schafale 1998a, Schafale and Weakley 1990, Southeastern Ecology Working Group n.d., TDNH unpubl. data

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Carex crinita</i> (fringed sedge)
Herb (field)	Graminoid	<i>Dulichium arundinaceum</i> (threeway sedge)

GREEN ASH - MIXED HARDWOOD FLOODPLAIN FOREST

Fraxinus pennsylvanica - (*Juglans nigra*, *Platanus occidentalis*) Forest

Range: This type is currently described from the northern Piedmont of Pennsylvania, Delaware, New Jersey, and possibly Maryland.

Environmental Description: These floodplain forests occur behind levees and on low terraces that are flooded annually for short durations (less than one week per year). The water table is high for the majority of the growing season. Soils are generally silts or clay loams but can have coarser substrates where floodwater velocity is higher.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: The canopy is codominated by *Fraxinus pennsylvanica* (green ash) with *Juglans nigra* (black walnut) and/or *Platanus occidentalis* (sycamore). Additional associates include *Ulmus americana* (American elm), *Celtis occidentalis* (common hackberry), *Acer rubrum* (red maple), *Acer saccharinum* (silver maple), and *Quercus palustris* (pin oak). Subcanopy and shrub layers are sparse and generally comprised of canopy species regeneration plus *Lindera benzoin* (northern spicebush), *Viburnum prunifolium* (smooth blackhaw), and *Viburnum dentatum* (southern arrow-wood). Herbaceous species, where exotics are not rampant, can include *Impatiens pallida* (yellow jewelweed), *Impatiens capensis* (orange jewelweed), *Laportea canadensis* (Canadian wood-nettle), *Verbesina alternifolia* (wingstem), *Hydrophyllum canadense* (mapleleaf waterleaf), *Podophyllum peltatum* (mayapple), *Symplocarpus foetidus* (skunk-cabbage), *Circaea lutetiana* (broadleaf enchanter's-nightshade), *Boehmeria cylindrica* (small-spike false nettle), *Arisaema triphyllum* (Jack-in-the-pulpit), *Viola* (violet) spp., *Toxicodendron radicans* (eastern poison-ivy), and *Parthenocissus*

quinquefolia (Virginia creeper). Diagnostic features of this floodplain forest include the presence of *Juglans nigra* (black walnut) and rich herbs.

Characteristic Species: *Boehmeria cylindrica* (small-spike false nettle), *Impatiens pallida* (yellow jewelweed), *Juglans nigra* (black walnut)

Dynamics/Successional Trajectory: Flood frequency, intensity and duration influence the vegetation structure and composition of this type.

Management Concerns: Exotic invasive plants species are often abundant in this association due to disturbance from flooding and the mesic environment. *Rosa multiflora* (multiflora rose) and *Lonicera japonica* (Japanese honeysuckle) can be problematic in the shrub layer; *Alliaria petiolata* (garlic mustard), *Glechoma hederacea* (ground-ivy), and *Microstegium vimineum* (Japanese stiltgrass) often dominate the herbaceous layer. Many sites for this community have been lost to clearing for agriculture, ditching and draining, levees, hydrologic alteration, and development.

Reference Sites: Corderus Creek, York County, PA

Global and State Conservation Ranks and Reasons: GNR (21-Apr-2004). DE: SNR, NJ: SNR, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.731010

References: Bowman 2000, Breden et al. 2001, Clancy 1996, Eastern Ecology Working Group n.d., Fike 1999, Podnieszinski and Wagner 2002, WPC and TNC 2002

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Fraxinus pennsylvanica</i> (green ash)
Tree canopy	Broad-leaved deciduous tree	<i>Juglans nigra</i> (black walnut)
Tree canopy	Broad-leaved deciduous tree	<i>Platanus occidentalis</i> (sycamore)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Lindera benzoin</i> (northern spicebush)

MID-ATLANTIC TERRACE HARDWOOD FLOODPLAIN FOREST

Liriodendron tulipifera - *Fraxinus* spp. / *Lindera benzoin* - *Viburnum prunifolium* / *Podophyllum peltatum*
Forest

Range: This community type occurs along the active floodplains of larger rivers in the Delaware Estuary in New Jersey, Delaware and Pennsylvania.

Environmental Description: These rich floodplain forests are found on slightly elevated alluvial terraces and active floodplains of larger rivers of the Delaware Estuary watershed and possible other watersheds in the Mid-Atlantic.

Vegetation Description: The canopy dominants can vary from site to site but are usually some combination of *Liriodendron tulipifera* (tuliptree) and *Fraxinus americana* (white ash), *Fraxinus pennsylvanica* (green ash), *Fraxinus nigra* (black ash), and/or *Fraxinus profunda* (pumpkin ash), *Carya cordiformis* (bitternut hickory), *Carya alba* (mockernut hickory), *Carya ovata* (shagbark hickory), *Fagus grandifolia* (American beech), *Quercus rubra* (northern red oak), *Ulmus*



Photo by Pennsylvania Natural Heritage Program

americana (American elm), *Nyssa sylvatica* (blackgum), and *Prunus serotina* (black cherry). *Acer saccharum* (sugar maple) is often codominant along with *Tilia americana* (American basswood) in Pennsylvania; however, these species are less common or do not occur in New Jersey and Delaware. Minor canopy associates include *Juglans cinerea* (butternut) and *Acer rubrum* (red maple). Shrubs include *Lindera benzoin* (northern spicebush), *Viburnum prunifolium* (smooth blackhaw), *Carpinus caroliniana* (American hornbeam), *Staphylea trifolia* (American bladdernut), *Viburnum dentatum* (southern arrow-wood), *Corylus americana* (American hazelnut), *Viburnum lentago* (nannyberry), and *Prunus virginiana* (choke cherry); vines such as *Toxicodendron radicans* (eastern poison-ivy), *Parthenocissus* (Virginia creeper) spp., or *Vitis* (grape) spp. may be locally common. The herb layer usually features *Mertensia virginica* (Virginia bluebells), *Podophyllum peltatum* (mayapple), *Matteuccia struthiopteris* (ostrich fern), and a mixture of other ferns, forbs and graminoids. Characteristic species include *Ageratina altissima* (white snakeroot), *Eurybia divaricata* (white wood-aster), *Carex radiata* (eastern star sedge), and a very rich spring ephemeral flora. The presence of *Liriodendron tulipifera* (tuliptree), *Fraxinus profunda* (pumpkin ash), and *Mertensia virginica* (Virginia bluebells) differentiate this type from similar associations in the alliance.

Characteristic Species: *Ageratina altissima* (white snakeroot), *Carex radiata* (eastern star sedge), *Eurybia divaricata* (white wood-aster), *Fraxinus profunda* (pumpkin ash), *Mertensia virginica* (Virginia bluebells)

Dynamics/Successional Trajectory: Flood frequency, intensity, and duration influence the vegetation structure and composition of this type.

Reference Sites: Wainford on Crosswicks Creek, Monmouth County Park, NJ; Hogback in the Delaware Water Gap National Recreational Area, PA

Global and State Conservation Ranks and Reasons: GNR (21-Sep-2005). DE: SNR, NJ: SNR, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.787703

References: Breden 1989, Breden et al. 2001, Cowardin et al. 1979, Eastern Ecology Working Group n.d., Eyre 1980, Hupp 1982, Hupp 1986, McAvoy pers. comm., NAP pers. comm. 1998, Perles pers. comm., Podniesinski pers. comm., Rawinski 1984, Shreve 1910, Sperduto and Crowley 2002a, Thompson 1996

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Liriodendron tulipifera</i> (tuliptree)
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Lindera benzoin</i> (northern spicebush)
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Viburnum prunifolium</i> (smooth blackhaw)

NORTHEASTERN BUTTONBUSH SHRUB SWAMP

Cephalanthus occidentalis - *Decodon verticillatus* Shrubland

Range: This association includes buttonbush swamps of the eastern and northeastern United States. In the Delaware Estuary, this community occurs in New Jersey, Pennsylvania, and Delaware.

Environmental Description: This association includes buttonbush swamps that experience prolonged or semipermanent flooding for much of the growing season with water tables receding below the soil surface only during drought or very late in the growing season. They occur in a



Photo by Pennsylvania Natural Heritage Program

variety of environmental settings including backwater sloughs or oxbow ponds, wet swales in floodplains, pond and lake borders, and small, isolated depressions where water levels recede very slowly, such as those with perched water tables. Soils are often organic mucks or silt loams.

Vegetation Description: *Cephalanthus occidentalis* (common buttonbush) is dominant and often monotypic. Occasional associates depend on the environmental setting and most often occur in drier areas. They include *Vaccinium corymbosum* (highbush blueberry), *Rhododendron viscosum* (swamp azalea), *Acer rubrum* (red maple), *Alnus serrulata* (smooth alder), and *Cornus* (dogwood) spp. closer to upland borders; *Acer saccharinum* (silver maple), *Fraxinus pennsylvanica* (green ash), or *Viburnum dentatum* (southern arrow-wood) where adjacent to floodplains; or *Decodon verticillatus* (swamp-loosestrife) and *Spiraea alba var. latifolia* (broadleaf meadowsweet) in more stagnant basins. Herbaceous species tend to be sparse but can include *Glyceria canadensis* (rattlesnake manna grass), *Dulichium arundinaceum* (threeway sedge), *Carex stricta* (tussock sedge), *Scirpus cyperinus* (woolgrass bulrush), *Thelypteris palustris* (eastern marsh fern), *Alisma plantago-aquatica* (European water-plantain), *Polygonum* (smartweed, knotweed) spp., *Sparganium* (bur-reed) spp., and floating or submerged aquatic species such as *Lemna minor* (lesser duckweed), *Potamogeton natans* (floating pondweed), and *Nuphar lutea ssp. variegata* (variegated yellow pond-lily). Bryophytes, if present, cling to shrub bases and include *Warnstorfia fluitans*, *Drepanocladus aduncus* (drepanocladus moss), or *Sphagnum fallax* (flat-top bogmoss).

Characteristic Species: *Cephalanthus occidentalis* (common buttonbush)

Dynamics/Successional Trajectory: Seasonal flooding and heavy rains contribute nutrients, sediments, and organic debris to this community. Excessive inputs of any of these can greatly accelerate natural successional processes which are responsible for the conversion of wetlands to terrestrial habitats.

Management Concerns: Management would include protection of existing sites, but more importantly, restoration of deepwater shrub swamps where feasible.

Reference Sites: Coastal Plain Intermittent Ponds in NJ; Great Marsh, Chester County, PA; Seasonal Ponds, DE

Global and State Conservation Ranks and Reasons: G4G5 (8-Dec-2005). DE: SNR, NJ: SNR, PA: SNR. This association is widely distributed in the northeastern U.S. and relatively common in its small-patch setting.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685066

References: Bowman 2000, Breden et al. 2001, CAP pers. comm. 1998, Cowardin et al. 1979, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Fike 1999, Fleming et al. 2001, Gawler 2002, Harrison 2004, Harrison pers. comm., Metzler and Barrett 2001, Nichols et al. 2001, Sperduto 2000b, Swain and Kearsley 2001, Thompson 1996, Thompson and Sorenson 2000

MOST ABUNDANT SPECIES

STRATUM	LIFEFORM	SPECIES
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Cephalanthus occidentalis</i> (common buttonbush)

NORTHEASTERN TEMPERATE COBBLE SCOUR RIVERSHORE

Carex torta - *Apocynum cannabinum* - *Cyperus* spp. Herbaceous Vegetation

Range: This association is found from New England south through New York, Pennsylvania and Delaware.

Environmental Description: This community occurs on cobble, gravel, and sand bars or banks of streams and rivers with medium to high gradients. Seasonal flooding and ice-scour maintain the open nature of these communities.

Vegetation Description: Vegetation can be sparse to dense depending on degree of flooding and length of exposure. Characteristic perennial species that tolerate inundation and flood scouring include *Carex torta* (twisted sedge) and low *Salix* (willow) spp.



Photo by Delaware Natural Heritage Program

Associated species tend to vary widely from site to site, can be diverse, and may be sparse; they include *Apocynum cannabinum* (Indian-hemp), *Verbena hastata* (swamp verbena), *Symphotrichum purpureum* (purple-stem aster), *Doellingeria umbellata* (parasol whitetop), *Solidago rugosa* (wrinkleleaf goldenrod), *Solidago canadensis* (Canada goldenrod), *Solidago gigantea* (giant goldenrod), *Calamagrostis canadensis* (bluejoint), *Phalaris arundinacea* (reed canarygrass), *Scirpus expansus* (woodland bulrush), *Scirpus cyperinus* (woolgrass bulrush), *Thelypteris palustris* (eastern marsh fern), *Scutellaria lateriflora* (blue skullcap), *Dichanthelium clandestinum* (deer-tongue witchgrass), *Eupatorium maculatum* (spotted joe-pyeweed), *Eupatorium perfoliatum* (common boneset), *Elymus riparius* (riverbank wild rye), *Cyperus strigosus* (straw-colored flatsedge) and other *Cyperus* (flatsedge) spp., *Eleocharis* (spikerush) spp., *Lobelia cardinalis* (cardinal-flower), *Onoclea sensibilis* (sensitive fern), *Viola* (violet) spp., *Clematis virginiana* (virgin's-bower), *Polygonum amphibium* (water smartweed), *Polygonum hydropiper* (marsh-pepper knotweed), *Polygonum pennsylvanicum* (Pennsylvania smartweed), *Polygonum sagittatum* (arrowleaf tearthumb), *Polygonum persicaria* (spotted lady's-thumb), *Polygonum lapathifolium* (pale smartweed), *Schizachyrium scoparium* (little bluestem), *Andropogon gerardii* (big bluestem), and occasionally *Sanguisorba canadensis* (Canada burnet). Scattered, battered and stunted shrubs and trees can occur, including *Salix sericea* (silky willow), *Salix eriocephala* (Missouri willow), *Cornus amomum* (silky dogwood), *Betula nigra* (river birch), *Populus deltoides* (eastern cottonwood), and *Platanus occidentalis* (sycamore). Nonvascular plants can be sparse, but where present can include *Bryum* (bryum moss) spp.

Characteristic Species: *Apocynum cannabinum* (Indian-hemp), *Carex torta* (twisted sedge)

Dynamics/Successional Trajectory: These are highly dynamic communities with regular disturbance from flooding and ice-scour. Vegetation cover can be inversely proportional to inundation and scour.

Management Concerns: This association is particularly susceptible to invasive exotic species such as *Tussilago farfara* (colt's-foot), *Lythrum salicaria* (purple loosestrife), *Polygonum cuspidatum* (Japanese knotweed), *Polygonum persicaria* (spotted lady's-thumb), and *Microstegium vimineum* (Japanese stiltgrass). In addition, alteration in flow regime may affect the species composition and vegetation structure in this community.

Reference Sites: White Clay Creek, DE; Lycoming Creek, Lycoming County, PA

Global and State Conservation Ranks and Reasons: G4G5 (2-Feb-2005). DE: SNR, PA: SNR. This community is common in tributaries in the upper portions of watersheds. The rank within Pennsylvania is S3; considering its whole range, its rank should probably be changed to G5.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684638

References: Bowman 2000, Eastern Ecology Working Group n.d., Edinger et al. 2002, Metzler and Barrett 2001, Nichols et al. 2001, Perles et al. 2004, Sperduto and Nichols 2004, Swain and Kearsley 2000, Thompson 1996, Thompson and Sorenson 2000

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Carex torta</i> (twisted sedge)

RED MAPLE - GREEN ASH FORESTED SWAMP

Acer rubrum - *Fraxinus pennsylvanica* / *Boehmeria cylindrica* Forest

Range: This community occurs within the New Jersey and Pennsylvania portions of the Delaware Estuary and possibly Delaware's portion as well.

Environmental Description: These communities are found on water-deposited clay or loamy sediments on oxbows or floodplains of rivers and large perennial streams. Soils are flooded or saturated for a significant portion of the growing season. Water may be ponded in shallow depressions for most of the year.

Vegetation Description: In the Central Appalachians these are closed-canopy deciduous floodplain forests characterized by abundant *Acer rubrum* (red maple) and *Fraxinus pennsylvanica* (green ash) with associates *Quercus palustris* (pin oak), *Quercus bicolor* (swamp white oak), *Ulmus americana* (American elm), *Acer saccharinum* (silver maple), and *Platanus occidentalis* (sycamore). The diverse shrub layer includes *Carpinus caroliniana* (American hornbeam), *Cephalanthus occidentalis* (common buttonbush), and *Cornus amomum* (silky dogwood). The herbaceous layer is usually well-developed and may include *Boehmeria cylindrica* (small-spike false nettle), *Symplocarpus foetidus* (skunk-cabbage), *Carex* (sedge) spp., *Glyceria* (mannagrass) spp., *Juncus* (rush) spp., *Laportea canadensis* (Canadian wood-nettle), *Leersia* (cutgrass) spp., *Pilea pumila* (Canadian clearweed), *Impatiens capensis* (orange jewelweed), *Urtica* (nettle) spp., *Elymus* (wild rye) spp., and exotics. Vines are characteristic, including *Vitis* (grape) spp., *Toxicodendron radicans* (eastern poison-ivy), and *Parthenocissus quinquefolia* (Virginia creeper).

Characteristic Species: *Acer rubrum* (red maple), *Boehmeria cylindrica* (small-spike false nettle), *Carpinus caroliniana* (American hornbeam), *Fraxinus pennsylvanica* (green ash)

Management Concerns: The herbaceous layer of this community is typically invaded by exotics.

Reference Sites: none identified

Global and State Conservation Ranks and Reasons: GNR (8-Jul-1999). DE?:SNA, NJ: SNR, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686717

References: Eastern Ecology Working Group n.d.

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)
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Carpinus caroliniana</i> (American hornbeam)

RIVER BIRCH LOW FLOODPLAIN FOREST

Betula nigra - *Platanus occidentalis* / *Impatiens capensis* Forest

Range: This floodplain forest occurs in the Mid-Atlantic states including New Jersey, Pennsylvania and possibly Delaware.

Environmental Description: This floodplain forest can be found in large and moderately large rivers and their tributaries. It occurs on sandy, gravelly, well-drained soils of levees, gravel bars, islands, braided channels and other areas of frequent flooding. The substrate is usually coarse sand and gravel often with inclusions of cobble-lined scour channels.

Vegetation Description: The tree canopy is well-developed and dominated by *Betula nigra* (river birch) and *Platanus occidentalis* (sycamore), with associates including *Acer negundo* (box-elder) and occasionally *Acer saccharinum* (silver maple). The shrub layer includes *Carpinus caroliniana* (American hornbeam), *Lindera benzoin* (northern spicebush), *Cornus amomum* (silky dogwood), and *Alnus* (alder) spp. The vine and herb layers are lush and diverse and may include *Boehmeria cylindrica* (small-spike false nettle), *Elymus hystrix* (bottlebrush grass), *Stellaria pubera* (great chickweed), *Impatiens capensis* (orange jewelweed), *Impatiens pallida* (yellow jewelweed), *Laportea canadensis* (Canadian wood-nettle), *Pilea pumila* (Canadian clearweed), *Thelypteris palustris* (eastern marsh fern), *Toxicodendron radicans* (eastern poison-ivy), *Parthenocissus quinquefolia* (Virginia creeper), *Vitis rotundifolia* (muscadine) or *Vitis riparia* (riverbank grape), *Chasmanthium latifolium* (river-oats), *Podophyllum peltatum* (mayapple), *Polygonum virginianum* (jumpseed), *Apocynum cannabinum* (Indian-hemp), and *Urtica* (nettle) sp.

Characteristic Species: *Betula nigra* (river birch), *Impatiens capensis* (orange jewelweed)

Management Concerns: Exotic species are typical and may include *Lysimachia* (loosestrife) sp., *Microstegium vimineum* (Japanese stiltgrass), *Lonicera japonica* (Japanese honeysuckle), *Lonicera morrowii* (Morrow's honeysuckle), *Polygonum cuspidatum* (Japanese knotweed), and *Alliaria petiolata* (garlic mustard).

Reference Sites: Blackbird Creek, DE (?); Rancocas State Park, NJ; Kettle Creek, Clinton County, PA

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686338

References: Bartgis 1986, Bowman 2000, CAP pers. comm. 1998, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Harrison 2004, Podnieszinski and Wagner 2002, Thomson et al. 1999

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Betula nigra</i> (river birch)
Tree canopy	Broad-leaved deciduous tree	<i>Platanus occidentalis</i> (sycamore)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Cornus amomum</i> (silky dogwood)

SILVER MAPLE - ELM FOREST

Acer saccharinum - *Ulmus americana* Forest

Range: This association is found throughout the midwestern United States and parts of the eastern United States, ranging from Pennsylvania west to Minnesota, and south to Arkansas. It also occurs in all three states of the Delaware Estuary.

Environmental Description: This community occurs on temporarily flooded soils along major rivers and smaller perennial streams. Soils may be well-drained and sandy, more loamy on infrequently flooded bottomlands and levees, or deep silts on stabilized sites along larger rivers. The structure and composition of the type is influenced by the flooding regime. Floods leave river-deposited debris on the forest floor, ice scars on trees, and abandoned channels that retain water at or above the level of the main river channel.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: Canopy cover is more-or-less closed and dominated by *Acer saccharinum* (silver maple). Codominants may include *Platanus occidentalis* (sycamore), *Acer negundo* (box-elder), and *Betula nigra* (river birch). Associated species may include *Ulmus americana* (American elm), *Ulmus rubra* (slippery elm), *Salix nigra* (black willow), *Celtis occidentalis* (common hackberry), and *Fraxinus pennsylvanica* (green ash). The shrub and sapling layer is often open (<25% cover). Species that may be present include *Sambucus canadensis* (American elder) or *Lindera benzoin* (northern spicebush). Woody and herbaceous vines can be prominent, including, among the woody vines, *Parthenocissus quinquefolia* (Virginia creeper) and *Vitis riparia* (riverbank grape). Herbaceous vines species include *Apios americana* (groundnut), *Amphicarpaea bracteata* (American hog-peanut), and *Echinocystis lobata* (wild cucumber). Herbaceous grasses, forbs, and ferns dominate the ground layer, including *Symphotrichum lateriflorum* (calico aster), *Boehmeria cylindrica* (small-spike false nettle), *Elymus virginicus* (Virginia wild rye), *Impatiens pallida* (yellow jewelweed), *Laportea canadensis* (Canadian wood-nettle), *Matteuccia struthiopteris* (ostrich fern), *Onoclea sensibilis* (sensitive fern), *Pilea pumila* (Canadian clearweed), *Urtica dioica* (stinging nettle), and others.

Characteristic Species: *Acer saccharinum* (silver maple)

Dynamics/Successional Trajectory: The structure and composition of the type is influenced by the flooding regime, which is typically an annual flooding of relatively brief duration (several weeks), but may be absent in dry years or extensive during flash-flood years. Floods leave river-deposited debris on the forest floor, ice scars on trees, and abandoned channels that retain water at or above the level of the main river channel.

Management Concerns: Many of the forest stands have been impacted by drainage and conversion to agricultural land, logging, channel dredging, and dam construction. This can lead to changes in tree dominants and ground flora. *Acer negundo* (box-elder) is an increasingly common component of floodplain forests because of human disturbance, while *Ulmus americana* (American elm) has declined because of Dutch elm disease (MNNHP 1993). A variety of exotics may be present, including *Lysimachia* (loosestrife) spp., *Microstegium vimineum* (Japanese stiltgrass), *Polygonum cuspidatum* (Japanese knotweed), *Rosa multiflora* (multiflora rose), and *Lonicera japonica* (Japanese honeysuckle) (MNNHP 1993, Anderson 1996, Central Appalachian Ecoregional Team pers. comm. 1998). *Polygonum*

cuspidatum (Japanese knotweed) is a serious problem invasive plant species in this community type within the Delaware and Pennsylvania portions of the Delaware Estuary.

Reference Sites: Christiana River, DE; White Clay Creek, DE; Delaware Water Gap, PA (outside estuary); Crosswicks Creek at Provinceline Road, NJ; near Namanock Island in the Delaware Water Gap National Recreation Area, PA; Shapnack Island in the Delaware Water Gap National Recreation Area, PA

Global and State Conservation Ranks and Reasons: G4? (3-Oct-1996). DE: SNR, NJ: SNR, PA: SNR. There has been significant conversion of stands to agriculture, hydrologic modifications due to river dams, etc., and siltation caused by modified flooding regimes.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686814

References: Anderson 1996, CAP pers. comm. 1998, Eyre 1980, Fike 1999, INAI unpubl. data, MNNHP 1993, Midwestern Ecology Working Group n.d., TDNH unpubl. data, WINHIP unpubl. data, WPC and TNC 2002

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Acer negundo</i> (box-elder)
Tree canopy	Broad-leaved deciduous tree	<i>Acer saccharinum</i> (silver maple)
Tree canopy	Broad-leaved deciduous tree	<i>Betula nigra</i> (river birch)
Tree canopy	Broad-leaved deciduous tree	<i>Platanus occidentalis</i> (sycamore)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Lindera benzoin</i> (northern spicebush)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Sambucus canadensis</i> (American elder)
Herb (field)	Forb	<i>Symphotrichum lateriflorum</i> (calico aster)

SMALL RIVER RED MAPLE - ELM FLOODPLAIN FOREST

Acer (rubrum, saccharinum) - Ulmus americana Forest

Range: This floodplain community occurs within the Lower New England/Piedmont ecoregion within New Hampshire, Rhode Island, Massachusetts, New Jersey and Pennsylvania.

Environmental Description: This is a floodplain community that occurs often within the lower alluvial terraces, backwaters, bars, and islands of minor rivers and smaller tributaries, creeks and drainages. The terrain is relatively flat, and hummock-and-hollow microtopography is absent or poorly developed.

Vegetation Description: The canopy is typically dominated by either *Acer rubrum* (red maple) or, less commonly, by *Acer saccharinum* (silver maple). *Ulmus americana* (American elm) occurs as an associate in the canopy and/or subcanopy. *Fraxinus americana* (white ash) (to the north) or *Fraxinus pennsylvanica* (green ash) (to the south) may also be present in the subcanopy. The shrub layer is generally sparse, containing canopy species and occasional wetland shrubs, such as *Cornus amomum* (silky dogwood), *Vaccinium corymbosum* (highbush blueberry), *Ilex verticillata* (common winterberry), *Lindera benzoin* (northern spicebush), and *Cephalanthus occidentalis* (common buttonbush). *Onoclea sensibilis* (sensitive fern) and *Boehmeria cylindrica* (small-spike false nettle) are characteristic in the herb layer. Other herbs that may be present include *Impatiens capensis* (orange jewelweed), *Phalaris arundinacea* (reed canarygrass), *Osmunda regalis var. spectabilis* (royal fern), *Carex crinita* (fringed sedge), *Lythrum salicaria* (purple loosestrife), *Cinna arundinacea* (sweet woodreed), and *Matteuccia struthiopteris* (ostrich fern).

Characteristic Species: *Acer rubrum* (red maple), *Boehmeria cylindrica* (small-spike false nettle), *Onoclea sensibilis* (sensitive fern), *Ulmus americana* (American elm)

Dynamics/Successional Trajectory: This community is adapted to the periodic flooding of the associated river or stream system. The soil is saturated for at least part of the growing season and may stay inundated for extended periods of time.

Reference Sites: None identified, but PA and NJ both have sites.

Global and State Conservation Ranks and Reasons: GNR (8-Nov-2000). NJ: SNR, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688249

References: Barrett and Enser 1997, Collins and Anderson 1994, Eastern Ecology Working Group n.d., Fike 1999, Sperduto and Nichols 2004

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>Ulmus americana</i> (American elm)
Tree subcanopy	Broad-leaved deciduous tree	<i>Fraxinus pennsylvanica</i> (green ash)
Herb (field)	Fern or fern ally	<i>Onoclea sensibilis</i> (sensitive fern)

WATER-WILLOW ROCKY BAR AND SHORE

Justicia americana Herbaceous Vegetation

Range: This type is found primarily in the Piedmont, Interior Low Plateau, Cumberland Plateau, Ozarks, Ouachita Mountains, and adjacent provinces. It ranges from Alabama, Georgia and the Carolinas west to Arkansas and Oklahoma and north to Ohio, Pennsylvania, and Delaware. It occurs in Pennsylvania's portion of the Delaware Estuary.

Environmental Description: This association occurs on the heads of islands, along the edges of bars, banks, terraces and spits, and in shallow sections of river channels. The lower portion of the *Justicia* (water-willow) stems are under water for most of the year, with the tops of the plants emerging above the flowing water. These beds are entirely submerged by most flood events. During extreme low water periods, the soil below the beds can be exposed, showing a varied mixture of sand, gravel, cobbles, silt, and/or muck.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: *Justicia americana* (American water-willow) is the characteristic dominant. Since *Justicia americana* (American water-willow) spreads by rhizomes, it can form extensive monocultural colonies. *Saururus cernuus* (lizard's-tail) is often present and may be codominant. Other herbaceous species that may be present include *Diodia teres* (rough buttonweed), *Leersia oryzoides* (rice cutgrass), *Lemna minor* (lesser duckweed), *Podostemum ceratophyllum* (riverweed), *Scirpus* (bulrush) sp., *Schoenoplectus pungens* (common threesquare), *Cyperus* (flatsedge) spp., and *Eleocharis* (spikerush) spp. Exotics include *Lythrum salicaria* (purple loosestrife) and *Lysimachia vulgaris* (garden loosestrife). In some areas, *Justicia* (water-willow) usually grows in nearly pure patches, so that few other species are associated with it. *Hibiscus laevis* (halberd-leaf rosemallow), *Polygonum amphibium* (water smartweed), *Rorippa sylvestris* (creeping yellowcress), *Bidens* (beggarticks) spp., *Cuscuta gronovii* (scaldweed), *Mimulus ringens* (Allegheny monkeyflower), *Polygonum* (smartweed, knotweed) spp.,

Rumex (dock, sorrel) spp., and *Salix interior* (sandbar willow) can occur (Anderson 1982). A few scattered seedlings may be present, including *Betula nigra* (river birch), *Salix* (willow) spp., *Acer saccharinum* (silver maple), and *Platanus occidentalis* (sycamore).

Characteristic Species: *Justicia americana* (American water-willow)

Dynamics/Successional Trajectory: Stands in some situations may be obliterated by ongoing river channeling. Anderson (1982) describes some of the life-history characteristics of *Justicia americana* (American water-willow) that allow it to persist in river channels.

Management Concerns: This association is susceptible to invasion by *Lythrum salicaria* (purple loosestrife) and *Lysimachia vulgaris* (garden loosestrife).

Reference Sites: Dark Hollow County Park, Bucks County, PA

Global and State Conservation Ranks and Reasons: G4G5 (12-Sep-1997). PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685634

References: Allard 1990, Anderson 1982, Anderson 1996, Fike 1999, Fleming et al. 2001, Harrison 2004, Hoagland 1997, Hoagland 2000, Major et al. 1999, McCoy 1958, Nelson 1986, OHNHD unpubl. data, Palmer-Ball et al. 1988, Peet et al. unpubl. data 2002, Penfound 1953, Perles et al. 2004, Schafale 1998b, Schafale 2002, Schafale and Weakley 1990, Schmalzer and DeSelm 1982, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data, TNC and WPC 2004

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Forb	<i>Justicia americana</i> (American water-willow)
Herb (field)	Forb	<i>Saururus cernuus</i> (lizard's-tail)

ECOLOGICAL SYSTEM: CENTRAL APPALACHIAN PINE-OAK ROCKY WOODLAND

Summary: This system of the central Appalachians encompasses open or sparsely wooded hilltops and outcrops or rocky slopes, mostly at lower elevations, but occasionally up to 1220 m (4000 feet) in West Virginia. The substrate rock is granitic or of other acidic lithology. The vegetation is patchy, with woodland as well as open portions. *Pinus* (pine) spp. are diagnostic and often are mixed with xerophytic *Quercus* (oak) spp. Some areas have a fairly well-developed heath shrub layer, others a graminoid layer. Conditions are dry and nutrient-poor, and many, if not most, sites have a history of fire.

High-ranked Species: *Arabis serotina* (G2, shale barren rockcress), *Canis rufus* (G1Q, red wolf), *Catocala herodias gerhardi* (G3T3, herodias or pine barrens underwing), *Gaylussacia brachycera* (G3, box huckleberry), *Malaxis bayardii* (G1G2, bayard's malaxis), *Packera millefolia* (G2, piedmont groundsel), *Pyrgus wyandot* (G1G2Q, Appalachian grizzled skipper), *Taenidia montana* (G3, mountain-pimpernel), *Vaccinium hirsutum* (G3, hairy blueberry), *Virginia valeriae pulchra* (G5T3T4, mountain earth snake)

Range: This system occurs from central New England south to Virginia and West Virginia. United States: CT, MA, MD?, ME, NH, NJ, NY, PA, VA, VT, WV

Delaware Estuary Associations:

- Central Appalachian Blueberry Shrubland
- Little Bluestem - Poverty Grass Low- to Mid-Elevation Outcrop Opening
- Pitch Pine Rocky Summit
- Ridgetop Scrub Oak Barrens

CLASSIFIERS FOR CENTRAL APPALACHIAN PINE-OAK ROCKY WOODLAND

Primary Division: 202

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); Shrubland (Shrub-dominated); Woody-Herbaceous;

Ridge/Summit/Upper Slope; Acidic Soil; *Pinus* (*strobus*, *rigida*, *echinata*, *virginiana*) - *Quercus prinus*

Non-diagnostic Classifiers: Lowland; Temperate; Oligotrophic Soil; Shallow Soil; Ustic; Consolidated; F-Patch/Medium Intensity; Needle-Leaved Tree; Broad-Leaved Deciduous Tree; Moderate (100-500 yrs) Persistence

CENTRAL APPALACHIAN BLUEBERRY SHRUBLAND

Vaccinium (*angustifolium*, *myrtilloides*, *pallidum*) High Allegheny Plateau / Central Appalachian Dwarf-shrubland

Range: Within the Delaware Estuary, this community occurs within high-elevation portions of the Blue, First, and Second mountains in Schuylkill County in Pennsylvania.

Environmental Description: This association occurs on dry, high-elevation portions of the Blue, First, and Second mountains where the fire frequency and intensity is high. This particular vegetation type is best expressed where fire has recently occurred. The soil is typically sandy or thin soils over bedrock. Soils are



Photo by Pennsylvania Natural Heritage Program

typically acidic with low moisture content. Droughty soil conditions limit tree development and most trees (when present) are stunted.

Vegetation Description: This community is dominated by heaths or heath-like shrubs, including *Gaylussacia baccata* (black huckleberry), *Vaccinium angustifolium* (northern lowbush blueberry), *Vaccinium pallidum* (hillside blueberry), and *Vaccinium stamineum* (deerberry). Other common shrubs can include *Kalmia angustifolia* (sheep laurel), *Kalmia latifolia* (mountain laurel), *Gaylussacia frondosa* (dangleberry), *Comptonia peregrina* (sweet-fern), and *Quercus ilicifolia* (bear oak). Associated herbaceous plants are *Deschampsia flexuosa* (wavy hairgrass), *Schizachyrium scoparium* (little bluestem), *Danthonia spicata* (poverty oatgrass), *Carex pensylvanica* (Pennsylvania sedge), *Carex swanii* (swan's sedge), *Piptatherum pungens* (slender mountain ricegrass), *Euthamia graminifolia* (flat-top goldentop), *Solidago canadensis* (Canada goldenrod), *Lycopodium dendroideum* (tree clubmoss), and *Lycopodium digitatum* (fan clubmoss). Mosses and lichens usually are present.

Characteristic Species: *Gaylussacia baccata* (black huckleberry), *Vaccinium angustifolium* (northern lowbush blueberry), *Vaccinium pallidum* (hillside blueberry), *Vaccinium stamineum* (deerberry)

Dynamics/Successional Trajectory: This association is maintained as a shrubland by periodic fire, shallow rocky soils, and harsh edaphic conditions.

Management Concerns: The applicability of utilizing prescribed fire as a restoration technique for this association should be evaluated on a site-specific basis.

Reference Sites: Weiser State Forest and Locust Lake State Park, Schuylkill County, PA

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686894

References: Eastern Ecology Working Group n.d., Fike 1999, Harrison 2004, Walton et al. 1997

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Gaylussacia baccata</i> (black huckleberry)
Short shrub/sapling blueberry)	Broad-leaved deciduous shrub	<i>Vaccinium angustifolium</i> (northern lowbush blueberry)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Vaccinium pallidum</i> (hillside blueberry)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Vaccinium stamineum</i> (deerberry)
Herb (field)	Graminoid	<i>Deschampsia flexuosa</i> (wavy hairgrass)

LITTLE BLUESTEM - POVERTY GRASS LOW- TO MID-ELEVATION OUTCROP OPENING

Schizachyrium scoparium - *Danthonia spicata* - *Carex pensylvanica* / *Cladonia* spp. Herbaceous Vegetation

Range: This community occurs in the Pennsylvania portion of the Delaware Estuary.

Environmental Description: This Central Appalachian community occurs on rock outcrops, flat summits, plateaus, and southwest-facing upper slopes with grassy openings. It occurs between 365 and 425 m (1200-1400 feet) in elevation. The bedrock consists of acidic sandstone and conglomerates.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: *Danthonia spicata* (poverty

oatgrass), *Schizachyrium scoparium* (little bluestem), and *Deschampsia flexuosa* (wavy hairgrass) dominate this community. Other associates include *Carex pensylvanica* (Pennsylvania sedge), *Piptatherum pungens* (slender mountain ricegrass), *Piptatherum racemosum* (black-seed mountain ricegrass), *Hypericum gentianoides* (pineweed), *Rubus* (blackberry) spp., *Sibbaldiopsis tridentata* (mountain-cinquefoil), *Cladonia* (cup lichen) sp., *Umbilicaria* (rocktripe) sp. Scattered shrubs include *Vaccinium* (blueberry) spp., *Gaylussacia baccata* (black huckleberry), and *Photinia melanocarpa* (black chokeberry).

Characteristic Species: *Danthonia spicata* (poverty oatgrass), *Deschampsia flexuosa* (wavy hairgrass), *Schizachyrium scoparium* (little bluestem)

Dynamics/Successional Trajectory: This community is typically associated with Pitch Pine Rocky Summit (CEGL006116) and similar dry ridgetop woodlands and shrublands. It is relatively stable where controlled by edaphic conditions (thin, poor soils over bedrock), or successional where fire has removed or reduced woody plant cover.

Management Concerns: This community requires maintenance of a natural disturbance regime, including fire where necessary for reducing woody plant cover.

Reference Sites: Delaware Water Gap National Recreation Area, Pike County, PA; Sussex County, NJ; Pike County, PA

Global and State Conservation Ranks and Reasons: GNR (8-Jul-1999). PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685616

References: Eastern Ecology Working Group n.d., Fike 1999

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Danthonia spicata</i> (poverty oatgrass)
Herb (field)	Graminoid	<i>Schizachyrium scoparium</i> (little bluestem)

PITCH PINE ROCKY SUMMIT

Pinus rigida / (*Quercus ilicifolia*) / *Photinia melanocarpa* / *Deschampsia flexuosa* Woodland

Range: Within the Delaware Estuary, this association likely occurs only in high-elevation portions of the Blue, First, and Second mountains in Schuylkill County in Pennsylvania.

Environmental Description: This northeastern pitch pine community occurs on dry rocky ridges and summits of low to moderate elevations. Soils are derived from acidic bedrock and are typically shallow, well- to excessively drained, coarse sands or gravels that develop in pockets of the exposed bedrock expanses.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: The canopy is open and trees are often stunted. Tall shrubs are scattered and not abundant. The dwarf-shrub layer is typically well-developed. Herb distribution is patchy. The bryoid layer is of variable cover, with lichens prominent. The ground cover is bare rock,

deciduous and coniferous litter. The canopy is dominated by *Pinus rigida* (pitch pine) with a variable mixture of associates, such as *Betula populifolia* (gray birch), *Quercus rubra* (northern red oak), *Pinus strobus* (eastern white pine), *Pinus resinosa* (red pine), *Betula lenta* (sweet birch), *Acer rubrum* (red maple), and *Prunus serotina* (black cherry). The tall-shrub layer is comprised of scattered *Nemopanthus mucronatus* (catberry), *Quercus ilicifolia* (bear oak), or *Quercus prinoides* (dwarf chinquapin oak). The shrub layer is dominated by heaths, such as *Vaccinium angustifolium* (northern lowbush blueberry), *Vaccinium pallidum* (hillside blueberry), *Kalmia angustifolia* (sheep laurel), and *Gaylussacia baccata* (black huckleberry), as well as other shrubs, such as *Comptonia peregrina* (sweet-fern) and *Photinia melanocarpa* (black chokeberry). The herbaceous layer typically includes *Pteridium aquilinum* (bracken fern), *Schizachyrium scoparium* (little bluestem), *Deschampsia flexuosa* (wavy hairgrass), *Danthonia spicata* (poverty oatgrass), *Carex pensylvanica* (Pennsylvania sedge) and/or *Carex lucorum* (Blue Ridge sedge), *Maianthemum canadense* (Canada mayflower), *Aralia nudicaulis* (wild sarsaparilla), *Melampyrum lineare* (narrowleaf cow-wheat), *Fragaria virginiana* (Virginia strawberry), *Trientalis borealis* (starflower), *Rumex acetosella* (common sheep sorrel), *Erechtites hieraciifolia* (American burnweed), *Corydalis sempervirens* (rock harlequin), *Polypodium virginianum* (rock polypody), and *Cypripedium acaule* (pink lady's-slipper). In the central Appalachians, this community occurs at elevations of 305 to 520 m (1000-1700 feet), with occasional associates including *Pinus pungens* (Table Mountain pine), *Pinus virginiana* (Virginia pine), and *Ilex montana* (mountain holly).

Noteworthy Associated Plant and/or Animal Species: *Dendroica discolor* (prairie warbler)

Characteristic Species: *Deschampsia flexuosa* (wavy hairgrass), *Photinia melanocarpa* (black chokeberry), *Pinus rigida* (pitch pine), *Quercus ilicifolia* (bear oak)

Dynamics/Successional Trajectory: Periodic fires are probably necessary for persistence of this type, except at the most extreme sites. The prominent areas of exposed bedrock also maintain this association in an open woodland state.

Management Concerns: The applicability of utilizing prescribed fire as a restoration technique for this association should be evaluated on a site-specific basis.

Reference Sites: near Crater Lake, Delaware Water Gap National Recreation Area, NJ

Global and State Conservation Ranks and Reasons: GNR (1-Dec-1997). NJ: S1, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686132

References: Breden 1989, Breden et al. 2001, CAP pers. comm. 1998, Eastern Ecology Working Group n.d., Edinger et al. 2002, Eyre 1980, Fike 1999, Fleming 1985, Gawler 2002, Harrison 2004, Hunt 1999, Kuchler 1956, Lundgren 1999a, Metzler and Barrett 2001, Moore and Taylor 1927, Rawinski 1984, Sperduto 1997a, Swain and Kearsley 2001, Thompson 1996, Thompson and Sorenson 2000

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus rigida</i> (pitch pine)
Tree canopy	Broad-leaved deciduous tree	<i>Betula populifolia</i> (gray birch)
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Quercus ilicifolia</i> (bear oak)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Vaccinium angustifolium</i> (northern lowbush blueberry)
Herb (field)	Fern or fern ally	<i>Pteridium aquilinum</i> (bracken fern)

RIDGETOP SCRUB OAK BARRENS

Quercus ilicifolia - *Prunus pumila* Shrubland

Range: Within the Delaware Estuary, this association likely occurs only in high-elevation portions of the Blue, First, and Second mountains in Schuylkill County in Pennsylvania.

Environmental Description: This shrubland occurs on extremely shallow, stable acidic soils over bedrock. Open bedrock is common. Periodic fires can help maintain this association in a shrubland state.

Vegetation Description: This shrubland is dominated by *Quercus ilicifolia* (bear oak), which occurs with variable cover depending on site conditions. Associated shrubs include *Vaccinium angustifolium* (northern lowbush



Photo by Pennsylvania Natural Heritage Program

blueberry), *Vaccinium pallidum* (hillside blueberry), *Comptonia peregrina* (sweet-fern), *Kalmia angustifolia* (sheep laurel), *Gaylussacia baccata* (black huckleberry), *Photinia melanocarpa* (black chokeberry), *Quercus prinoides* (dwarf chinquapin oak), *Gaultheria procumbens* (wintergreen), and *Prunus pumila* var. *susquehanae* (Susquehanna cherry). Herbaceous species are generally sparse but include *Danthonia spicata* (poverty oatgrass), *Schizachyrium scoparium* (little bluestem), *Pteridium aquilinum* (bracken fern), *Deschampsia flexuosa* (wavy hairgrass), *Carex pensylvanica* (Pennsylvania sedge), *Comandra umbellata* (bastard toadflax), *Melampyrum lineare* (narrowleaf cow-wheat), *Hypericum gentianoides* (pinweed), *Corydalis sempervirens* (rock harlequin), *Sibbaldiopsis tridentata* (mountain-cinquefoil), plus *Andropogon gerardii* (big bluestem) at some sites. Scattered trees are common and include species from the surrounding ridgetop forests, such as *Quercus prinus* (chestnut oak), *Quercus rubra* (northern red oak), *Quercus alba* (white oak), *Pinus rigida* (pitch pine), *Populus tremuloides* (quaking aspen), *Betula populifolia* (gray birch), and *Carya* (hickory) spp.

Noteworthy Associated Plant and/or Animal Species: *Prunus pumila* var. *susquehanae* (Susquehanna cherry)

Characteristic Species: *Prunus pumila* var. *susquehanae* (Susquehanna cherry), *Quercus ilicifolia* (bear oak)

Dynamics/Successional Trajectory: This shrubland is influenced by the extremely thin soils over acidic bedrock, with fire as a secondary influence.

Management Concerns: The applicability of utilizing prescribed fire as a restoration technique for this association should be evaluated on a site-specific basis.

Reference Sites: Weiser State Forest and Locust Lake State Park, Schuylkill County, PA

Global and State Conservation Ranks and Reasons: GNR (10-May-2002). PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689771

References: Eastern Ecology Working Group n.d., Fike 1999, Metzler and Barrett 2001, Swain and Kearsley 2000

MOST ABUNDANT SPECIES

STRATUM	LIFEFORM	SPECIES
Shrub/sapling (tall & short)	Broad-leaved deciduous tree	<i>Quercus ilicifolia</i> (bear oak)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Prunus pumila</i> var. <i>susquehanae</i> (Susquehanna cherry)
Short shrub/sapling blueberry)	Broad-leaved deciduous shrub	<i>Vaccinium angustifolium</i> (northern lowbush
Herb (field)	Graminoid	<i>Danthonia spicata</i> (poverty oatgrass)
Herb (field)	Graminoid	<i>Schizachyrium scoparium</i> (little bluestem)

ECOLOGICAL SYSTEM: CENTRAL APPALACHIAN 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. Flooding is the major process affecting the vegetation, but compared to flat floodplain areas, the substrate is more rapidly drained, and deposition is less important than erosion. The vegetation is a mosaic of forest, woodland, shrubland, and herbaceous communities. Common trees include *Betula nigra* (river birch), *Platanus occidentalis* (sycamore), and *Acer negundo* (box-elder). 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), *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), *Gymnoderma lineare* (G2, rock gnome lichen), *Hasteola suaveolens* (G3, false Indian-plantain), *Hexastylis naniflora* (G3, dwarf-flower heartleaf), *Hexastylis rhombiformis* (G2, french broad heartleaf), *Hexastylis shuttleworthii* var. *harperi* (G4T3, harper's heartleaf), *Isotria medeoloides* (G2, small whorled pogonia), *Jamesianthus alabamensis* (G3, alabama warbonnet), *Lejeunea blomquistii* (G1G2, blomquist leafy liverwort), *Lysimachia fraseri* (G2, Fraser's 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 spiraea), *Trillium rugelii* (G3, ill-scented wakerobin), *Waldsteinia lobata* (G2, lobed 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. United States: CT, MA, MD, NH, NJ?, NY, OH, PA, VA, VT, WV

Delaware Estuary Associations:

- Birch - Willow Riverbank Shrubland
- Coastal Plain Oak Floodplain Swamp
- Fall-line Riverwash Bedrock Prairie
- Loosestrife - Dogbane Scoured Rivershore
- Northeastern Temperate Cobble Scour Rivershore
- Rocky Bar and Shore (Riverweed Type)
- Successional Aspen - Gray Birch Forest
- Water-willow Rocky Bar and Shore
- Willow River-Bar Shrubland

Similar Ecological Systems in the Delaware Estuary:

- Central Appalachian Floodplain

CLASSIFIERS FOR CENTRAL APPALACHIAN 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

BIRCH - WILLOW RIVERBANK SHRUBLAND

Betula nigra - *Platanus occidentalis* - *Salix* (*interior*, *caroliniana*) Shrubland

Range: This shrubland is found in the High Allegheny Plateau and Central Appalachian ecoregions from West Virginia, Maryland (and possibly Virginia) north to New York. It is also attributed to the Western Allegheny Plateau and occurs in Pennsylvania within the Delaware Estuary.

Environmental Description: This early-successional community occurs on riverbank floodplains and river gravel bars and islands and is subject to periodic flooding and ice-scour. It occurs on sand, gravel or cobble deposits.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: This association is dominated by stunted and often battered trees and shrubs (less than 5 m tall) that can include *Acer saccharinum* (silver maple), *Platanus occidentalis* (sycamore), *Betula nigra* (river birch), *Acer negundo* (box-elder), *Fraxinus* (ash) spp., *Populus deltoides* (eastern cottonwood), and *Ulmus americana* (American elm). *Betula nigra* (river birch) is characteristic and often dominant. Associates include *Cornus amomum* (silky dogwood), *Salix nigra* (black willow), *Salix interior* (sandbar willow), *Salix sericea* (silky willow), *Alnus serrulata* (smooth alder), and sometimes *Cephalanthus occidentalis* (common buttonbush) or *Physocarpus opulifolius* (eastern ninebark). Characteristic herbs include *Apocynum cannabinum* (Indian-hemp), *Polygonum virginianum* (jumpseed), *Eupatorium* (boneset, joe-pyeweed, thoroughwort) spp., *Hypericum* (St. John's-wort) spp., *Bidens* (beggarticks) spp., *Sorghastrum nutans* (yellow Indiangrass), *Andropogon gerardii* (big bluestem), and *Justicia americana* (American water-willow). Exotics such as *Lythrum salicaria* (purple loosestrife) and *Polygonum cuspidatum* (Japanese knotweed) are a frequent problem.

Characteristic Species: *Apocynum cannabinum* (Indian-hemp), *Betula nigra* (river birch)

Dynamics/Successional Trajectory: This association is maintained as a shrubland by frequent scour from floodwaters and ice.

Management Concerns: This association is susceptible to invasive exotic species such as *Lythrum salicaria* (purple loosestrife) and *Polygonum cuspidatum* (Japanese knotweed). Alteration of flow regimes may affect the species composition and vegetation structure of this type.

Reference Sites: Woodcock Bar Island in the Delaware Water Gap National Recreation Area, NJ

Global and State Conservation Ranks and Reasons: G4G5 (1-Dec-1997). NJ: SNR, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687668

References: CAP pers. comm. 1998, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Harrison 2004, Kartesz 1999, Perles et al. 2004, TNC and WPC 2004

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Betula nigra</i> (river birch)
Tree canopy	Broad-leaved deciduous tree	<i>Platanus occidentalis</i> (sycamore)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Cornus amomum</i> (silky dogwood)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Salix exigua</i> ssp. <i>interior</i> (sandbar willow)

COASTAL PLAIN OAK FLOODPLAIN SWAMP

Quercus (palustris, phellos) - Acer rubrum / Cinna arundinacea Forest

Range: This community is found in the Chesapeake Bay region north to the southern Coastal Plain of New Jersey and Pennsylvania.

Environmental Description: This floodplain swamp community of the Chesapeake Bay region and environs occurs in topographic depressions within alluvial floodplains. It occurs in pockets of saturated soils in, or at the edges of, depressions within a larger floodplain forest with annual flooding. Soils are poorly drained loams or clay loams.

Vegetation Description: The tree canopy is dominated by *Quercus palustris* (pin oak), *Quercus phellos* (willow oak), *Acer rubrum* (red maple), and *Liquidambar styraciflua* (sweetgum). The shrub layer is of relatively low cover and comprised of *Viburnum dentatum* (southern arrow-wood), *Viburnum prunifolium* (smooth blackhaw), and *Ilex verticillata* (common winterberry). *Vaccinium corymbosum* (highbush blueberry) is a less frequent shrub layer associate. Typical vines include *Toxicodendron radicans* (eastern poison-ivy), *Parthenocissus quinquefolia* (Virginia creeper), and *Smilax rotundifolia* (roundleaf greenbrier). The herb layer is characterized by *Cinna arundinacea* (sweet woodreed), *Boehmeria cylindrica* (small-spike false nettle), *Symphotrichum lateriflorum* var. *lateriflorum* (calico aster), and *Carex* (sedge) spp., with less frequent associates including *Arisaema triphyllum* (Jack-in-the-pulpit), *Eurybia divaricata* (white wood-aster), *Lycopus virginicus* (Virginia water-horehound), *Ranunculus abortivus* (kidneyleaf buttercup), *Euonymus americanus* (American strawberry-bush), *Chasmanthium laxum* (slender spikegrass), and *Glyceria striata* (fowl mannagrass).

Characteristic Species: *Boehmeria cylindrica* (small-spike false nettle), *Cinna arundinacea* (sweet woodreed), *Quercus palustris* (pin oak)

Dynamics/Successional Trajectory: This floodplain forest is subject to annual flooding.

Reference Sites: Cape May, NJ, and potentially Cedar Swamp WMA, New Castle County, DE

Global and State Conservation Ranks and Reasons: GNR (27-Mar-2000). DE?: SNA, NJ?:SNA, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689632

References: Eastern Ecology Working Group n.d., Fleming et al. 2001, Harrison 2004, Harrison and Stango 2003, Patterson pers. comm., Thomson et al. 1999

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>Quercus palustris</i> (pin oak)
Tree canopy	Broad-leaved deciduous tree	<i>Quercus phellos</i> (willow oak)
Herb (field)	Graminoid	<i>Cinna arundinacea</i> (sweet woodreed)

FALL-LINE RIVERWASH BEDROCK PRAIRIE

Andropogon gerardii - *Panicum virgatum* - *Baptisia australis* Herbaceous Vegetation

Range: This riverwash grassland community is found in the east-central United States, from Pennsylvania, West Virginia, Virginia, and possibly Ohio.

Environmental Description: Stands occur only along high-gradient sections of major rivers, such as on low islands, in gorges and along the fall-line. They occur within the active channel shelf at an intermediate level above the low-water level and the bank-full level. Flood scouring and river ice may become powerful and ecologically important abrasive forces along the riverbanks. Soils are rapidly drained Psamments. Often, soil material is restricted to the narrow interstices of tightly packed boulders or to small crevices in bedrock exposures.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: This community is characterized by a luxuriant growth of the robust grasses *Andropogon gerardii* (big bluestem), *Sorghastrum nutans* (yellow Indiangrass), *Panicum virgatum* (switchgrass), *Schizachyrium scoparium* (little bluestem), and *Spartina pectinata* (prairie cordgrass), which resembles prairie vegetation. *Tripsacum dactyloides* (eastern gammagrass) may also occur. Many of the forbs are also typical of prairies. Characteristic species include *Toxicodendron radicans* (eastern poison-ivy), *Cerastium arvense* (field chickweed), *Coreopsis tripteris* (tall tickseed), *Phlox divaricata* (wild blue phlox), *Pycnanthemum virginianum* (Virginia mountainmint), *Apocynum* (dogbane, Indian-hemp) spp., *Lespedeza* (bushclover) spp., *Phalaris arundinacea* (reed canarygrass), *Solidago speciosa* (showy goldenrod), *Teucrium canadense* (American germander), *Veronicastrum virginicum* (culver's-root), *Vicia americana* (American purple vetch), and *Zizia aurea* (golden alexanders). Scattered shrubs also may be present, including *Betula nigra* (river birch), *Salix* (willow) spp., and *Platanus occidentalis* (sycamore).

Noteworthy Associated Plant and/or Animal Species: *Prunus pumila* var. *depressa* (sand cherry), *Vicia americana* (American purple vetch)

Characteristic Species: *Andropogon gerardii* (big bluestem), *Panicum virgatum* (switchgrass), *Schizachyrium scoparium* (little bluestem), *Sorghastrum nutans* (yellow Indiangrass), *Spartina pectinata* (prairie cordgrass)

Dynamics/Successional Trajectory: Flash floods actively scour the floodplain, keeping the vegetation open.

Management Concerns: This community is threatened by invasion of exotic weeds, especially *Sorghum halepense* (Johnson grass), *Centaurea biebersteinii* (spotted knapweed), and *Lythrum salicaria* (purple loosestrife).

Reference Sites: Shapnack Island in the Delaware Water Gap National Recreation Area, PA

Global and State Conservation Ranks and Reasons: G2G3 (14-Dec-1998). PA: SNR. There are probably fewer than 100 occurrences of this community rangewide, depending on how an occurrence is defined. It is known from Maryland, the District of Columbia, and Virginia along the Potomac River, from the James River, Shenandoah River, and various tributaries in Virginia, and from about 50 miles along the Greenbrier River in West Virginia. It is also reported from the Delaware River in Pennsylvania and may also occur in Ohio.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688945

References: Eastern Ecology Working Group n.d., Fike 1999, Fleming and Coulling 2001, Fleming et al. 2001, Grossman et al. 1994, Harrison 2004, Lea 2000, Perles et al. 2004, Rawinski 1988, Rawinski et al. 1996, TDNH unpubl. data, VDNH 2003

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Andropogon gerardii</i> (big bluestem)
Herb (field)	Graminoid	<i>Panicum virgatum</i> (switchgrass)
Herb (field)	Graminoid	<i>Schizachyrium scoparium</i> (little bluestem)
Herb (field)	Graminoid	<i>Sorghastrum nutans</i> (yellow Indiangrass)

LOOSESTRIFE - DOGBANE SCoured RIVERSHORE

Lysimachia ciliata - *Apocynum cannabinum* Sparse Vegetation

Range: This community is found throughout the Delaware Watershed, on all orders of streams, and in a wide variety of riverine settings.

Environmental Description: Island heads, bars, spits, low terraces, and riverbanks are all home to this broadly defined community. The underlying substrate also varies greatly, although it is often cobbles and sand, with thin deposits of silt, muck or organic matter. Species composition also varies greatly from site to site. The unifying factor that bridges the differences in environmental factors and species composition is the frequent scour that these sites experience. This community establishes in areas of the active channel that are underwater for the majority of the year and are exposed only at low water or in drought years. Therefore, these areas are subjected to high water velocities, floods and ice-scour more frequently than the other herbaceous communities or shrublands described in this report (with the exception of the emergent beds). The constant scour removes established vegetation and maintains or creates exposed sediments, cobbles or bedrock. New seeds and plant propagules are constantly being dispersed to these areas by water, air and animals. This causes a continual flux in species composition that is characteristic of this community.

Vegetation Description: Frequent disturbance of these areas creates conditions that promote continual colonization by a wide variety of plants. After a disturbance, herbaceous and graminoid species may establish sparsely across bare substrate. As more time elapses between disturbance events, vegetation can become dense, completely covering the area. The species composition of the community varies depending upon the available seed bank, surrounding vegetation, type of substrate, ecoregion, and hydrologic conditions. Not all of the species listed below will be present at the same site. In general, species composition at a particular site will tend to favor species either towards the beginning of the list or towards the end of the list. However, many combinations and variations in species composition are possible. Some of the common species are *Cyperus* (flatsedge) spp., *Equisetum arvense* (field horsetail), *Eleocharis* (spikerush) spp., *Schoenoplectus pungens* (common threesquare), *Juncus* (rush) spp., *Justicia americana* (American water-willow), *Sagittaria latifolia* (broadleaf arrowhead), *Ludwigia palustris* (marsh seedbox), *Rorippa sylvestris* (creeping yellowcress), *Chamaesyce maculata* (spotted sandmat), *Hydrocotyle americana* (American marsh pennywort), *Rhexia virginica* (Virginia meadowbeauty), *Mollugo verticillata* (green carpetweed), *Polygonum amphibium* (water smartweed), *Polygonum pensylvanicum*

(Pennsylvania smartweed), *Polygonum hydropiper* (marsh-pepper knotweed), *Polygonum sagittatum* (arrowleaf tearthumb), *Polygonum caespitosum* (oriental lady's-thumb), *Polygonum persicaria* (spotted lady's-thumb), *Calystegia sepium* (hedge false bindweed), *Pilea pumila* (Canadian clearweed), *Galium* (bedstraw) spp., *Onoclea sensibilis* (sensitive fern), *Leersia oryzoides* (rice cutgrass), *Leersia virginica* (white cutgrass), *Setaria* (bristleglass) spp., *Packera aurea* (golden ragwort), *Epilobium ciliatum* ssp. *glandulosum* (fringed willowherb), *Lysimachia vulgaris* (garden loosestrife), *Lysimachia terrestris* (swamp-candles), *Lysimachia ciliata* (fringed loosestrife), *Mimulus ringens* (Allegheny monkeyflower), *Lindernia dubia* (yellowseed false pimpernel), *Apocynum cannabinum* (Indian-hemp), *Apocynum androsaemifolium* (spreading dogbane), *Bidens frondosa* (devil's pitchfork), *Bidens connata* (purple-stem beggarticks), *Boehmeria cylindrica* (small-spike false nettle), *Impatiens capensis* (orange jewelweed), *Hibiscus laevis* (halberd-leaf rosemallow), *Lythrum salicaria* (purple loosestrife), *Lycopus uniflorus* (northern bugleweed), *Lobelia cardinalis* (cardinal-flower), *Triadenum virginicum* (Virginia marsh St. John's-wort), *Hypericum mutilum* (dwarf St. John's-wort), *Hypericum ellipticum* (pale St. John's-wort), *Solidago gigantea* (giant goldenrod), *Solidago rugosa* (wrinkleleaf goldenrod), *Euthamia graminifolia* (flat-top goldentop), *Viola* (violet) spp., *Mentha arvensis* (wild mint), *Mentha X gracilis* (= *Mentha gentilis*), *Eupatorium perfoliatum* (common boneset), *Eupatorium maculatum* (spotted joe-pyeweed), *Verbena hastata* (swamp verbena), *Verbena urticifolia* (white vervain), *Asclepias incarnata* (swamp milkweed), *Heliopsis helianthoides* (smooth oxeye), *Coreopsis tinctoria* (golden tickseed), *Doellingeria umbellata* (parasol whitetop), *Symphotrichum lateriflorum* (calico aster), *Pycnanthemum virginianum* (Virginia mountainmint), *Carex lacustris* (lake sedge), *Carex torta* (twisted sedge), *Sorghastrum nutans* (yellow Indiangrass), *Andropogon gerardii* (big bluestem), *Echinochloa muricata* (rough barnyard grass)

Characteristic Species: *Apocynum cannabinum* (Indian-hemp), *Lysimachia ciliata* (fringed loosestrife)

Dynamics/Successional Trajectory: The unifying factor that bridges the differences in environmental factors and species composition is the frequent scour that these sites experience. This community establishes in areas of the active channel that are underwater for the majority of the year and are exposed only at low water or in drought years. Therefore, these areas are subjected to high water velocities, floods and ice-scour more frequently than the many other riverine herbaceous- or shrub-dominated communities (with the exception of the emergent beds). The constant scour removes established vegetation and maintains or creates exposed sediments, cobbles or bedrock. New seeds and plant propagules are constantly being dispersed to these areas by water, air and animals. This causes a continual flux in species composition that is characteristic of this community.

Management Concerns: This association is difficult to manage due to the constant scour and natural fluctuation in species composition and abundance. However, *Lythrum salicaria* (purple loosestrife) can invade and dominate this community.

Reference Sites: This is a difficult type to identify reference sites for in Pennsylvania because the type is extremely variable by definition.

Global and State Conservation Ranks and Reasons: GNR (8-Jul-1999). PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685497

References: Eastern Ecology Working Group n.d., Fike 1999, TNC and WPC 2004

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Forb	<i>Lysimachia ciliata</i> (fringed loosestrife)

NORTHEASTERN TEMPERATE COBBLE SCOUR RIVERSHORE

Carex torta - *Apocynum cannabinum* - *Cyperus* spp. Herbaceous Vegetation

Range: This association is found from New England south through New York, Pennsylvania and Delaware.

Environmental Description: This community occurs on cobble, gravel, and sand bars or banks of streams and rivers with medium to high gradients. Seasonal flooding and ice-scour maintain the open nature of these communities.

Vegetation Description: Vegetation can be sparse to dense depending on degree of flooding and length of exposure. Characteristic perennial species that tolerate inundation and flood scouring include *Carex torta* (twisted sedge) and low *Salix* (willow)



Photo by Delaware Natural Heritage Program

spp. Associated species tend to vary widely from site to site, can be diverse, and may be sparse; they include *Apocynum cannabinum* (Indian-hemp), *Verbena hastata* (swamp verbena), *Symphotrichum puniceum* (purple-stem aster), *Doellingeria umbellata* (parasol whitetop), *Solidago rugosa* (wrinkleleaf goldenrod), *Solidago canadensis* (Canada goldenrod), *Solidago gigantea* (giant goldenrod), *Calamagrostis canadensis* (bluejoint), *Phalaris arundinacea* (reed canarygrass), *Scirpus expansus* (woodland bulrush), *Scirpus cyperinus* (woolgrass bulrush), *Thelypteris palustris* (eastern marsh fern), *Scutellaria lateriflora* (blue skullcap), *Dichanthelium clandestinum* (deer-tongue witchgrass), *Eupatorium maculatum* (spotted joe-pyeweed), *Eupatorium perfoliatum* (common boneset), *Elymus riparius* (riverbank wild rye), *Cyperus strigosus* (straw-colored flatsedge) and other *Cyperus* (flatsedge) spp., *Eleocharis* (spikerush) spp., *Lobelia cardinalis* (cardinal-flower), *Onoclea sensibilis* (sensitive fern), *Viola* (violet) spp., *Clematis virginiana* (virgin's-bower), *Polygonum amphibium* (water smartweed), *Polygonum hydropiper* (marsh-pepper knotweed), *Polygonum pennsylvanicum* (Pennsylvania smartweed), *Polygonum sagittatum* (arrowleaf tearthumb), *Polygonum persicaria* (spotted lady's-thumb), *Polygonum lapathifolium* (pale smartweed), *Schizachyrium scoparium* (little bluestem), *Andropogon gerardii* (big bluestem), and occasionally *Sanguisorba canadensis* (Canada burnet). Scattered, battered and stunted shrubs and trees can occur, including *Salix sericea* (silky willow), *Salix eriocephala* (Missouri willow), *Cornus amomum* (silky dogwood), *Betula nigra* (river birch), *Populus deltoides* (eastern cottonwood), and *Platanus occidentalis* (sycamore). Nonvascular plants can be sparse, but where present can include *Bryum* (bryum moss) spp.

Characteristic Species: *Apocynum cannabinum* (Indian-hemp), *Carex torta* (twisted sedge)

Dynamics/Successional Trajectory: These are highly dynamic communities with regular disturbance from flooding and ice-scour. Vegetation cover can be inversely proportional to inundation and scour.

Management Concerns: This association is particularly susceptible to invasive exotic species such as *Tussilago farfara* (colt's-foot), *Lythrum salicaria* (purple loosestrife), *Polygonum cuspidatum* (Japanese knotweed), *Polygonum persicaria* (spotted lady's-thumb), and *Microstegium vimineum* (Japanese stiltgrass). In addition, alteration in flow regime may affect the species composition and vegetation structure in this community.

Reference Sites: White Clay Creek, DE; Lycoming Creek, Lycoming County, PA

Global and State Conservation Ranks and Reasons: G4G5 (2-Feb-2005). DE: SNR, PA: SNR. This community is common in tributaries in the upper portions of watersheds. The rank within Pennsylvania is S3; considering its whole range, its rank should probably be changed to G5.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684638

References: Bowman 2000, Eastern Ecology Working Group n.d., Edinger et al. 2002, Metzler and Barrett 2001, Nichols et al. 2001, Perles et al. 2004, Sperduto and Nichols 2004, Swain and Kearsley 2000, Thompson 1996, Thompson and Sorenson 2000

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Carex torta</i> (twisted sedge)

ROCKY BAR AND SHORE (RIVERWEED TYPE)

Podostemum ceratophyllum Herbaceous Vegetation

Range: This community is wide-ranging, occurring in rivers throughout the eastern and southeastern United States. Over 140 occurrences of *Podostemum ceratophyllum* (riverweed) have been documented in the upper Delaware River (Kunsman 1994). Its distribution and abundance in the Delaware Estuary study area is significantly less than in the upper Delaware River in Pennsylvania.

Environmental Description: This association includes vegetation of shoals in rocky streambeds and riverbeds in mature drainage systems where the streams have cut down to rock, and the floodplain is relatively narrow; or on dams in moderately fast- to fast-flowing water. It tends to be associated with higher pH streams which cut through diabase, limestone or calcareous shales. In the Piedmont region and possibly elsewhere, the occurrence of macrophytic vegetation may be limited by unstable sediments, moderate to high gradients, and large variations in stream flow (Mulholland and Lenat 1992). *Podostemum* (riverweed) is one of the few vascular plants present in Piedmont streams and rivers.

Vegetation Description: This vegetation is almost always a monospecific community dominated by *Podostemum ceratophyllum* (riverweed) with no other vascular plants present; some Rhodophyta (red algae) may be present.

Characteristic Species: *Podostemum ceratophyllum* (riverweed)

Dynamics/Successional Trajectory: *Podostemum* (riverweed) appears to require relatively stable streamflow to accumulate significant biomass; at high nutrient levels filamentous green algae may outcompete it (Mulholland and Lenat 1992). Dense beds of this vegetation may serve as important substratum for a variety of invertebrates and other aquatic species (Nelson and Scott 1962). At least one rare species of snail of the Piedmont drainages, *Somatogyryus virginicus* (panhandle pebblesnail), appears to be very closely tied to the occurrence of good beds of *Podostemum* (riverweed) (B. Adams pers. comm.). Although it is not clear whether the snail is actually dependent on *Podostemum* (riverweed), it could be that *Podostemum* (riverweed) is just a good habitat indicator.

Management Concerns: *Podostemum ceratophyllum* (riverweed) is adversely affected by sedimentation and other water pollution, including acid mine drainage. It also appears to be sensitive to nutrient enrichment which may cause this species to be outcompeted by algae.

Reference Sites: Woodcock Bar and Arrow Island, Delaware Water Gap National Recreation Area, PA

Global and State Conservation Ranks and Reasons: G3G5 (19-Aug-2002). DE: SNR, NJ: SNR, PA: SNR. Although this species appears to have a fairly extensive range across the eastern United States, it is unclear whether all geographic areas supporting the species actually support stands of this association. Secondly, *Podostemum* may be in trouble across large parts of this range. It is very sensitive

to sedimentation and watershed erosion (Mulholland and Lenat 1992). These factors may have contributed to declines of this type in the Piedmont, where it has been lost from many areas historically occupied in drainages such as the Upper Neuse (B. Adams pers. comm.).

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685056

References: Adams pers. comm., Ambrose 1990a, Bowman 2000, Breden et al. 2001, CAP pers. comm. 1998, Campbell et al. 1990, Fleming et al. 2001, Harrison 2004, Hoagland 2000, Jones and Coile 1988, Kunsman 1994, Mulholland and Lenat 1992, Nelson 1986, Nelson and Scott 1962, Peet et al. unpubl. data 2002, Schafale 1998b, Schafale 2002, Schafale and Weakley 1990, Schmalzer and DeSelm 1982, Schotz pers. comm., Smith 1988b, Southeastern Ecology Working Group n.d., Sperduto 2000a, TDNH unpubl. data, Thomas and Allen 1993, Wharton 1978

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Submerged aquatic	Aquatic herb (floating & submergent)	<i>Podostemum ceratophyllum</i> (riverweed)

SUCCESSIONAL ASPEN - GRAY BIRCH FOREST

Populus tremuloides - *Betula populifolia* Forest

Range: This community occurs in Pennsylvania in the Delaware Estuary.

Environmental Description: This is an early-successional forest type, commonly found on former agricultural land, in areas of ice-scour along streambanks, and where there has been major disturbance resulting in areas of exposed mineral soil. This type may also result from forestry practices that maintain an early-successional stage.

Vegetation Description: This type is frequently mixed, but sometimes occurs in nearly pure stands of one of the named species. The birch may be *Betula papyrifera* (paper birch) on more northern sites, or *Betula populifolia* (gray birch) and occasionally *Betula lenta* (sweet birch). The aspen may be *Populus grandidentata* (bigtooth aspen) or *Populus tremuloides* (quaking aspen). Associates include *Sassafras albidum* (sassafras), *Acer* (maple) spp., and *Prunus* (plum, cherry) spp.



Photo by Pennsylvania Natural Heritage Program

Characteristic Species: *Betula populifolia* (gray birch), *Populus tremuloides* (quaking aspen)

Dynamics/Successional Trajectory: Successional trajectory is uncertain and may be controlled by availability of propagules from adjacent forest stands.

Management Concerns: Not a conservation target, early-successional community typical of disturbed land.

Reference Sites: Fort Indiantown Gap National Guard Training Center, Lebanon County, PA; Delaware Water Gap National Recreation Area; Valley Forge National Historical Park

Global and State Conservation Ranks and Reasons: GNR (8-Jul-1999). PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688070

References: Eastern Ecology Working Group n.d., Fike 1999

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Populus tremuloides</i> (quaking aspen)

WATER-WILLOW ROCKY BAR AND SHORE

Justicia americana Herbaceous Vegetation

Range: This type is found primarily in the Piedmont, Interior Low Plateau, Cumberland Plateau, Ozarks, Ouachita Mountains, and adjacent provinces. It ranges from Alabama, Georgia and the Carolinas west to Arkansas and Oklahoma and north to Ohio, Pennsylvania, and Delaware. It occurs in Pennsylvania's portion of the Delaware Estuary.

Environmental Description:

This association occurs on the heads of islands, along the edges of bars, banks, terraces and spits, and in shallow sections of river channels. The lower portion of the *Justicia* (water-willow) stems are under water for most of the year, with the tops of the plants emerging above the flowing water. These beds are entirely submerged by most flood events. During extreme low water periods, the soil below the beds can be exposed, showing a varied mixture of sand, gravel, cobbles, silt, and/or muck.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: *Justicia americana* (American water-willow) is the characteristic dominant. Since *Justicia americana* (American water-willow) spreads by rhizomes, it can form extensive monocultural colonies. *Saururus cernuus* (lizard's-tail) is often present and may be codominant. Other herbaceous species that may be present include *Diodia teres* (rough buttonweed), *Leersia oryzoides* (rice cutgrass), *Lemna minor* (lesser duckweed), *Podostemum ceratophyllum* (riverweed), *Scirpus* (bulrush) sp., *Schoenoplectus pungens* (common threesquare), *Cyperus* (flatsedge) spp., and *Eleocharis* (spikerush) spp. Exotics include *Lythrum salicaria* (purple loosestrife) and *Lysimachia vulgaris* (garden loosestrife). In some areas, *Justicia* (water-willow) usually grows in nearly pure patches, so that few other species are associated with it. *Hibiscus laevis* (halberd-leaf rosemallow), *Polygonum amphibium* (water smartweed), *Rorippa sylvestris* (creeping yellowcress), *Bidens* (beggarticks) spp., *Cuscuta gronovii* (scaldweed), *Mimulus ringens* (Allegheny monkeyflower), *Polygonum* (smartweed, knotweed) spp., *Rumex* (dock, sorrel) spp., and *Salix interior* (sandbar willow) can occur (Anderson 1982). A few scattered seedlings may be present, including *Betula nigra* (river birch), *Salix* (willow) spp., *Acer saccharinum* (silver maple), and *Platanus occidentalis* (sycamore).

Characteristic Species: *Justicia americana* (American water-willow)

Dynamics/Successional Trajectory: Stands in some situations may be obliterated by ongoing river channeling. Anderson (1982) describes some of the life-history characteristics of *Justicia americana* (American water-willow) that allow it to persist in river channels.

Management Concerns: This association is susceptible to invasion by *Lythrum salicaria* (purple loosestrife) and *Lysimachia vulgaris* (garden loosestrife).

Reference Sites: Dark Hollow County Park, Bucks County, PA

Global and State Conservation Ranks and Reasons: G4G5 (12-Sep-1997). PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685634

References: Allard 1990, Anderson 1982, Anderson 1996, Fike 1999, Fleming et al. 2001, Harrison 2004, Hoagland 1997, Hoagland 2000, Major et al. 1999, McCoy 1958, Nelson 1986, OHNHD unpubl. data, Palmer-Ball et al. 1988, Peet et al. unpubl. data 2002, Penfound 1953, Perles et al. 2004, Schafale 1998b, Schafale 2002, Schafale and Weakley 1990, Schmalzer and DeSelm 1982, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data, TNC and WPC 2004

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Forb	<i>Justicia americana</i> (American water-willow)
Herb (field)	Forb	<i>Saururus cernuus</i> (lizard's-tail)

WILLOW RIVER-BAR SHRUBLAND

Salix nigra / *Carex torta* Temporarily Flooded Shrubland

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



Photo by Pennsylvania Natural Heritage Program

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* (sycamore), *Salix eriocephala* (Missouri willow), *Salix sericea* (silky willow), *Alnus incana* (speckled alder), *Alnus serrulata* (smooth alder), *Alnus viridis* (green alder) (infrequent), *Cornus amomum* (silky dogwood), *Cornus sericea* (red-osier dogwood), *Spiraea alba* var. *latifolia* (broadleaf meadowsweet), *Platanus occidentalis* (sycamore), and *Populus deltoides* (eastern cottonwood). The herbaceous layer is typically sparse with variable composition, including *Carex torta* (twisted sedge), *Carex trichocarpa* (hairy-fruit sedge), *Panicum dichotomiflorum* (fall panicgrass), *Dichanthelium clandestinum* (deer-tongue witchgrass), *Echinochloa crus-galli* (large barnyard grass), *Phalaris arundinacea* (reed canarygrass), *Calamagrostis canadensis* (bluejoint), *Apocynum cannabinum* (Indian-hemp), *Agrostis* (bentgrass) spp., *Solidago gigantea* (giant goldenrod), *Solidago rugosa* (wrinkleleaf goldenrod), *Eupatorium maculatum* (spotted joe-pyeweed), *Lysimachia terrestris* (swamp-candles), *Polygonum* (smartweed, knotweed) spp., and *Bidens* (beggarticks) spp. Invasive, exotic species can be problematic in this community, including *Polygonum cuspidatum* (Japanese knotweed), *Tussilago farfara* (colt's-foot), and *Cynanchum louiseae* (black 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

Global and State Conservation Ranks and Reasons: GNR (25-Mar-2003). PA: SNR.

VegBank Link for Plot Data: 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, 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)

ECOLOGICAL SYSTEM: LAURENTIAN-ACADIAN FRESHWATER MARSH

Summary: These freshwater emergent and/or submergent marshes are dominated by herbaceous vegetation. They are common throughout the northeastern United States and adjacent Canadian provinces. Freshwater marshes occur in closed or open basins that are generally flat and shallow. They are associated with lakes, ponds, slow-moving streams, and/or impoundments or ditches. The herbaceous vegetation does not persist through the winter. Scattered shrubs are often present and usually total less than 25% cover. Trees are generally absent and, if present, are scattered. The substrate is typically muck over mineral soil. Examples of vegetation in the Delaware Estuary freshwater marsh communities include *Typha latifolia* (broadleaf cattail), *Typha angustifolia* (narrowleaf cattail), *Phragmites australis* (common reed), *Schoenoplectus americanus* (chairmaker's bulrush), *Thelypteris palustris* (eastern marsh fern), *Impatiens capensis* (orange jewelweed), *Carex* (sedge) spp., *Vallisneria americana* (tape-grass), *Potamogeton perfoliatus* (clasping-leaf pondweed), *Nuphar lutea ssp. advena* (broadleaf pond-lily), and *Nymphaea odorata* (white water-lily).

Range: This system occurs in New England and northern New York west across the upper Great Lakes to Minnesota, and adjacent Canada, southward to Pennsylvania, New Jersey, and Ohio; mostly north of the glacial boundary. United States: CT, IL?, IN?, MA, ME, MI, MN, NH, NJ, NY, OH?, PA, VT, WI

Delaware Estuary Associations:

- Bulrush Deepwater Marsh
- Dogwood - Willow Swamp
- Eastern Cattail Marsh
- Eastern Reed Marsh
- Northeastern Leafy Forb Marsh
- Open Water Marsh with Mixed Submergents/Emergents
- Water-lily Aquatic Wetland
- Woolgrass Marsh

Similar Ecological Systems in the Delaware Estuary:

- Laurentian-Acadian Wet Meadow-Shrub Swamp

CLASSIFIERS FOR LAURENTIAN-ACADIAN FRESHWATER MARSH

Primary Division: 201

Land Cover Class: Herbaceous Wetland

Spatial Scale & Pattern: Large patch

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

Diagnostic Classifiers: Depressional [Lakeshore]; Riverine / Alluvial; Graminoid; Shallow (<15 cm) Water;

>180-day hydroperiod

Non-diagnostic Classifiers: Herbaceous; Extensive Wet Flat; Depressional [Pond]; Muck; Aquatic Herb;

Circumneutral Water; Acidic Water; Moderate (100-500 yrs) Persistence

BULRUSH DEEPWATER MARSH

Schoenoplectus (tabernaemontani, acutus) Eastern Herbaceous Vegetation

Range: This variable deepwater marsh community occurs in the northeastern United States and adjacent Canadian provinces. It occurs in the Pennsylvania portion of the Delaware Estuary.

Environmental Description: These deepwater bulrush marshes occur across the northeastern United States and adjacent Canadian provinces. They are found in a variety of wetland settings, most commonly in quiet-water areas along the shores of ponds, lakes, rivers, and larger streams, but also in flooded basins and ditches. The



Photo by Pennsylvania Natural Heritage Program

vegetation occurs in deep water (usually 0.4-1 m deep) that is present in all but the driest of conditions. Seasonal spring flooding and heavy rainstorms provide nutrient input. The substrate is usually deep muck overlying mineral soil; where wave action is more prevalent, the mineral soil may be exposed.

Vegetation Description: The vegetation is dominated by bulrushes and robust graminoids, with scattered emergent forbs. Trees and shrubs are absent. Dominant species are usually *Schoenoplectus acutus* (hardstem bulrush), *Schoenoplectus tabernaemontani* (softstem bulrush), and/or *Schoenoplectus americanus* (chairmaker's bulrush). Associated herbs include *Carex aquatilis* (aquatic sedge), *Carex pellita* (woolly sedge), *Carex utriculata* (beaked sedge), *Thelypteris palustris* (eastern marsh fern), *Typha latifolia* (broadleaf cattail), *Asclepias incarnata* (swamp milkweed), *Impatiens capensis* (orange jewelweed), *Pontederia cordata* (pickerelweed), *Sagittaria latifolia* (broadleaf arrowhead), *Schoenoplectus fluviatilis* (river bulrush), *Scutellaria lateriflora* (blue skullcap), *Verbena hastata* (swamp verbena), and others. Floating-leaved and submerged plants (such as *Potamogeton* (pondweed) spp., *Sparganium* (bur-reed) spp., *Elodea canadensis* (Canadian waterweed), *Ceratophyllum* (coontail) spp.) may be scattered among the emergent plants.

Characteristic Species: *Schoenoplectus acutus* (hardstem bulrush), *Schoenoplectus tabernaemontani* (softstem bulrush)

Management Concerns: This association is susceptible to invasion by the exotic plant species *Lythrum salicaria* (purple loosestrife).

Reference Sites: No reference sites were identified.

Global and State Conservation Ranks and Reasons: GNR (1-Dec-1997). DE: SNR, NJ: S2S4, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.683450

References: Bowman 2000, Breden et al. 2001, CAP pers. comm. 1998, Clancy 1996, Cowardin et al. 1979, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Gawler 2002, Harrison 2004, Hill 1923, Northern Appalachian Ecology Working Group 2000, Sperduto 2000b, Swain and Kearsley 2000, Thompson 1996, Thompson and Sorenson 2000

MOST ABUNDANT SPECIES			
STRATUM	LIFEFORM	SPECIES	
Herb (field) bulrush)	Graminoid	<i>Schoenoplectus</i>	<i>americanus</i> (chairmaker's)
Herb (field) bulrush)	Graminoid	<i>Schoenoplectus</i>	<i>tabernaemontani</i> (softstem)

DOGWOOD - WILLOW SWAMP

Cornus sericea - *Salix* spp. - (*Rosa palustris*) Shrubland

Range: This dogwood - willow shrub swamp community type is found in the upper midwestern region of the United States and adjacent Canada, ranging from Minnesota east to western New York and Ontario, south to Illinois and Pennsylvania. In the Delaware Estuary, this type occurs in Pennsylvania.



Photo by Pennsylvania Natural Heritage Program

Environmental Description: Stands are found along streams and lakes, or in upland depressions. Hydrology is variable, but is typically seasonally flooded. Soils are wet, organic, and minerotrophic, with either highly decomposed peat or fine mineral soils (Curtis 1959, Harris et al. 1996). The vegetation is dominated by tall shrubs between 1 and 3 m tall, with at least 25% cover, and often very dense (>60% cover). More open stands may have high graminoid cover. Trees may be scattered but cover less than 25%.

Vegetation Description: Composition of the shrub layer is quite diverse, primarily due to the diversity of *Salix* (willow) spp., which collectively share dominance with *Cornus amomum* (silky dogwood), less often with *Cornus racemosa* (gray dogwood) or *Cornus sericea* (red-osier dogwood). Willow species include *Salix nigra* (black willow), *Salix bebbiana* (long-beak willow), *Salix discolor* (pussy willow), *Salix eriocephala* (Missouri willow), *Salix exigua* (coyote willow), *Salix fragilis* (crack willow), *Salix petiolaris* (meadow willow), and *Salix sericea* (silky willow). Other shrub associates include *Cephalanthus occidentalis* (common buttonbush) (southeastward), *Ribes americanum* (wild black currant), *Rosa palustris* (swamp rose) (more common eastward), *Rosa blanda* (smooth rose), *Sambucus canadensis* (American elder), *Spiraea alba* (white meadowsweet), and *Viburnum lentago* (nannyberry). Woody vines present include *Clematis virginiana* (virgin's-bower), *Parthenocissus quinquefolia* (Virginia creeper), and *Toxicodendron radicans* (eastern poison-ivy). Characteristic herbs include *Asclepias incarnata* (swamp milkweed), *Symphyotrichum lanceolatum* var. *lanceolatum* (swamp aster), *Calamagrostis canadensis* (bluejoint), *Eupatorium maculatum* (spotted joe-pyeweed), *Glyceria striata* (fowl mannagrass), *Impatiens capensis* (orange jewelweed), *Lycopus americanus* (American water-horehound), *Lycopus uniflorus* (northern bugleweed), *Phalaris arundinacea* (reed canarygrass), *Solidago gigantea* (giant goldenrod), and *Thalictrum dasycarpum* (purple meadowrue). A variety of sedges may dominate more open stands, including *Carex lacustris* (lake sedge) and *Carex stricta* (tussock sedge). Tree species include *Acer rubrum* (red maple), *Fraxinus pennsylvanica* (green ash), and *Ulmus americana* (American elm) (Curtis 1959, White and Madany 1978, Chapman et al. 1989, Reschke 1990, MNNHP 1993, Harris et al. 1996).

Characteristic Species: *Asclepias incarnata* (swamp milkweed), *Cornus amomum* (silky dogwood), *Salix bebbiana* (long-beak willow), *Salix discolor* (pussy willow), *Salix nigra* (black willow)

Dynamics/Successional Trajectory: Shrub swamps may naturally succeed herbaceous wet meadows as part of successional series in lakes and ponds. They may also originate from clearing of forested swamps (Curtis 1959), or draining of wet meadows (MNNHP 1993). Such open herbaceous meadows may first succeed to a shrubby meadow before becoming a dense shrub swamp.

Management Concerns: Infrequent fires may have maintained shrub swamps in the western part of the range, preventing tree canopy closure (MNNHP 1993).

Reference Sites: Great Marsh, Chester County, PA

Global and State Conservation Ranks and Reasons: G5 (3-Oct-1996). PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686190

References: Anderson 1996, Bakowsky and Lee 1996, Borowitz and Stephenson 1985, Chapman 1986, Curtis 1959, Edinger et al. 2002, Harris et al. 1996, Lee et al. 1998, MNNHP 1993, Midwestern Ecology Working Group n.d., Reschke 1990, WINHIP unpubl. data, White and Madany 1978

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 bebbiana</i> (long-beak willow)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Salix discolor</i> (pussy willow)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Salix nigra</i> (black willow)

EASTERN CATTAIL MARSH

Typha (angustifolia, latifolia) - (*Schoenoplectus* spp.) Eastern Herbaceous Vegetation

Range: These tall emergent marshes are common throughout the northeastern United States and adjacent Canadian provinces. They occur in New Jersey, Pennsylvania, and Delaware in the Delaware Estuary.

Environmental Description: This community occurs in permanently flooded basins, often as part of a larger wetland mosaic and associated with lakes, ponds, or slow-moving streams. The substrate is muck over mineral soil. Lacustrine cattail marshes typically have a muck-bottom zone bordering the shoreline, where cattails are rooted in the bottom substrate, and a floating mat zone, where the roots grow suspended in a buoyant peaty mat. This association is often found in impounded waters.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: Tall graminoids dominate the vegetation; scattered shrubs are often present (usually totaling less than 25% cover) and are frequently shorter than the graminoids. Trees are absent. Bryophyte cover varies and is rarely extensive; bryophytes are mostly confined to the hummocks. *Typha angustifolia* (narrowleaf cattail), *Typha latifolia* (broadleaf cattail), or their hybrid *Typha X glauca* (blue cattail) dominate, either alone or in combination with other tall emergent marsh species. Associated species vary widely; sedges, such as *Carex lurida* (sallow sedge), *Carex pellita* (woolly sedge), *Scirpus cyperinus* (woolgrass bulrush), and bulrushes, such as *Schoenoplectus americanus* (chairmaker's bulrush) and *Schoenoplectus acutus* (hardstem bulrush), occur along with patchy grasses, such as *Calamagrostis canadensis* (bluejoint). Broad-leaved herbs include *Thelypteris palustris* (eastern marsh

fern), *Asclepias incarnata* (swamp milkweed), *Impatiens capensis* (orange jewelweed), *Sagittaria latifolia* (broadleaf arrowhead), *Scutellaria lateriflora* (blue skullcap), *Sparganium eurycarpum* (giant bur-reed), and *Verbena hastata* (swamp verbena). Floating aquatics such as *Lemna minor* (lesser duckweed) may be common in deeper zones. Shrub species vary across the geographic range of this type; in the northern part of its range, *Ilex verticillata* (common winterberry) and *Spiraea alba* (white meadowsweet) are common.

Characteristic Species: *Typha angustifolia* (narrowleaf cattail), *Typha latifolia* (broadleaf cattail)

Dynamics/Successional Trajectory: This association is often found in impounded waters and detention basins.

Management Concerns: The invasive exotic plants *Lythrum salicaria* (purple loosestrife) and *Phragmites australis* (common reed) may be abundant in parts of some occurrences.

Reference Sites: Quakertown Swamp, State Game Lands 139, Bucks County, PA

Global and State Conservation Ranks and Reasons: G5 (1-Dec-1997). DE: SNR, NJ: S5, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685511

References: Breden 1989, Breden et al. 2001, CAP pers. comm. 1998, Clancy 1996, Cowardin et al. 1979, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Gawler 2002, Grace and Wetzel 1981, Harrison 2004, Metzler and Barrett 2001, Northern Appalachian Ecology Working Group 2000, Rawinski 1984, Sperduto and Nichols 2004, Swain and Kearsley 2001, Thompson 1996, Thompson and Sorenson 2000

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Typha angustifolia</i> (narrowleaf cattail)
Herb (field)	Graminoid	<i>Typha latifolia</i> (broadleaf cattail)
Herb (field)	Graminoid	<i>Typha x glauca</i> (blue cattail)

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.

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.



Photo by Linda Kelly

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: 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

References: Bailey 1997, Bailey 1998, 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)

NORTHEASTERN LEAFY FORB MARSH

Pontederia cordata - *Peltandra virginica* - *Sagittaria latifolia* Herbaceous Vegetation

Range: This association occurs in the northeastern United States. It occurs in New Jersey and Pennsylvania in the Delaware Estuary.

Environmental Description: This association occurs along pondshores, lakeshores, impoundments, and quiet riverbanks in shallow to deep standing water usually on muck soils.

Vegetation Description: Common species include *Pontederia cordata* (pickerelweed), *Sagittaria latifolia* (broadleaf arrowhead), *Peltandra virginica* (green arrow-arum), and *Sparganium* (bur-reed) spp.

Additional emergent species include *Eleocharis palustris* (marsh spikerush), *Schoenoplectus tabernaemontani* (softstem bulrush), *Acorus calamus* (sweetflag), *Nuphar lutea ssp. variegata* (variegated yellow pond-lily), *Nymphaea odorata* (white water-lily), *Sium suave* (hemlock water-parsnip), and submerged species including *Ceratophyllum demersum* (coontail) and *Utricularia macrorhiza* (greater bladderwort). This community is closely related to Freshwater Tidal Marsh, *Peltandra virginica* - *Pontederia cordata* Tidal Herbaceous Vegetation (CEGL004706).

Characteristic Species: *Peltandra virginica* (green arrow-arum), *Pontederia cordata* (pickerelweed), *Sagittaria latifolia* (broadleaf arrowhead)



Photo by Pennsylvania Natural Heritage Program

Dynamics/Successional Trajectory: This community represents a stage of lake-infill succession, replacing floating-leaved vegetation as the lake depth becomes shallower. Overtime, additional accumulation of sediment and organic material will allow shallow emergent vegetation (especially graminoids) to colonize the substrate and displace this community type. In riverine systems, occasional scouring and reshaping of channel beds during flood events may reset successional sequences by creating and destroying conditions suitable for this community. In man-made impoundments, this plant community may be intentionally managed for through water-level manipulations.

Management Concerns: This community is less prone to invasion by exotic plants under normal conditions due to water depth. Changes in hydrology, especially greatly deeper or shallower water levels would adversely affect this community.

Reference Sites: John Heinz National Wildlife Refuge, Delaware County, PA; this community occurs in NJ, but reference sites have not been identified there.

Global and State Conservation Ranks and Reasons: G5 (19-Jan-2006). NJ: SNR, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685246

References: Cowardin et al. 1979, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Gawler 2002, Metzler and Barrett 2001, Rawinski 1984, Sperduto 2000a, Swain and Kearsley 2000, Thompson 1996, Thompson and Sorenson 2000

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Forb	<i>Peltandra virginica</i> (green arrow-arum)
Herb (field)	Forb	<i>Pontederia cordata</i> (pickerelweed)
Herb (field)	Forb	<i>Sagittaria latifolia</i> (broadleaf arrowhead)

OPEN WATER MARSH WITH MIXED SUBMERGENTS/EMERGENTS

Vallisneria americana - *Potamogeton perfoliatus* Herbaceous Vegetation

Range: This aquatic vegetation occurs in sheltered bays of the northeastern United States. This community occurs in all three states in the Delaware Estuary. It has been documented as relatively common in the Delaware River between the confluences of the Lackawaxen River and Slateford Creek with the Delaware River. However, it may be relatively uncommon in other sections of the river (Kunsman 1994).

Environmental Description: This aquatic vegetation of sheltered bays of the northeastern United States occurs on lakes and streams where it is not highly disturbed by wave action. In rivers and streams, this vegetation type is often found in pools or sections of slow-moving water, typically with a sandy substrate.

Vegetation Description: The vegetation is dominated by submergent or emergent plants with only minor floating-leaved components. Characteristic species may include *Vallisneria americana* (tape-grass), *Potamogeton perfoliatus* (clasping-leaf pondweed), *Potamogeton epihydrus* (ribbonleaf pondweed), *Potamogeton nodosus* (longleaf pondweed), *Heteranthera dubia* (grassleaf mud-plantain), *Heteranthera reniformis* (kidneyleaf mud-plantain), *Myriophyllum* (water-milfoil) spp., *Elodea canadensis* (Canadian waterweed), and *Utricularia* (bladderwort) spp.

Characteristic Species: *Potamogeton perfoliatus* (clasping-leaf pondweed), *Vallisneria americana* (tape-grass)

Management Concerns: This aquatic vegetation could be negatively impacted by alteration in flow regimes due to dam releases. Siltation, nutrient inputs, and major pollution spills also have the potential

to negatively impact this association. Frequent, concentrated human recreation at access points and camping areas can have deleterious effects on localized examples of this type. The exotic plant species *Potamogeton crispus* (curly pondweed) and *Myriophyllum spicatum* (Eurasian water-milfoil) have been documented in this community and have the potential to outcompete the native species associated with this type (Kunsman 1994).

Reference Sites: Potomack, NJ; near Woodcock Bar in the Delaware Water Gap National Recreation Area, PA

Global and State Conservation Ranks and Reasons: G5 (1-Dec-1997). DE: S4?, NJ: S4, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684294

References: Bowman 2000, Breden et al. 2001, CAP pers. comm. 1998, Eastern Ecology Working Group n.d., Gawler 2002, Harrison 2004, Kunsman 1994, Metzler and Barrett 2004

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Floating aquatic	Aquatic herb (floating & submergent)	<i>Potamogeton perfoliatus</i> (clasping-leaf pondweed)

WATER-LILY AQUATIC WETLAND

Nuphar lutea ssp. *advena* - *Nymphaea odorata* Herbaceous Vegetation

Range: This rooted aquatic community occupies shallow, quiet waters throughout the central and eastern United States, extending from Maine to Ontario and Minnesota, south to Oklahoma and east to Georgia. In the Delaware Estuary, this pond community occurs on the Inner Coastal Plain of Pennsylvania, New Jersey and Delaware.

Environmental Description: This community occupies shallow water depressions, oxbow ponds, and backwater sloughs of river floodplains, ponds, and small lakes.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: This community is dominated by rooted, floating-leaved aquatic species, with both submergent and emergent aquatics also present. *Nuphar lutea* ssp. *advena* (broadleaf pond-lily) and *Nymphaea odorata* (white water-lily) can be dominants. Other species present include *Brasenia schreberi* (watershield), various *Potamogeton* (pondweed) spp., *Polygonum amphibium* (water smartweed), *Sparganium* (bur-reed) spp., *Sagittaria latifolia* (broadleaf arrowhead), *Alisma* (water-plantain) spp., *Schoenoplectus tabernaemontani* (softstem bulrush), *Peltandra virginica* (green arrow-arum), and *Polygonum amphibium* var. *emersum* (water smartweed) (Anderson 1982). Submerged aquatic species more common in the southern part of the range include *Cabomba caroliniana* (Carolina fanwort), *Ceratophyllum demersum* (coontail), and *Heteranthera dubia* (grassleaf mud-plantain). This broadly conceived type may include ponds, or zones of ponds, dominated by *Nymphaea odorata* (white water-lily), with or without *Nuphar lutea* ssp. *advena* (broadleaf pond-lily).

Characteristic Species: *Nuphar lutea* ssp. *advena* (broadleaf pond-lily), *Nymphaea odorata* (white water-lily)

Management Concerns: This is not a rare or imperiled vegetation type, even though its occurrence is poorly documented. Stands may occur in natural lakes and ponds or in artificial impoundments.

Reference Sites: Swatara State Park, PA; Schuylkill County, PA

Global and State Conservation Ranks and Reasons: G4G5 (15-Oct-2002). DE: SNR, NJ: S4, PA: SNR. The dominant species in stands of this vegetation are widespread across the eastern and central United States and adjacent Canada.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686226

References: Ambrose 1990a, Anderson 1982, Breden et al. 2001, Clancy 1996, FNAI 1990, Fike 1999, Fleming et al. 2001, Foti et al. 1994, Gawler 2002, Harrison 2004, Hoagland 2000, INAI unpubl. data, Midwestern Ecology Working Group n.d., NAP pers. comm. 1998, NatureServe Ecology - Southeastern U.S. unpubl. data, Peet et al. unpubl. data 2002, Penfound 1953, Rawinski 1984, Schafale and Weakley 1990, Schmalzer and DeSelm 1982, Schotz pers. comm., Sperduto and Nichols 2004, Swain and Kearsley 2001, TDNH unpubl. data, Thompson and Jenkins 1992, WINHIP unpubl. data, Zanoni et al. 1979

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Floating aquatic	Aquatic herb (floating & submergent)	<i>Nuphar lutea</i> ssp. <i>advena</i> (broadleaf pond-lily)

WOOLGRASS MARSH

Scirpus cyperinus Seasonally Flooded Herbaceous Vegetation

Range: These marshes occur in Pennsylvania within the Delaware Estuary.

Environmental Description: This community consists of seasonally flooded marshes.

Vegetation Description: This community is dominated or characterized by *Scirpus cyperinus* (woolgrass bulrush). The vegetation composition is variable. Associated species include *Glyceria* (mannagrass) spp., *Thelypteris palustris* (eastern marsh fern), as well as other species of *Scirpus* (bulrush), including *Scirpus microcarpus* (red-tinge bulrush) and *Scirpus atrovirens* (green bulrush).



Photo by Pennsylvania Natural Heritage Program

Characteristic Species: *Scirpus cyperinus* (woolgrass bulrush)

Reference Sites: No sites identified in PA.

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687973

References: Breden et al. 2001, Cowardin et al. 1979, Eastern Ecology Working Group n.d., Fike 1999, Gawler 2002, Harrison 2004

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Scirpus cyperinus</i> (woolgrass bulrush)

ECOLOGICAL SYSTEM: LAURENTIAN-ACADIAN WET MEADOW-SHRUB SWAMP

Summary: This system encompasses shrub swamps and wet meadows on mineral soils of the Northeast and upper Midwest. They are often associated with lakes and ponds, but are also found along streams, where the water level does not fluctuate greatly. They are commonly flooded for part of the growing season but often do not have standing water throughout the season. The size of occurrences ranges from small pockets to extensive acreages. The system can have a patchwork of shrub and graminoid dominance; typical species include *Salix* (willow) spp., *Cornus amomum* (silky dogwood), *Alnus incana* (speckled alder), *Spiraea alba* (white meadowsweet), *Calamagrostis canadensis* (bluejoint), tall *Carex* (sedge) spp., and *Juncus effusus* (soft rush). Trees are generally absent and, if present, are scattered.

High-ranked Species: *Calephelis muticum* (G3, swamp metalmark), *Clonophis kirtlandii* (G2, kirtland's snake), *Eleocharis nitida* (G3G4, slender spikerush), *Platanthera leucophaea* (G3, prairie white fringed orchid), *Polemonium vanbruntiae* (G3G4, bog jacob's-ladder), *Scirpus ancistrochaetus* (G3, barbed-bristle bulrush)

Range: New England and northern New York west across the upper Great Lakes to Minnesota, and adjacent Canada, southward to Pennsylvania and Ohio; mostly north of the glacial boundary. United States: CT, IL?, IN?, MA, ME, MI, MN, NH, NY, OH?, PA, VT, WI

Delaware Estuary Associations:

- Bluejoint Wet Meadow
- Dogwood - Willow Swamp
- Eastern Reed Marsh
- Eastern Tussock Sedge Meadow
- Reed Canarygrass Eastern Marsh
- Seasonally Flooded Mixed Graminoid Meadow
- Speckled Alder Swamp
- Willow River-Bar Shrubland
- Woolgrass Marsh

Similar Ecological Systems in the Delaware Estuary:

- Laurentian-Acadian Freshwater Marsh

CLASSIFIERS FOR LAURENTIAN-ACADIAN WET MEADOW-SHRUB SWAMP

Primary Division: 201

Land Cover Class: Herbaceous Wetland

Spatial Scale & Pattern: Large patch

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

Diagnostic Classifiers: Depressional [Lakeshore]; Riverine / Alluvial; Broad-Leaved Shrub; Graminoid; Shallow

(<15 cm) Water

Non-diagnostic Classifiers: Herbaceous; Extensive Wet Flat; Depressional [Pond]; Muck; Circumneutral Water;

Acidic Water; Moderate (100-500 yrs) Persistence

BLUEJOINT WET MEADOW

Calamagrostis canadensis - *Phalaris arundinacea* Herbaceous Vegetation

Range: This wet meadow vegetation is widely distributed in the northeastern and midwestern United States and south-central and southeastern Canada. It ranges from Maine south to West Virginia and possibly Virginia and west to Minnesota.

Environmental Description: Stands occur on the floodplains of small streams, in poorly drained depressions, beaver meadows, and lakeshores. Soils are typically mineral soil or well-decomposed peat, with a thick root mat. Water regime varies between temporarily and seasonally flooded.

Vegetation Description: Graminoid cover is typically dense, and can form hummocky microtopography. *Calamagrostis canadensis* (bluejoint) is dominant, often occurring in almost pure stands or with tall sedges, such as *Carex aquatilis* (aquatic sedge), *Carex lacustris* (lake sedge), *Carex rostrata* (swollen-beak sedge), and *Carex stricta* (tussock sedge). In fen transitions, *Carex lasiocarpa* (wiregrass sedge) can be present. *Agrostis gigantea* (giant bentgrass), *Glyceria grandis* (American mannagrass), *Poa palustris* (fowl bluegrass), *Scirpus cyperinus* (woolgrass bulrush), and *Typha latifolia* (broadleaf cattail) are sometimes abundant. Forbs include *Campanula aparinoides* (marsh bellflower), *Epilobium leptophyllum* (bog willowherb), *Eupatorium maculatum* (spotted joe-pyeweed), *Iris versicolor* (harlequin blueflag), *Polygonum amphibium* (water smartweed), and *Comarum palustre* (purple marshlocks). Scattered shrubs, such as *Viburnum nudum* (wild raisin), *Viburnum dentatum* (southern arrow-wood), *Spiraea alba* (white meadowsweet), *Alnus incana* (speckled alder), or *Alnus serrulata* (smooth alder), may be present.

Characteristic Species: *Calamagrostis canadensis* (bluejoint)

Reference Sites: No reference site identified in PA; NJ needs to confirm if in estuary and locations of reference sites.

Global and State Conservation Ranks and Reasons: G4G5 (31-Mar-2000). DE: SNR, NJ: SNR, PA: SNR. This type is widespread throughout the northeastern and upper midwestern United States and central/southern Canada.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687162

References: Breden et al. 2001, CAP pers. comm. 1998, Cowardin et al. 1979, Eastern Ecology Working Group n.d., Fike 1999, Gawler 2002, Harris et al. 1996, Harrison 2004, Metzler and Barrett 2001, NAP pers. comm. 1998, Rawinski 1984, Swain and Kearsley 2001, TDNH unpubl. data, Thompson 1996, Thompson and Sorenson 2000, WINHIP unpubl. data

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Calamagrostis canadensis</i> (bluejoint)

DOGWOOD - WILLOW SWAMP

Cornus sericea - *Salix* spp. - (*Rosa palustris*) Shrubland

Range: This dogwood - willow shrub swamp community type is found in the upper midwestern region of the United States and adjacent Canada, ranging from Minnesota east to western New York and Ontario, south to Illinois and Pennsylvania. In the Delaware Estuary, this type occurs in Pennsylvania.

Environmental Description: Stands are found along streams and lakes, or in upland depressions. Hydrology is variable, but is typically seasonally flooded. Soils are wet, organic, and minerotrophic, with either highly decomposed peat or fine mineral soils (Curtis 1959, Harris et al. 1996). The vegetation is dominated by tall shrubs between 1 and 3 m tall, with at least 25% cover, and often very dense (>60% cover). More open stands may have high graminoid cover. Trees may be scattered but cover less than 25%.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: Composition of the shrub layer is quite diverse, primarily due to the diversity of *Salix* (willow) spp., which collectively share dominance with *Cornus amomum* (silky dogwood), less often with *Cornus racemosa* (gray dogwood) or *Cornus sericea* (red-osier dogwood). Willow species include *Salix nigra* (black willow), *Salix bebbiana* (long-beak willow), *Salix discolor* (pussy willow), *Salix eriocephala* (Missouri willow), *Salix exigua* (coyote willow), *Salix fragilis* (crack willow), *Salix petiolaris* (meadow willow), and *Salix sericea* (silky willow). Other shrub associates include *Cephalanthus occidentalis* (common buttonbush) (southeastward), *Ribes americanum* (wild black currant), *Rosa palustris* (swamp rose) (more common eastward), *Rosa blanda* (smooth rose), *Sambucus canadensis* (American elder), *Spiraea alba* (white meadowsweet), and *Viburnum lentago* (nannyberry). Woody vines present include *Clematis virginiana* (virgin's-bower), *Parthenocissus quinquefolia* (Virginia creeper), and *Toxicodendron radicans* (eastern poison-ivy). Characteristic herbs include *Asclepias incarnata* (swamp milkweed), *Symphyotrichum lanceolatum* var. *lanceolatum* (swamp aster), *Calamagrostis canadensis* (bluejoint), *Eupatorium maculatum* (spotted joe-pyeweed), *Glyceria striata* (fowl mannagrass), *Impatiens capensis* (orange jewelweed), *Lycopus americanus* (American water-horehound), *Lycopus uniflorus* (northern bugleweed), *Phalaris arundinacea* (reed canarygrass), *Solidago gigantea* (giant goldenrod), and *Thalictrum dasycarpum* (purple meadowrue). A variety of sedges may dominate more open stands, including *Carex lacustris* (lake sedge) and *Carex stricta* (tussock sedge). Tree species include *Acer rubrum* (red maple), *Fraxinus pennsylvanica* (green ash), and *Ulmus americana* (American elm) (Curtis 1959, White and Madany 1978, Chapman et al. 1989, Reschke 1990, MNNHP 1993, Harris et al. 1996).

Characteristic Species: *Asclepias incarnata* (swamp milkweed), *Cornus amomum* (silky dogwood), *Salix bebbiana* (long-beak willow), *Salix discolor* (pussy willow), *Salix nigra* (black willow)

Dynamics/Successional Trajectory: Shrub swamps may naturally succeed herbaceous wet meadows as part of successional series in lakes and ponds. They may also originate from clearing of forested swamps (Curtis 1959), or draining of wet meadows (MNNHP 1993). Such open herbaceous meadows may first succeed to a shrubby meadow before becoming a dense shrub swamp.

Management Concerns: Infrequent fires may have maintained shrub swamps in the western part of the range, preventing tree canopy closure (MNNHP 1993).

Reference Sites: Great Marsh, Chester County, PA

Global and State Conservation Ranks and Reasons: G5 (3-Oct-1996). PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686190

References: Anderson 1996, Bakowsky and Lee 1996, Borowitz and Stephenson 1985, Chapman 1986, Curtis 1959, Edinger et al. 2002, Harris et al. 1996, Lee et al. 1998, MNNHP 1993, Midwestern Ecology Working Group n.d., Reschke 1990, WINHIP unpubl. data, White and Madany 1978

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 bebbiana</i> (long-beak willow)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Salix discolor</i> (pussy willow)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Salix nigra</i> (black willow)

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.

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.



Photo by Linda Kelly

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: 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

References: Bailey 1997, Bailey 1998, 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

Herb (field)

LIFEFORM

Graminoid

SPECIES*Phragmites australis* (common reed)

EASTERN TUSSOCK SEDGE MEADOW

Carex stricta - *Carex vesicaria* Herbaceous Vegetation

Range: This tussock sedge meadow is found in northern New England, the Adirondack Mountains, and parts of the Appalachians. In the Delaware Estuary, this community occurs in Pennsylvania.

Environmental Description: These tussock sedge meadows are distributed across the northeastern United States. They occur in seasonally flooded basins or on stream or lake margins. The substrate is peat or muck of variable depth overlying mineral soil. Standing water may be present only at the beginning of, or through much of, the growing season depending on the site and the year's precipitation; even when the water drops, the soils remain saturated. Microtopography is characterized by large tussocks, particularly when the hydroperiod is extended.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: The physiognomy is strongly herbaceous, or in some cases herbs mixed with shrubs (up to 25% shrub cover); trees are absent. Bryophyte cover is usually sparse but may occasionally reach over 50%. *Carex stricta* (tussock sedge), in its tussock form, is the usual dominant. *Carex vesicaria* (inflated sedge), *Carex utriculata* (beaked sedge), and *Calamagrostis canadensis* (bluejoint) may also be locally abundant. Associated graminoids include *Carex canescens* (silvery sedge), *Carex comosa* (longhair sedge), *Carex scoparia* (broom sedge), *Carex stipata* (stalk-grain sedge), *Carex vulpinoidea* (fox sedge), *Glyceria canadensis* (rattlesnake mannagrass), *Dulichium arundinaceum* (threeway sedge), *Leersia oryzoides* (rice cutgrass), and *Scirpus cyperinus* (woolgrass bulrush); forbs and ferns include *Asclepias incarnata* (swamp milkweed), *Thelypteris palustris* (eastern marsh fern), *Eupatorium maculatum* (spotted joe-pyeweed), *Campanula aparinoides* (marsh bellflower), *Osmunda regalis* (royal fern), *Comarum palustre* (purple marshlocks), *Lysimachia terrestris* (swamp-candles), *Angelica atropurpurea* (great angelica), *Eupatorium perfoliatum* (common boneset), *Lycopus americanus* (American water-horehound), *Galium obtusum* (bluntleaf bedstraw), and others. *Lythrum salicaria* (purple loosestrife) may be invasive in some settings. Shrub associates vary with geography. In the northern part of the range, *Alnus incana* (speckled alder), *Myrica gale* (sweet gale), *Ilex verticillata* (common winterberry), *Chamaedaphne calyculata* (leatherleaf), and *Spiraea alba* (white meadowsweet) are often present. Bryophytes, where present, include *Sphagnum magellanicum* (Magellan's peatmoss), *Sphagnum girgensohnii* (Girgensohn's peatmoss), *Sphagnum palustre* (prairie peatmoss), *Drepanocladus aduncus* (drepanocladus moss), and others.

Noteworthy Associated Plant and/or Animal Species: *Scirpus ancistrochaetus* (barbed-bristle bulrush)

Characteristic Species: *Carex stricta* (tussock sedge)

Dynamics/Successional Trajectory: Some of these sedge meadows may be associated with beaver impoundments.

Management Concerns: *Lythrum salicaria* (purple loosestrife) may be invasive in some settings.

Reference Sites: No reference sites were identified.

Global and State Conservation Ranks and Reasons: G4G5 (12-Dec-2005). DE: SNR, NJ: SNR, PA: SNR. This association is widely distributed throughout New England and northern New York in its small-patch setting and extends sporadically southward.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.690011

References: Breden 1989, Breden et al. 2001, CAP pers. comm. 1998, Cowardin et al. 1979, Curtis 1959, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Gawler 2002, Harrison 2004, Metzler and Barrett 2001, NAP pers. comm. 1998, Northern Appalachian Ecology Working Group 2000, Rawinski 1984, Sperduto 2000b, Swain and Kearsley 2001, Thompson 1996, Thompson and Jenkins 1992, Thompson and Sorenson 2000

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Calamagrostis canadensis</i> (bluejoint)
Herb (field)	Graminoid	<i>Carex stricta</i> (tussock sedge)
Herb (field)	Graminoid	<i>Carex utriculata</i> (beaked sedge)
Herb (field)	Graminoid	<i>Carex vesicaria</i> (inflated sedge)

REED CANARYGRASS EASTERN MARSH

Phalaris arundinacea Eastern Herbaceous Vegetation

Range: This association is found throughout the northeastern United States and Canada, but its distribution as a natural type is complicated elsewhere. It currently ranges from Virginia north to Vermont, east to Minnesota and south to Tennessee. It occurs in the Pennsylvania portion of the Delaware Estuary.

Environmental Description: Stands are found in both minerotrophic basin wetlands as well as river shores. It has been widely used as a forage and hay crop, especially in marshes and floodplains, and is used for wildlife food, for shoreline and ditch stabilization (Barnes 1999).



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: Stands are dominated by *Phalaris arundinacea* (reed canarygrass), a 0.5-2 m tall perennial grass that is native to the United States and Canada, but which has also been introduced from European strains. The introduced strains may be a more aggressive ecotype than native strains (Barnes 1999). It tends to occur in monocultures or associated with *Calamagrostis canadensis* (bluejoint). Other associates in the Northeast include *Viburnum nudum* (wild raisin), *Alnus incana* (speckled alder) or *Alnus serrulata* (smooth alder), *Viburnum dentatum* (southern arrow-wood), and *Agrostis gigantea* (giant bentgrass). Midwest associates include species characteristic of wet meadows. *Phalaris arundinacea* (reed canarygrass) can displace native species over time (Apfelbaum and Sams 1987, Barnes 1999, and references therein). Further work is required to resolve the natural versus introduced nature of this type in the Southeast before a description can be completed.

Characteristic Species: *Phalaris arundinacea* (reed canarygrass)

Dynamics/Successional Trajectory: Shoreline habitats can be temporarily or seasonally flooded in spring. *Phalaris arundinacea* (reed canarygrass) may respond well to summer drawdowns (Barnes 1999).

Management Concerns: The European strain of *Phalaris arundinacea* (reed canarygrass) may be a more aggressive ecotype than native strains (Barnes 1999).

Reference Sites: This community does not need a reference condition, as it is not a desirable type for restoration.

Global and State Conservation Ranks and Reasons: GNA (invasive) (1-Dec-1997). DE: SNA, NJ: SNA, PA: SNA.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689615

References: Apfelbaum and Sams 1987, Barnes 1999, Cowardin et al. 1979, Edinger et al. 2002, Fike 1999, Metzler and Barrett 2001, Midwestern Ecology Working Group n.d., Perles et al. 2004, Podniesinski et al. 2006, Rawinski 1984, Sperduto 2000a, Swain and Kearsley 2001, TDNH unpubl. data, TNC and WPC 2004, Thompson 1996, Thompson and Sorenson 2000

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Phalaris arundinacea</i> (reed canarygrass)

SEASONALLY FLOODED MIXED GRAMINOID MEADOW

Calamagrostis canadensis - *Scirpus* spp. - *Dulichium arundinaceum* Herbaceous Vegetation

Range: These are seasonally flooded, mixed-composition wetland meadows of the northeastern United States. Within the Delaware Estuary, this community occurs in Pennsylvania and Delaware.

Environmental Description: These are seasonally flooded, mixed-composition wetland meadows of the northeastern United States. They occur on flats, floodplains of small streams, beaver meadows, and lakeshores. The substrate is muck or well-decomposed peat overlying mineral soil, usually slightly acidic (pH 5.0-6.0). After spring flooding, many sites will dry to exposed soil during the summer.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: Shrub species typically include *Spiraea alba* (white meadowsweet) and *Salix* (willow) spp. Other shrub constituents vary from site to site, and may include *Alnus incana* (speckled alder), *Alnus serrulata* (smooth alder), *Cephalanthus occidentalis* (common buttonbush), *Cornus sericea* (red-osier dogwood), *Ilex verticillata* (common winterberry), *Myrica gale* (sweet gale), *Salix pedicellaris* (bog willow), *Spiraea tomentosa* (steeplebush), *Vaccinium corymbosum* (highbush blueberry), or *Viburnum dentatum* (southern arrow-wood). The herbaceous layer is often dominated by *Calamagrostis canadensis* (bluejoint), *Scirpus* (bulrush) spp. (including *Scirpus cyperinus* (woolgrass bulrush), *Scirpus expansus* (woodland bulrush), and *Scirpus atrovirens* (green bulrush)), and *Dulichium arundinaceum* (threeway sedge). Other locally common species may include *Acorus calamus* (sweetflag), *Agrostis gigantea* (giant bentgrass), *Carex lacustris* (lake sedge), *Carex lupulina* (hop sedge), *Carex lupuliformis* (false hop sedge), *Carex lurida* (sallow sedge), *Carex stricta* (tussock sedge), *Carex utriculata* (beaked

sedge), *Glyceria canadensis* (rattlesnake mannagrass), *Glyceria grandis* (American mannagrass), *Iris versicolor* (harlequin blueflag), *Hypericum ellipticum* (pale St. John's-wort), *Juncus canadensis* (Canadian rush), *Leersia oryzoides* (rice cutgrass), *Lysimachia terrestris* (swamp-candles), *Onoclea sensibilis* (sensitive fern), *Osmunda regalis* (royal fern), *Phalaris arundinacea* (reed canarygrass), *Poa palustris* (fowl bluegrass), and *Triadenum fraseri* (Fraser's marsh-St. John's-wort).

Noteworthy Associated Plant and/or Animal Species: *Scirpus ancistrochaetus* (barbed-bristle bulrush)

Characteristic Species: *Calamagrostis canadensis* (bluejoint), *Dulichium arundinaceum* (threeway sedge), *Scirpus cyperinus* (woolgrass bulrush)

Dynamics/Successional Trajectory: These seasonally flooded wet meadows are typically wet in the spring and dry in the summer. The vegetation is dominated by robust graminoids or graminoids mixed with shrubs. Shrub cover can range up to 50%, but in most cases graminoid cover exceeds woody cover. The herbaceous layer is well-developed, often over 40% cover and up to nearly 100% cover. Bryophyte cover is usually little to none but may occasionally be extensive.

Reference Sites: Unionville, Fern Hill, Brintons Quarry (Chester), PA; Pink Hill, DE

Global and State Conservation Ranks and Reasons: GNR (6-Jul-1999). DE: SNR, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685540

References: Calhoun et al. 1994, Eastern Ecology Working Group n.d., Gawler 2002, Northern Appalachian Ecology Working Group 2000, Sperduto 2000b, Sperduto and Nichols 2004, Thompson and Sorenson 2000

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Spiraea alba</i> (white meadowsweet)
Herb (field)	Graminoid	<i>Calamagrostis canadensis</i> (bluejoint)
Herb (field)	Graminoid	<i>Dulichium arundinaceum</i> (threeway sedge)
Herb (field)	Graminoid	<i>Scirpus cyperinus</i> (woolgrass bulrush)

SPECKLED ALDER SWAMP

Alnus incana Swamp Shrubland

Range: This alder swamp community type is widespread in the midwestern and northeastern United States and southern Canada, ranging from Maine west to Manitoba, south to Iowa, and east to New Jersey. It occurs in Pennsylvania's portion of the Delaware Estuary.

Environmental Description: Sites are typically along streams, lakeshores, edges of beaver meadows, swales associated with small streams in peatlands or upland forests, or near seeps. Most have little to no slope, but some sites are on moderate slopes. Hydrologic conditions can range from temporarily flooded to seasonally flooded, or even saturated, but are typically seasonally



Photo by Pennsylvania Natural Heritage Program

flooded/saturated. The water ranges from non-stagnant, nutrient-rich, and often slightly calcareous (Curtis 1959) to rather stagnant and nutrient-poor where over acidic bedrock or till. Soils are wet, often mucks or peats (Anderson 1982, Chapman et al. 1989). In the upper Midwest, this community is found on Precambrian Shield bedrock that is overlaid with sandy loam soils, which are moderately well-drained and deep (>60 cm). In northeastern Minnesota stands can occur on northeast- and south-facing slopes that are moderate to steep, with slopes ranging from 4 to 45% (Ohmann and Ream 1971). The climate is highly variable, with temperature extremes between -46 and 38 degrees C and 58-91 cm precipitation.

Vegetation Description: The vegetation is dominated by tall shrubs, 2-8 m in height, with a moderately open to dense shrub canopy. There is an understory of shorter shrubs and herbaceous species. The density of the understory varies inversely with the tall-shrub canopy. The overstory is usually overwhelmingly dominated by *Alnus incana* (speckled alder), but where it is not as dominant, other shrubs, such as *Cornus sericea* (red-osier dogwood), *Rubus idaeus* (red raspberry), *Salix* (willow) spp., *Spiraea alba* (white meadowsweet), *Spiraea tomentosa* (steeplebush), and *Viburnum* (viburnum) spp., can be found. The herbaceous layer contains species such as *Symphytotrichum lanceolatum* var. *lanceolatum* (swamp aster), *Symphytotrichum puniceum* (purple-stem aster), *Calamagrostis canadensis* (bluejoint), *Caltha palustris* (yellow marsh-marigold), *Carex lacustris* (lake sedge), *Carex prairea* (prairie sedge), *Carex trisperma* (three-seed sedge), *Doellingeria umbellata* (parasol whitetop), *Eupatorium maculatum* (spotted joe-pyeweed), *Impatiens capensis* (orange jewelweed), *Lycopus uniflorus* (northern bugleweed), *Onoclea sensibilis* (sensitive fern), *Osmunda cinnamomea* (cinnamon fern), *Rubus pubescens* (dewberry), *Scirpus atrovirens* (green bulrush), *Symplocarpus foetidus* (skunk-cabbage), *Thelypteris palustris* (eastern marsh fern), *Typha* (cattail) spp., and *Viola* (violet) spp. Mosses include *Climacium dendroides* (tree climacium moss) and *Sphagnum* (peatmoss) spp. Where the tall-shrub canopy is open, the graminoids can become dense. Scattered trees are found in many stands, including *Acer rubrum* (red maple), *Fraxinus nigra* (black ash), and *Thuja occidentalis* (northern white-cedar) (Curtis 1959, Anderson 1982, MNNHP 1993, Harris et al. 1996, Sperduto 2000b, Thompson and Sorenson 2000, Gawler 2002). Where stands border on saturated conditions with peaty soils, peatland species such as *Chamaedaphne calyculata* (leatherleaf), *Rhododendron canadense* (rhodora), and *Sphagnum* (peatmoss) spp. may be present.

Characteristic Species: *Alnus incana* (speckled alder)

Reference Sites: No reference sites identified.

Global and State Conservation Ranks and Reasons: G5? (3-Oct-1996). NJ: S2S4, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689638

References: Anderson 1982, Anderson and Barren 1991, Breden et al. 2001, Chapman 1986, Curtis 1959, Fike 1999, Gawler 2002, Greenall 1996, Harris et al. 1996, INAI unpubl. data, MNNHP 1993, Midwestern Ecology Working Group n.d., NDNHI unpubl. data, Ohmann and Ream 1971, Sperduto 2000b, Swain and Kearsley 2001, Thompson and Sorenson 2000, WINHIP unpubl. data

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Alnus incana</i> (speckled alder)

WILLOW RIVER-BAR SHRUBLAND

Salix nigra / *Carex torta* Temporarily Flooded Shrubland

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



Photo by Pennsylvania Natural Heritage Program

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* (sycamore), *Salix eriocephala* (Missouri willow), *Salix sericea* (silky willow), *Alnus incana* (speckled alder), *Alnus serrulata* (smooth alder), *Alnus viridis* (green alder) (infrequent), *Cornus amomum* (silky dogwood), *Cornus sericea* (red-osier dogwood), *Spiraea alba* var. *latifolia* (broadleaf meadowsweet), *Platanus occidentalis* (sycamore), and *Populus deltoides* (eastern cottonwood). The herbaceous layer is typically sparse with variable composition, including *Carex torta* (twisted sedge), *Carex trichocarpa* (hairy-fruit sedge), *Panicum dichotomiflorum* (fall panicgrass), *Dichanthelium clandestinum* (deer-tongue witchgrass), *Echinochloa crus-galli* (large barnyard grass), *Phalaris arundinacea* (reed canarygrass), *Calamagrostis canadensis* (bluejoint), *Apocynum cannabinum* (Indian-hemp), *Agrostis* (bentgrass) spp., *Solidago gigantea* (giant goldenrod), *Solidago rugosa* (wrinkleleaf goldenrod), *Eupatorium maculatum* (spotted joe-pyeweed), *Lysimachia terrestris* (swamp-candles), *Polygonum* (smartweed, knotweed) spp., and *Bidens* (beggarticks) spp. Invasive, exotic species can be problematic in this community, including *Polygonum cuspidatum* (Japanese knotweed), *Tussilago farfara* (colt's-foot), and *Cynanchum louiseae* (black 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

Global and State Conservation Ranks and Reasons: GNR (25-Mar-2003). PA: SNR.

VegBank Link for Plot Data: 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, 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)

WOOLGRASS MARSH

Scirpus cyperinus Seasonally Flooded Herbaceous Vegetation

Range: These marshes occur in Pennsylvania within the Delaware Estuary.

Environmental Description: This community consists of seasonally flooded marshes.

Vegetation Description: This community is dominated or characterized by *Scirpus cyperinus* (woolgrass bulrush). The vegetation composition is variable. Associated species include *Glyceria* (mannagrass) spp., *Thelypteris palustris* (eastern marsh fern), as well as other species of *Scirpus* (bulrush), including *Scirpus microcarpus* (red-tinge bulrush) and *Scirpus atrovirens* (green bulrush).



Photo by Pennsylvania Natural Heritage Program

Characteristic Species: *Scirpus cyperinus* (woolgrass bulrush)

Reference Sites: No sites identified in PA.

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687973

References: Breden et al. 2001, Cowardin et al. 1979, Eastern Ecology Working Group n.d., Fike 1999, Gawler 2002, Harrison 2004

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Scirpus cyperinus</i> (woolgrass bulrush)

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 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 red-cedar) 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?), *Aneides aeneus* (G3G4, green salamander), *Bryum riparium* (G2G4), *Canis rufus* (G1Q, red wolf), *Carex biltmoreana* (G3, biltmore 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. John's-wort), *Krigia montana* (G3, mountain cynthia), *Leptohymenium sharpii* (G1, mount leconte moss), *Liatris helleri* (G2, heller's blazingstar), *Liatris microcephala* (G3G4, small-head blazingstar), *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), *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, mountain wavy-leaf moss), *Platyhypnidium pringlei* (G2G3), *Porella japonica* ssp. *appalachiana* (G5?T1), *Radula sullivantii* (G3), *Rhododendron vaseyi* (G3, pink-shell azalea), *Saxifraga careyana* (G3, golden-eye saxifrage), *Saxifraga caroliniana* (G2, Carolina saxifrage), *Scutellaria arguta* (G2?Q, hairy skullcap), *Sedum nevirii* (G3, nevirii stonecrop), *Tetradontium brownianum* (G3G4, little georgia), *Thelypteris pilosa* var. *alabamensis* (G4T1, streak-sorus fern), *Tsuga caroliniana* (G3, Carolina hemlock)

Range: This system is found from central New England and New York south to Virginia. United States: CT, MA, MD?, NY, OH, PA, VA, VT, WV

Delaware Estuary Associations:

- Chestnut Oak - Black Birch Wooded Talus Slope
- Kittatinny Ridge Sparsely Vegetated Sandstone 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

CHESTNUT OAK - BLACK BIRCH WOODED TALUS SLOPE

Quercus prinus - *Betula lenta* / *Parthenocissus quinquefolia* Talus Woodland

Range: This community occurs locally throughout the Blue Ridge and Ridge and Valley sections of Pennsylvania, Virginia, West Virginia, and Maryland. In Virginia, it reaches optimal development on sideslopes of linear sandstone and quartzite strike ridges in the Ridge and Valley, and on the western, metasedimentary flank of the northern Blue Ridge.

Environmental Description: Sites include the edges of very large, unvegetated (except for lichens), scarcely weathered block fields, as well as a variety of more weathered boulderfields and slopes covered by coarse to fine, bouldery colluvium. Much of the bouldery rubble is weathered from resistant quartzite or sandstone caprock. Slope position and aspect



Photo by Pennsylvania Natural Heritage Program

are variable, while associated landforms include landslide scarps, slide masses, concave hollow heads, and incised hollow bottoms. Mean cover of exposed boulders at Virginia sampling sites is 72%. Soils are largely organic and usually extremely acidic and infertile. There is often some heterogeneity of boulder depth and weathering, as well as of microclimate and soil moisture, within boulderfields. In general, sites are somewhat xeric and show little evidence of subsurface drainage. However, this regime is ameliorated by higher elevations and north aspects, which probably slow evaporation and increase the moisture-holding capacity of the bouldery substrate.

Vegetation Description: The canopy is dominated by more-or-less gnarled specimens of *Betula lenta* (sweet birch) and *Quercus prinus* (chestnut oak) generally <20 m tall. *Betula lenta* (sweet birch) is usually the sole dominant of less weathered, steeper, more unstable boulderfield habitats, while a greater variety of trees is often codominant with *Betula lenta* (sweet birch) on more weathered and stable habitats. Other overstory associates that may be important on some sites are *Quercus rubra* (northern red oak), *Nyssa sylvatica* (blackgum), *Betula populifolia* (gray birch), *Carya glabra* (pignut hickory), *Tsuga canadensis* (eastern hemlock), and *Betula alleghaniensis* (yellow birch). The presence of well-preserved, fallen boles indicates that *Castanea dentata* (American chestnut) was important on some boulderfields prior to the arrival of chestnut blight (Fleming and Moorhead 2000). *Acer rubrum* (red maple) and *Nyssa sylvatica* (blackgum) are scattered canopy associates and frequent understory species. The typically open shrub layer contains *Acer pensylvanicum* (striped maple), *Acer spicatum* (mountain maple), *Amelanchier arborea* (common serviceberry), *Castanea dentata* (American chestnut) sprouts, *Hamamelis virginiana* (American witch-hazel), *Ilex montana* (mountain holly), *Kalmia latifolia* (mountain laurel), *Menziesia pilosa* (minniebush), and *Ribes rotundifolium* (Appalachian gooseberry). The herb layer consists almost entirely of low-statured shrubs, particularly *Vaccinium* (blueberry) spp., and/or scattered to abundant vines of *Parthenocissus quinquefolia* (Virginia creeper), *Vitis* (grape) spp., *Toxicodendron radicans* (eastern poison-ivy), and *Smilax rotundifolia* (roundleaf greenbrier). Flat, mossy boulders provide rooting habitats for a few specially adapted herbaceous plants such as *Polypodium appalachianum* (Appalachian rockcap fern), *Dryopteris marginalis* (marginal woodfern), *Heuchera* (alumroot) spp., and *Aralia nudicaulis* (wild sarsaparilla). Bryophyte cover ranges up to 65% in some microhabitats. The rocktripes *Lasallia papulosa* (toadskin lichen) and *Umbilicaria mammulata* (common rocktripe) are generally the most conspicuous lichens. The combination of surficial boulder cover and nutrient-poor substrate results in a notably low mean species richness (n = 22 taxa per 400 square meters) in Virginia plot samples of this type.

Characteristic Species: *Betula lenta* (sweet birch), *Lasallia papulosa* (toadskin lichen), *Quercus prinus* (chestnut oak), *Umbilicaria mammulata* (common rocktripe)

Dynamics/Successional Trajectory: In this very rocky environment, soil is limited to local, interstitial, root-rich duff deposits or to "pads" of moss and underlying, thin, organic / sandy material that have developed on wide, flat boulder surfaces. Interstitial air spaces between boulders may be prevalent for 1.0 m or more below the surface. Physiognomy varies from nearly closed forest to open woodland with widely spaced trees. Landsliding and debris avalanches, which generate and regenerate boulderfield environments, are dominant erosional processes in these landscapes (Hack and Goodlett 1960).

Management Concerns: Stands occupy rugged habitats that are not prone to anthropogenic disturbances. Landsliding and debris avalanches, which generate and regenerate boulderfield environments, are dominant erosional processes in these landscapes (Hack and Goodlett 1960).

Reference Sites: Dark Hollow County Park, Bucks County, PA; Hopewell Furnace National Historic Site, Berks County, PA

Global and State Conservation Ranks and Reasons: G3G4 (9-Aug-2004). PA: SNR. Although this community type occurs in small patches over a limited geographic range, there are probably >200 sites (if not many hundreds of sites) in Virginia and West Virginia alone.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685271

References: Anderson et al. 1998, Eastern Ecology Working Group n.d., Fike 1999, Fleming and Coulling 2001, Fleming and Moorhead 2000, Fleming et al. 2001, Hack and Goodlett 1960, Harrison 2004, Hupp 1983, Lea 2003, Rawinski et al. 1996, Russell and Schuyler 1988, VDNH 2003

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Betula lenta</i> (sweet birch)
Tree canopy	Broad-leaved deciduous tree	<i>Quercus prinus</i> (chestnut oak)
Shrub/sapling (tall & short)	Broad-leaved deciduous tree	<i>Nyssa sylvatica</i> (blackgum)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Acer pensylvanicum</i> (striped maple)
Shrub/sapling (tall & short)	Vine/Liana	<i>Parthenocissus quinquefolia</i> (Virginia creeper)

KITTATINNY RIDGE SPARSELY VEGETATED SANDSTONE CLIFF

Kittatinny Ridge Sandstone Cliff Sparse Vegetation

Range: This type is restricted to sandstone cliffs with south- and southeast-facing aspects on Kittatinny Ridge in Pennsylvania and northern New Jersey.

Environmental Description: This association occurs on south- to southeast-facing, acidic, sandstone bedrock outcrops (Devonian Shawangunk Formation) along the Kittatinny Ridge in Pennsylvania and in northern New Jersey. The outcrops are typically vertical to near vertical. Vegetation habitat is restricted to narrow ledges and crevices in the rock face. These cliffs often occur immediately below the hickory-eastern red-cedar rocky woodlands that persist at the top of the cliff.

Vegetation Description: This vegetation type is characterized by sparse vegetation growing on narrow ledges or from bedrock crevices. The vegetation can vary greatly in composition but is generally limited to drought-tolerant species. Trees are typically absent, or when present, they are usually stunted and less than 10 m in height. Occasional trees include *Juniperus virginiana* (eastern red-cedar), *Fraxinus americana* (white ash), *Carya ovalis* (red hickory), *Carya glabra* (pignut hickory), *Pinus rigida* (pitch pine), *Betula lenta* (sweet birch), and *Quercus prinus* (chestnut oak). The tall-shrub and tree-sapling layer (2-5 m in height) may include scattered individuals of *Quercus ilicifolia* (bear oak), *Prunus serotina* (black cherry), *Prunus pensylvanica* (pin cherry), and other tree saplings. The short-shrub layer (<2 m in height),

when present, is variable and may include tree saplings, *Rhus* (sumac) spp., *Rubus allegheniensis* (Allegheny blackberry), *Rosa carolina* (Carolina rose), *Gaylussacia baccata* (black huckleberry), *Kalmia latifolia* (mountain laurel), *Kalmia angustifolia* (sheep laurel), *Vaccinium angustifolium* (northern lowbush blueberry), and *Vaccinium pallidum* (hillside blueberry). The herb layer can be very diverse, but the total cover is usually very low, ranging from <1% to as high as 40% total cover. Typical species are *Deschampsia flexuosa* (wavy hairgrass), *Schizachyrium scoparium* (little bluestem), *Digitaria ischaemum* (smooth crabgrass), *Danthonia spicata* (poverty oatgrass), *Carex pensylvanica* (Pennsylvania sedge), *Dichanthelium depauperatum* (starved witchgrass), *Dennstaedtia punctilobula* (eastern hay-scented fern), *Pteridium aquilinum* (bracken fern), and *Polypodium virginianum* (rock polypody). Occasional herbaceous species include *Opuntia humifusa* (eastern prickly-pear), *Woodsia ilvensis* (rusty cliff fern), *Cheilanthes lanosa* (hairy lipfern), *Aralia nudicaulis* (wild sarsaparilla), *Solidago odora* (anise-scented goldenrod), and *Phlox subulata* (moss phlox). Vines may be present, typically *Vitis aestivalis* (summer grape) and *Parthenocissus quinquefolia* (Virginia creeper). Lichens are usually present and often abundant on bare rock.

Noteworthy Associated Plant and/or Animal Species: *Opuntia humifusa* (eastern prickly-pear)

Characteristic Species: *Deschampsia flexuosa* (wavy hairgrass), *Schizachyrium scoparium* (little bluestem)

Dynamics/Successional Trajectory: This community consists of drought-tolerant species that take advantage of thin layers of soil that form on narrow ledges or in bedrock crevices (Podniesinski 2005). The successional stages of this type vary with resource availability from bare rock outcrops with no vegetation, to outcrops with lichen cover, to outcrops with lichen and moss cover, to outcrops with grass cover, and eventually to rock outcrops with stunted woodland or forest cover. These stages overlap in time and space, depending on resource availability (Collins and Anderson 1994). Species composition is variable given the limited habitat to support vegetation and the unpredictable nature of plant colonization and establishment. Trees are typically absent from this community, but when present, they are usually stunted and less than 10 m in height (Podniesinski 2005). Tree roots may straddle boulders or run horizontally over rock surfaces as they cannot penetrate the rock surface (Collins and Anderson 1994).

Management Concerns: Stands occupy rugged habitats that are not prone to anthropogenic disturbances. Landsliding and debris avalanches are typical erosional processes in these landscapes.

Reference Sites: Delaware Water Gap National Recreation Area (NJ & PA)

Global and State Conservation Ranks and Reasons: GNR (16-Nov-2005). NJ: SNR, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.789230

References: Anderson 1996, Collins and Anderson 1994, Eastern Ecology Working Group n.d., Podniesinski 2005, Sneddon and Menard 2002

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Juniperus virginiana</i> (eastern red-cedar)
Shrub/sapling (tall & short)	Vine/Liana	<i>Vitis aestivalis</i> (summer grape)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Gaylussacia baccata</i> (black huckleberry)
Herb (field)	Graminoid	<i>Deschampsia flexuosa</i> (wavy hairgrass)

ECOLOGICAL SYSTEM: NORTH-CENTRAL APPALACHIAN ACIDIC SWAMP

Summary: These swamps are distributed through the central Appalachians south to Virginia and west to Ohio. They are found in basins or on gently sloping seepage lowlands. The acidic substrate is mineral soil, often with a component of organic muck; if peat is present, it usually forms an organic epipedon over the mineral soil rather than a true peat substrate. *Tsuga canadensis* (eastern hemlock) is usually present and may be dominant. It is often mixed with deciduous wetland trees such as *Acer rubrum* (red maple) or *Nyssa sylvatica* (blackgum). *Sphagnum* (peatmoss) is an important component of the bryoid layer. Basin swamps tend to be more nutrient-poor and less species-rich than seepage swamps; in some settings, the two occur adjacent to each other with the basin swamp vegetation surrounded by seepage swamp vegetation on its upland periphery.

High-ranked Species: *Carex schweinitzii* (G3G4, schweinitz's sedge), *Helonias bullata* (G3, swamp-pink), *Polemonium vanbruntiae* (G3G4, bog Jacob's-ladder)

Range: This system occurs from central New England south to West Virginia and Virginia and west to Ohio. Its southern range limit in Virginia has not been determined or documented. United States: CT, MA, MD, NH, NJ, NY, OH, PA, RI, VA, VT, WV

Delaware Estuary Associations:

- Central Appalachian Forested Acid Seep
- Eastern Hemlock - Great Laurel Swamp
- Lower New England Red Maple - Blackgum Swamp
- Red Maple - Black Ash Swamp
- Red Maple - Blackgum Basin Swamp
- Red Maple - Tussock Sedge Wooded Marsh
- Southern New England Red Maple Seepage Swamp

Similar Ecological Systems in the Delaware Estuary:

- Atlantic Coastal Plain Northern Basin Peat Swamp

CLASSIFIERS FOR NORTH-CENTRAL APPALACHIAN ACIDIC SWAMP

Primary Division: 202

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); Extensive Wet Flat; Needle-Leaved Tree; 30-180-day hydroperiod

Non-diagnostic Classifiers: Lowland; Temperate; Mineral: W/ A-Horizon >10 cm; Broad-Leaved Deciduous Tree; Acidic Water; Shallow (<15 cm) Water; Moderate (100-500 yrs) Persistence

CENTRAL APPALACHIAN FORESTED ACID SEEP

Acer rubrum - *Nyssa sylvatica* High Allegheny Plateau, Central Appalachian Forest

Range: This acidic deciduous swamp occurs in the central Appalachian Mountains north of the Cumberland drainage in the Central Appalachians and High Allegheny ecoregions, as well as the adjacent Cumberlands and Western Allegheny Plateau. This seep community occurs in the Pennsylvania portion of the Delaware Estuary.

Environmental Description: This community occurs on substrates which are saturated for extended periods during the growing season but which rarely have standing water, including forested seeps, hillsides, streamheads, floodplain edges, and poorly drained depressions. Occurrences tend to be small.

Vegetation Description: Characteristic trees are *Acer rubrum* (red maple) and *Nyssa sylvatica* (blackgum), with other associates including *Tsuga canadensis* (eastern hemlock) and *Betula alleghaniensis* (yellow birch). The shrub stratum includes *Alnus serrulata* (smooth alder), *Photinia pyrifolia* (red chokeberry), *Ilex verticillata* (common winterberry), *Vaccinium corymbosum* (highbush blueberry), *Rhododendron maximum* (great laurel), and *Rubus hispidus* (bristly dewberry). Characteristic herbs include *Osmunda cinnamomea* (cinnamon fern), *Osmunda regalis* (royal fern), *Carex folliculata* (northern long sedge), *Carex trisperma* (three-seed sedge), *Carex intumescens* (greater bladder sedge), *Carex stricta* (tussock sedge), and *Poa trivialis* (rough bluegrass). *Sphagnum* (peatmoss) spp. are typical.

Characteristic Species: *Acer rubrum* (red maple), *Nyssa sylvatica* (blackgum), *Osmunda cinnamomea* (cinnamon fern)

Reference Sites: none identified

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689039

References: Anderson et al. 1998, CAP pers. comm. 1998, Eastern Ecology Working Group n.d., Fike 1999, Harrison 2004

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>Nyssa sylvatica</i> (blackgum)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Alnus serrulata</i> (smooth alder)

EASTERN HEMLOCK - GREAT LAUREL SWAMP

Tsuga canadensis / *Rhododendron maximum* / *Sphagnum* spp. Forest

Range: This hemlock swamp occurs in the Central Appalachians, southeastern New York and northern New Jersey. If this type occurs in the Delaware Estuary study area, its distribution would be limited to the upper portions of the Schuylkill watershed in Pennsylvania.

Environmental Description: This hemlock swamp occurs on saturated acidic muck to imperfectly drained mineral soils in upland valleys, bedrock depressions, low slopes, and adjacent to streams and lakes. Mounds and depressions caused by uprooted trees are typical.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: The tree canopy is closed or nearly closed and dominated by *Tsuga canadensis* (eastern hemlock) with associates including *Acer rubrum* (red maple), *Nyssa sylvatica* (blackgum), *Pinus strobus* (eastern white pine), and *Betula alleghaniensis* (yellow birch). The well-developed shrub layer is strongly dominated by *Rhododendron maximum* (great laurel). Other shrubs may include *Ilex verticillata* (common winterberry), *Rhododendron viscosum* (swamp azalea),

Vaccinium corymbosum (highbush blueberry), and *Lindera benzoin* (northern spicebush). The sparse herb layer includes a variety of sedges, such as *Carex folliculata* (northern long sedge), *Carex trisperma* (three-seed sedge), *Carex intumescens* (greater bladder sedge), as well as ferns and forbs, such as *Osmunda cinnamomea* (cinnamon fern), *Thelypteris palustris* (eastern marsh fern), *Onoclea sensibilis* (sensitive fern), *Maianthemum canadense* (Canada mayflower), *Coptis trifolia* (threeleaf goldthread), *Symplocarpus foetidus* (skunk-cabbage), *Trientalis borealis* (starflower), and *Calla palustris* (water arum). The bryophyte layer is well-developed and strongly dominated by *Sphagnum* (peatmoss) mosses. Other mosses may include *Aulacomnium palustre* (ribbed bog moss), *Hypnum imponens* (hypnum moss), and *Leucobryum glaucum* (pincushion moss) on drier hummocks.

Characteristic Species: *Rhododendron maximum* (great laurel), *Tsuga canadensis* (eastern hemlock)

Management Concerns: Hemlock wooly adelgid may have significant negative impacts to the vegetation structure, species composition, and habitat suitability of this association.

Reference Sites: near Long Pine Pond in the Delaware Water Gap National Recreation Area, NJ

Global and State Conservation Ranks and Reasons: GNR (1-Dec-1997). NJ: S1S2, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688628

References: Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Harrison 2004, Karlin 1988

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Tsuga canadensis</i> (eastern hemlock)
Tree canopy	Broad-leaved deciduous tree	<i>Acer rubrum</i> (red maple)
Herb (field)	Fern or fern ally	<i>Osmunda cinnamomea</i> (cinnamon fern)

LOWER NEW ENGLAND RED MAPLE - BLACKGUM SWAMP

Acer rubrum / *Rhododendron viscosum* - *Clethra alnifolia* Forest

Range: This type includes red maple basin swamps of Lower New England and adjacent areas. It occurs in the New Jersey portion of the Delaware Estuary.

Environmental Description: These swamps occur in poorly drained depressions characterized by acidic, tannic water that does not receive substantial nutrient input from overland flow or groundwater seepage. The soils are comprised of peat.

Vegetation Description: *Acer rubrum* (red maple) dominates the canopy. Other common species that generally occur in low abundance include *Betula alleghaniensis* (yellow birch), *Fraxinus* (ash) spp., *Ulmus americana* (American elm), and *Nyssa sylvatica* (blackgum). The shrub layer is well-developed and often dense. *Vaccinium corymbosum* (highbush blueberry) and *Ilex verticillata* (common winterberry) are common and abundant. *Clethra alnifolia* (coastal sweet-pepperbush), *Alnus incana* (speckled alder), *Lindera benzoin* (northern spicebush), *Viburnum dentatum* (southern arrow-wood), *Viburnum nudum* var. *cassinoides* (northern wild raisin), *Spiraea alba* var. *latifolia* (broadleaf meadowsweet), *Rosa palustris* (swamp rose), and *Rhododendron viscosum* (swamp azalea) are frequent but less abundant, and on the Atlantic Coastal Plain *Ilex glabra* (inkberry or little gallberry), *Rhododendron maximum* (great laurel), and *Leucothoe racemosa* (swamp doghobble) may also be present. The herbaceous layer has scattered herbs and commonly includes *Osmunda cinnamomea* (cinnamon fern), *Symplocarpus foetidus* (skunk-cabbage), *Thelypteris palustris* (eastern marsh fern), *Dryopteris cristata* (crested woodfern), *Lycopus uniflorus* (northern bugleweed), *Impatiens capensis* (orange jewelweed), *Carex folliculata* (northern long sedge), *Carex stricta* (tussock sedge), *Carex intumescens* (greater bladder sedge), *Osmunda regalis* (royal fern), and *Onoclea sensibilis* (sensitive fern). Hummock-and-hollow

microtopography is evident; tree seedlings and upland species occur on the hummocks, including *Coptis trifolia* (threeleaf goldthread) (a northern affiliate in NJ), *Aralia nudicaulis* (wild sarsaparilla), *Trientalis borealis* (starflower), and *Gaultheria procumbens* (wintergreen). *Sphagnum* (peatmoss) mosses are dominant or abundant in hollows and at the bases of hummocks. This community is differentiated from *Acer rubrum* - *Nyssa sylvatica* - *Betula alleghaniensis* / *Sphagnum* spp. Forest (CEGL006014), that occurs in Pennsylvania's portion of the estuary, by the absence or low abundance of *Nyssa sylvatica* (blackgum) and *Picea rubens* (red spruce).

Characteristic Species: *Acer rubrum* (red maple), *Ilex verticillata* (common winterberry), *Vaccinium corymbosum* (highbush blueberry)

Dynamics/Successional Trajectory: These are poorly drained basins with acidic, nutrient-poor peat soils. There is little overland flow or groundwater contribution to the water budget.

Reference Sites: Brendan Byrne State Forest, NJ

Global and State Conservation Ranks and Reasons: GNR (1-Dec-1997). NJ: S4S5.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689957

References: Breden 1989, Breden et al. 2001, Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Golet et al. 1993, Metzler and Barrett 1996, Metzler and Barrett 2001, Rawinski 1984, Reschke 1990, Sperduto 2000a, Swain and Kearsley 2000, Thompson and Jenkins 1992

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Acer rubrum</i> (red maple)
Tree subcanopy	Broad-leaved deciduous tree	<i>Betula alleghaniensis</i> (yellow birch)
Tree subcanopy	Broad-leaved deciduous tree	<i>Quercus bicolor</i> (swamp white oak)
Tree subcanopy	Broad-leaved deciduous tree	<i>Ulmus americana</i> (American elm)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Ilex verticillata</i> (common winterberry)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Vaccinium corymbosum</i> (highbush blueberry)
Herb (field)	Forb	<i>Symplocarpus foetidus</i> (skunk-cabbage)
Herb (field)	Fern or fern ally	<i>Osmunda cinnamomea</i> (cinnamon fern)

RED MAPLE - BLACK ASH SWAMP

Fraxinus nigra - *Acer rubrum* / *Carex leptalea* Saturated Forest

Range: This community is found in the unglaciated portions of the Lower New England/Northern Piedmont, High Allegheny Plateau, and Central Appalachians ecoregions, from New York to Maryland and West Virginia. It occurs in Pennsylvania in the Delaware Estuary.

Environmental Description: This is a closed-canopy deciduous swamp forest of poorly drained depressions or seepage zones in the unglaciated portions of the Lower New England/Northern Piedmont, High Allegheny Plateau, and Central Appalachians ecoregions. This forest can occur as narrow zones to small inclusions to large swamps.



Photo by Pennsylvania Natural Heritage Program

Soils are generally mucky and without substantial peat development. It often occurs in areas of calcareous bedrock.

Vegetation Description: The canopy is codominated by *Acer rubrum* (red maple) and *Fraxinus nigra* (black ash) with associates such as *Quercus bicolor* (swamp white oak), *Nyssa sylvatica* (blackgum), *Betula alleghaniensis* (yellow birch), *Ulmus rubra* (slippery elm), *Ulmus americana* (American elm), and *Pinus strobus* (eastern white pine). The understory is patchy, ranging from shrub-dominated to sedge-dominated. Shrubs include *Lindera benzoin* (northern spicebush), *Toxicodendron vernix* (poison-sumac), *Alnus incana* (speckled alder), *Alnus serrulata* (smooth alder), *Vaccinium corymbosum* (highbush blueberry), *Rhododendron viscosum* (swamp azalea), *Salix* (willow) spp., *Physocarpus opulifolius* (eastern ninebark), *Spiraea alba var. latifolia* (broadleaf meadowsweet), and *Rhamnus alnifolia* (alderleaf buckthorn). The herb layer is diverse with *Carex leptalea* (bristly-stalk sedge), *Carex bromoides* (brome-like sedge), *Caltha palustris* (yellow marsh-marigold), *Veratrum viride* (American false hellebore), *Platanthera grandiflora* (greater purple fringed orchid), *Geum rivale* (purple avens), *Symplocarpus foetidus* (skunk-cabbage), *Cypripedium reginae* (showy lady's-slipper), *Trollius laxus* (American globeflower), *Onoclea sensibilis* (sensitive fern), *Osmunda regalis* (royal fern), *Osmunda cinnamomea* (cinnamon fern), *Impatiens capensis* (orange jewelweed), *Cardamine bulbosa* (bulbous bittercress), *Saxifraga pensylvanica* (eastern swamp saxifrage), *Dryopteris cristata* (crested woodfern), *Carex lacustris* (lake sedge), and *Symplocarpus foetidus* (skunk-cabbage).

Characteristic Species: *Carex leptalea* (bristly-stalk sedge), *Fraxinus nigra* (black ash)

Dynamics/Successional Trajectory: This community is persistent and is not successional to another forest type. The community is sensitive to changes in hydrology. Flooding due to beaver or man-made impoundments will eliminate the forest and perhaps most of the shrub cover, resulting in a shift to emergent marsh and floating-leaved aquatic vegetation (depending on depth of flooding). Drought or reduction of hydrologic inputs (i.e., well water pumping) may cause a shift to terrestrial vegetation and initiate succession to a terrestrial forest type.

Management Concerns: The maintenance of hydrology is necessary. This community type is susceptible to invasion by non-native species, especially after canopy disturbances.

Reference Sites: French Creek State Park (Pine Swamp), Berks County, PA, Queene Anne Park, Bucks County, PA

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686573

References: CAP pers. comm. 1998, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Harrison 2004

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 nigra</i> (black ash)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Lindera benzoin</i> (northern spicebush)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Toxicodendron vernix</i> (poison-sumac)
Herb (field)	Fern or fern ally	<i>Osmunda cinnamomea</i> (cinnamon fern)

RED MAPLE - BLACKGUM BASIN SWAMP

Acer rubrum - *Nyssa sylvatica* - *Betula alleghaniensis* / *Sphagnum* spp. Forest

Range: This community occurs in Pennsylvania in the Delaware Estuary.

Environmental Description: This blackgum basin swamp of the northeastern United States is found from the central Appalachians north to central New England, at the northern range limit for *Nyssa sylvatica* (blackgum). It occupies saturated or seasonally wet basins, typically perched basins in small watersheds within upland forests. In most settings, the mineral soil is overlain with a shallow to deep peat layer. Conditions are highly acidic and nutrient-poor.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: The canopy is dominated by *Acer rubrum* (red maple) and *Nyssa sylvatica* (blackgum); however, even where red maple is more abundant, the longevity and stature of the blackgum trees give them a strong impact. *Betula alleghaniensis* (yellow birch), *Tsuga canadensis* (eastern hemlock), *Pinus strobus* (eastern white pine), and in the north *Picea rubens* (red spruce) may be minor canopy associates. The most abundant shrubs are *Ilex verticillata* (common winterberry) and *Vaccinium corymbosum* (highbush blueberry); associated shrub species include *Viburnum nudum* var. *cassinoides* (northern wild raisin), *Nemopanthus mucronatus* (catberry), *Kalmia angustifolia* (sheep laurel), *Lyonia ligustrina* (maleberry), and *Cephalanthus occidentalis* (common buttonbush). *Osmunda cinnamomea* (cinnamon fern) is the characteristic dominant in the herb layer, with associates including *Osmunda regalis* (royal fern), *Thelypteris palustris* (eastern marsh fern), *Woodwardia virginica* (Virginia chainfern), *Glyceria canadensis* (rattlesnake manna grass), *Coptis trifolia* (threeleaf goldthread), *Carex trisperma* (three-seed sedge), *Carex intumescens* (greater bladder sedge), *Triadenum virginicum* (Virginia marsh St. John's-wort), and *Symplocarpus foetidus* (skunk-cabbage). Mosses are primarily *Sphagnum* (peatmoss) spp., including *Sphagnum palustre* (prairie peatmoss) and *Sphagnum magellanicum* (Magellan's peatmoss). These swamps are distinguished from other basin swamps in the Northern Appalachians by the presence of *Nyssa sylvatica* (blackgum). They are distinguished from blackgum swamps further south by the absence of more central-Appalachian species such as *Liquidambar styraciflua* (sweetgum), *Rhododendron maximum* (great laurel), *Rhododendron viscosum* (swamp azalea), and *Magnolia virginiana* (sweetbay).

Characteristic Species: *Acer rubrum* (red maple), *Ilex verticillata* (common winterberry), *Nyssa sylvatica* (blackgum), *Osmunda cinnamomea* (cinnamon fern), *Vaccinium corymbosum* (highbush blueberry)

Dynamics/Successional Trajectory: The tree canopy varies from an open woodland to nearly complete. Shrubs are well represented and may be locally dense. Herbs are likewise patchy, and the herb layer is usually dominated by only a few species. The bryoid layer varies, but is often extensive. Hummock-and-hollow topography is often pronounced, with bryophytes common on the hummocks and in those hollows where water does not stand for long periods.

Reference Sites: near Portland Pumphouse #2, Delaware Water Gap, PA

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688103

References: Breden et al. 2001, Cain and Penfound 1938, Cowardin et al. 1979, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Gawler 2002, Golet et al. 1993, Harrison 2004, Metzler and Barrett 2001, NAP pers. comm. 1998, Rawinski 1984, Sperduto 2000b, Sperduto et al. 2000b, Swain and Kearsley 2001, Thompson 1996, Thompson and Sorenson 2000, Vogelmann 1976, Windisch 1995c, Zebryk 1990

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>Nyssa sylvatica</i> (blackgum)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Ilex verticillata</i> (common winterberry)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Vaccinium corymbosum</i> (highbush blueberry)

RED MAPLE - TUSSOCK SEDGE WOODED MARSH

Acer rubrum / *Carex stricta* - *Onoclea sensibilis* Woodland

Range: This wetland is found in central and northern New England, south to Pennsylvania and New Jersey. It occurs in Pennsylvania in the Delaware Estuary.

Environmental Description: This association is a partly wooded, deciduous-canopy wetland of central and northern New England. It occurs on muck soils or mineral soils with a surface organic layer, in poorly drained depressions influenced by groundwater. It is also common in those streamside and lakeside settings where the hydrology is that of a basin setting rather than a floodplain. The community is typically flooded in spring, with pools and small streams persisting throughout much of the growing season; soils may remain saturated, or may become dry on the surface over the course of the growing season. Hummock-and-hollow topography may be pronounced. In Pennsylvania this type is often associated with areas of past beaver impoundments.

Vegetation Description: The canopy consists of scattered trees, with as little as 25% overall cover. The shrub layer is patchy and may be extensive in places. The herb layer is typically well-developed, with ferns and graminoids dominant. The bryophyte cover is variable. *Acer rubrum* (red maple) is dominant in the canopy, often with many standing dead trees. Associated trees include *Fraxinus nigra* (black ash), *Nyssa sylvatica* (blackgum), *Quercus bicolor* (swamp white oak), *Quercus palustris* (pin oak), *Ulmus americana* (American elm), and occasional *Pinus strobus* (eastern white pine), *Tsuga canadensis* (eastern hemlock), or *Picea rubens* (red spruce). The shrub layer is characterized by *Vaccinium corymbosum* (highbush blueberry) and *Ilex verticillata* (common winterberry). Other shrubs may be locally common, including *Nemopanthus mucronatus* (catberry), *Viburnum nudum* var. *cassinoides* (northern wild raisin), *Viburnum recognitum* (northern arrow-wood), *Lyonia ligustrina* (maleberry), *Alnus incana* (speckled alder), *Ilex laevigata* (smooth winterberry holly), *Spiraea alba* (white meadowsweet), *Spiraea tomentosa* (steeplebush), and the creeping *Rubus hispidus* (bristly dewberry). The herbaceous layer is typically dominated by the graminoids *Carex stricta* (tussock sedge), *Carex lacustris* (lake sedge), or *Calamagrostis canadensis* (bluejoint), or the ferns *Onoclea sensibilis* (sensitive fern), *Osmunda cinnamomea* (cinnamon fern), or *Osmunda claytoniana* (interrupted fern). Less abundant herbs include *Carex intumescens* (greater bladder sedge), *Carex folliculata* (northern long sedge), *Carex canescens* (silvery sedge), *Carex trisperma* (three-seed sedge), *Glyceria striata* (fowl mannagrass), *Osmunda regalis* (royal fern), *Dryopteris cristata* (crested woodfern), *Thelypteris palustris* (eastern marsh fern), *Lycopus uniflorus* (northern bugleweed), *Caltha palustris* (yellow marsh-marigold), and *Impatiens capensis* (orange jewelweed). *Sphagnum* (peatmoss) spp. are the characteristic bryophytes, with non-sphagnum mosses as associates.

Characteristic Species: *Acer rubrum* (red maple), *Ilex verticillata* (common winterberry), *Onoclea sensibilis* (sensitive fern), *Spiraea alba* var. *latifolia* (broadleaf meadowsweet), *Vaccinium corymbosum* (highbush blueberry)

Dynamics/Successional Trajectory: This plant community type is sensitive to changes in hydrology and represents a transition from a wetter, open tussock sedge marsh with low forest cover to a red maple palustrine forest with high canopy cover (and much reduced *Carex stricta* (tussock sedge) cover). Changes in hydrology will tend to shift community composition between the two types, with persistent deeper water levels favoring *Carex stricta* (tussock sedge) and drying conditions favoring *Acer rubrum* (red maple).

Reference Sites: Lake Towhee Park, Bucks County, PA (needs to be field checked); Great Swamp National Wildlife Refuge, Morris County, NJ

Global and State Conservation Ranks and Reasons: G3G5 (1-Dec-1997). NJ: SNR, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684410

References: Barrett and Enser 1997, CAP pers. comm. 1998, Cowardin et al. 1979, Eastern Ecology Working Group n.d., Edinger et al. 2002, Eyre 1980, Fike 1999, Gawler 2002, Golet et al. 1993, Hunt 1999, Metzler and Barrett 2001, Moore and Taylor 1927, Rawinski 1984, Sperduto 2000a, Sperduto 2000b, Swain and Kearsley 2001, Thompson and Sorenson 2000

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Acer rubrum</i> (red maple)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Ilex verticillata</i> (common winterberry)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Vaccinium corymbosum</i> (highbush blueberry)
Short shrub/sapling meadowsweet)	Broad-leaved deciduous shrub	<i>Spiraea alba</i> var. <i>latifolia</i> (broadleaf meadowsweet)
Herb (field)	Graminoid	<i>Calamagrostis canadensis</i> (bluejoint)
Herb (field)	Graminoid	<i>Carex lacustris</i> (lake sedge)
Herb (field)	Graminoid	<i>Carex stricta</i> (tussock sedge)
Herb (field)	Fern or fern ally	<i>Osmunda cinnamomea</i> (cinnamon fern)
Herb (field)	Fern or fern ally	<i>Osmunda claytoniana</i> (interrupted fern)

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 possibly 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



Photo by Pennsylvania Natural Heritage Program

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 sweet-pepperbush), *Lindera benzoin* (northern spicebush), and less commonly *Vaccinium corymbosum* (highbush blueberry), *Lyonia ligustrina* (maleberry), *Toxicodendron vernix* (poison-sumac), *Viburnum dentatum* (southern arrow-wood), and *Viburnum nudum var. cassinoides* (northern wild raisin). 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* (orange jewelweed), *Carex stricta* (tussock sedge), *Veratrum viride* (American 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* (peatmoss) mosses are common on hummocks but do not in general form extensive carpets. Additional nonvascular species can include *Plagiomnium cuspidatum* 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 (25-Jun-1998). DE?:SNA, NJ: S3S5, PA: SNR.

VegBank Link for Plot Data: 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, Enser 1993, Golet et al. 1993, Harrison 2004, MENHP 1991, Metzler and Barrett 2001, 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 sweet-pepperbush)
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)

ECOLOGICAL SYSTEM: NORTH-CENTRAL APPALACHIAN CIRCUMNEUTRAL CLIFF AND TALUS

Summary: This cliff system occurs at low to mid elevations from central New England south to Virginia and West Virginia. It consists of vertical or near-vertical cliffs and steep talus slopes where weathering and/or bedrock lithology produce circumneutral to calcareous pH and enriched nutrient availability. Substrates include limestone, dolomite and other rocks. The vegetation varies from sparse to patches of small trees, in places forming woodland or even forest vegetation. *Fraxinus* (ash) spp., *Tilia americana* (American basswood), and *Staphylea trifolia* (American bladdernut) are woody indicators of the enriched setting. The herb layer is typically not extensive but includes at least some species that are indicators of enriched conditions, e.g., *Impatiens pallida* (yellow jewelweed), *Pellaea atropurpurea* (purple cliffbrake), *Asplenium platyneuron* (ebony spleenwort), or *Woodsia obtusa* (common cliff fern).

High-ranked Species: *Aneides aeneus* (G3G4, green salamander), *Arabis patens* (G3, spreading rockcress), *Clematis addisonii* (G2, addison's leatherflower), *Heuchera americana* var. *hispida* (G5T3?, American alumroot), *Homaliadelphus sharpii* (G3?, sharp's homaliadelphus), *Leptohymerium sharpii* (G1, mount leconte moss), *Neotoma magister* (G3G4, Allegheny woodrat), *Paxistima canbyi* (G2, Canby's mountain-lover), *Penstemon smallii* (G3, Small's beardtongue), *Platyhypnidium pringlei* (G2G3), *Radula voluta* (G3), *Sedum nevii* (G3, nevius' stonecrop), *Silene virginica* var. *robusta* (G5T1Q, fire-pink), *Taxiphyllum alternans* (G3?, Japanese yew-moss)

Range: This system ranges from central New England and New York south to Virginia and West Virginia. The extent of the Virginia range remains to be documented, but it appears to be absent from the Southern Blue Ridge and Southern Ridge and Valley portions of the state. United States: MA, MD, ME, NH, NJ, NY, OH, PA, VA, VT, WV

Delaware Estuary Associations:

- Calcareous Slope Forest
- Montane Cliff (Calcareous Type)

CLASSIFIERS FOR NORTH-CENTRAL APPALACHIAN CIRCUMNEUTRAL CLIFF AND TALUS

Primary Division: 202

Land Cover Class: Barren

Spatial Scale & Pattern: Small patch

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

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

Non-diagnostic Classifiers: Lowland; Sideslope; Circumneutral Soil; Very Shallow Soil; Ustic; Landslide; Moderate
(100-500 yrs) Persistence

CALCAREOUS SLOPE FOREST

Acer saccharum - *Fraxinus americana* - *Juglans cinerea* / *Staphylea trifolia* Forest

Range: This community is reported to occur in the northern and central Appalachian regions, from Vermont and New Hampshire south to Virginia and West Virginia. It occurs in the Pennsylvania portion of the Delaware Estuary.

Environmental Description: Sites include talus slopes or shallow rocky soils weathered from calcareous or circumneutral bedrock. Habitats are situated on lower to middle slopes subtending streams in low-elevation montane valleys and gorges. Slopes are steep, usually with north to east aspects. Bedrock outcrops are frequent. Exposed rock (boulder and outcrop) cover can be up to 50%, which reduces both species richness and herbaceous cover. However, due to the relatively rapid weathering of carbonate materials and extremely fertile soils, these habitats are typically well vegetated with herbaceous plants. High cover of mosses provides a foothold for many species, while organic mats and soil pockets are also numerous.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: In the northern part of this unit's range, canopy dominants are *Acer saccharum* (sugar maple) and *Fraxinus americana* (white ash), with typical associates of *Juglans cinerea* (butternut), *Quercus rubra* (northern red oak), *Tilia americana* (American basswood), *Carya cordiformis* (bitternut hickory), and *Quercus muehlenbergii* (chinquapin oak). *Betula alleghaniensis* (yellow birch), *Fagus grandifolia* (American beech), and *Ulmus* (elm) spp. may also occur locally. *Ostrya virginiana* (eastern hop-hornbeam) and *Carpinus caroliniana* (American hornbeam) are typical small trees. The shrub layer is open and characterized by *Staphylea trifolia* (American bladdernut), *Corylus* (hazelnut) spp., *Hamamelis virginiana* (American witch-hazel), *Rubus odoratus* (purple-flowering raspberry), *Parthenocissus quinquefolia* (Virginia creeper), *Toxicodendron radicans* (eastern poison-ivy), and *Vitis* (grape) spp. Typical species of the fairly diverse herb layer include *Actaea pachypoda* (white baneberry), *Allium tricoccum* (ramps), *Aralia nudicaulis* (wild sarsaparilla), *Aralia racemosa* (American spikenard), *Asplenium platyneuron* (ebony spleenwort), *Asarum canadense* (Canadian wild ginger), *Eurybia divaricata* (white wood-aster), *Circaea lutetiana* ssp. *canadensis* (broadleaf enchanter's-nightshade), *Cystopteris fragilis* (fragile fern), *Cystopteris bulbifera* (bulblet bladderfern), *Dryopteris* (woodfern) spp., *Polystichum acrostichoides* (Christmas fern), *Sanguinaria canadensis* (bloodroot), *Solidago flexicaulis* (zigzag goldenrod), *Trillium erectum* (stinking benjamin), *Woodsia obtusa* (common cliff fern), and others. Characteristic graminoids include *Carex laxiflora* (loose-flower sedge), *Carex sprengei* (longbeak sedge), *Carex virescens* (ribbed sedge), *Elymus hystrix* (bottlebrush grass), and *Piptatherum racemosum* (black-seed mountain ricegrass).

Characteristic Species: *Acer saccharum* (sugar maple), *Carex laxiflora* (loose-flower sedge), *Fraxinus americana* (white ash), *Juglans cinerea* (butternut), *Staphylea trifolia* (American bladdernut)

Dynamics/Successional Trajectory: Exposed rock (boulder and outcrop) cover can be up to 50%, which reduces both species richness and herbaceous cover. However, due to the relatively rapid weathering of carbonate materials and extremely fertile soils, these habitats are typically well vegetated with herbaceous plants. High cover of mosses provides a foothold for many species, while organic mats and soil pockets are also numerous.

Management Concerns: This community type has a wide geographic range and occupies rugged habitats that are not prone to many anthropogenic disturbances. Invasive exotic weeds do not appear to be particularly troublesome, but windthrow, slumping or landsliding of unstable colluvium, and other erosional disturbances appear to be relatively frequent in the habitats of this type.

Reference Sites: none identified

Global and State Conservation Ranks and Reasons: G4? (1-Oct-2001). NJ: S2, PA: S2?. Occurs mostly in small, local patches. There are likely >50 occurrences in Virginia, and many in West Virginia (D. Walton pers. comm.).

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688340

References: Breden 1989, Breden et al. 2001, CAP pers. comm. 1998, Eastern Ecology Working Group n.d., Eyre 1980, Fike 1999, Fleming 1999, Fleming and Coulling 2001, Fleming et al. 2001, Harrison 2004, Lundgren 2000, Metzler and Barrett 1996, Metzler and Barrett 2001, Rawinski 1984, Swain and Kearsley 2001, Thompson 1996, Thompson and Sorenson 2000, VDNH 2003, Walton pers. comm.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Acer saccharum</i> (sugar maple)
Tree canopy	Broad-leaved deciduous tree	<i>Fraxinus americana</i> (white ash)
Tree canopy	Broad-leaved deciduous tree	<i>Juglans cinerea</i> (butternut)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Ostrya virginiana</i> (eastern hop-hornbeam)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Staphylea trifolia</i> (American bladdernut)
Herb (field)	Fern or fern ally	<i>Polystichum acrostichoides</i> (Christmas fern)

MONTANE CLIFF (CALCAREOUS TYPE)

Asplenium ruta-muraria - *Pellaea atropurpurea* Sparse Vegetation

Range: This community occurs in areas of limestone or dolomite geology from Pennsylvania south to Alabama. It is found primarily in the Ridge and Valley and Cumberland Plateau, but ranges into scattered areas in the Blue Ridge.

Environmental Description: This community occurs on calcareous cliffs, outcrops, and rocky slopes and is often shaded by trees rooted in adjacent forested communities and/or the outcrops. It has little vegetative cover, often with 90% of the rock surface unvegetated. Mosses and lichens can have moderate coverage, and vascular plants occur on ledges and rooted in cracks.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: Stands of this association have little vegetative cover, often with 90% of the rock surface unvegetated. Mosses and lichens can have moderate coverage, and vascular plants occur on ledges and rooted in cracks. Calciphilic herbs, such as *Aquilegia canadensis* (eastern columbine), *Dodecatheon meadia* (pride-of-Ohio), *Symphotrichum ericoides* (white heath aster), *Cystopteris bulbifera* (bulblet bladderfern), *Bouteloua curtipendula* (sideoats grama), *Pellaea atropurpurea* (purple cliffbrake), *Dryopteris marginalis* (marginal woodfern), *Allium cernuum* (nodding onion), *Heuchera americana* (common alumroot), *Carex oligocarpa* (richwoods sedge), *Asplenium trichomanes* (maidenhair spleenwort), *Arabis hirsuta* (western hairy rockcress), *Arabis lyrata* (lyrate rockcress), and *Saxifraga virginiana* (early saxifrage) are characteristic. Woody species may occur scattered throughout or at the margins; these species include *Juniperus virginiana* (eastern red-cedar), *Rhus aromatica* (fragrant sumac), *Toxicodendron radicans* (eastern poison-ivy), *Hydrangea arborescens* (smooth

hydrangea), *Fraxinus americana* (white ash), *Parthenocissus quinquefolia* (Virginia creeper), *Cercis canadensis* (eastern redbud), *Tilia americana* (American basswood), *Carya* (hickory) spp., *Quercus muehlenbergii* (chinquapin oak), *Ostrya virginiana* (eastern hop-hornbeam), and *Cornus florida* (flowering dogwood).

Characteristic Species: *Aquilegia canadensis* (eastern columbine), *Asplenium trichomanes* (maidenhair spleenwort), *Dodecatheon meadia* (pride-of-Ohio), *Pellaea atropurpurea* (purple cliffbrake)

Dynamics/Successional Trajectory: Species composition varies with moisture, shade and exposure on the rocky surface.

Management Concerns: This community type occupies rugged habitats that are not prone to many anthropogenic disturbances. Invasive exotic weeds do not appear to be particularly troublesome, but windthrow, slumping or landsliding, and other erosional disturbances may be relatively frequent in the habitats of this type.

Reference Sites: none identified

Global and State Conservation Ranks and Reasons: G3G4 (11-Aug-1997). PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688984

References: Allard 1990, CAP pers. comm. 1998, Fike 1999, Fleming et al. 2001, Harrison 2004, Schafale 1998b, Schafale and Weakley 1990, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Juniperus virginiana</i> (eastern red-cedar)
Shrub/sapling (tall & short)	Vine/Liana	<i>Parthenocissus quinquefolia</i> (Virginia creeper)
Herb (field)	Forb	<i>Aquilegia canadensis</i> (eastern columbine)
Herb (field)	Forb	<i>Dodecatheon meadia</i> (pride-of-Ohio)

ECOLOGICAL SYSTEM: NORTH-CENTRAL APPALACHIAN SEEPAGE FEN

Summary: This system is found in scattered locations in the central Appalachians and eastern Great Lakes regions. Mostly non-forested, these open fens develop on shallow to deep peat over a sloping substrate, where seepage waters provide nutrients. Conditions are often circumneutral to alkaline. Sedges are the major dominants. *Packera aurea* (golden ragwort), *Symplocarpus foetidus* (skunk-cabbage), and *Lobelia kalmii* (Ontario lobelia) are among the characteristic forbs. Some of these areas are kept open by grazing, and succession to shrublands may occur in the absence of disturbance.

High-ranked Species: *Carex schweinitzii* (G3G4, schweinitz's sedge), *Carex* sp. 2 (G1, fen sedge), *Chelone cuthbertii* (G3, cuthbert's turtlehead), *Glyptemys muhlenbergii* (G3, bog turtle), *Neonympha mitchellii* (G1G2, Mitchell's satyr), *Parnassia grandifolia* (G3, largeleaf grass-of-parnassus), *Poa paludigena* (G3, bog bluegrass)

Range: This system is found in scattered locations from central New England and New York west to Lake Erie and south to western Virginia (Central Appalachians ecoregion). United States: CT, MA, MD, NJ, NY, PA, VA, VT, WV?

Delaware Estuary Associations:

- Calcareous Shrub Fen
- Northern Piedmont Rich Fen
- Pasture Fen
- Prairie Sedge - Tussock Sedge Fen
- Sedge - Cottongrass Peatland Fen
- Skunk-cabbage Seepage Meadow

CLASSIFIERS FOR NORTH-CENTRAL APPALACHIAN SEEPAGE FEN

Primary Division: 202

Land Cover Class: Herbaceous Wetland

Spatial Scale & Pattern: Small patch

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

Diagnostic Classifiers: Herbaceous; Seepage-Fed Sloping; Organic Peat (>40 cm)

Non-diagnostic Classifiers: Lowland; Shrubland (Shrub-dominated); Temperate; Isolated Wetland [Partially

Isolated]; Circumneutral Water; 1-29-day hydroperiod; Short (50-100 yrs) Persistence

CALCAREOUS SHRUB FEN

Cornus amomum - *Salix candida* / *Dasiphora fruticosa* ssp. *floribunda* / *Carex stricta* Shrubland

Range: This association occurs in Pennsylvania, New Jersey, Massachusetts, Connecticut, and New York. It occurs in Pennsylvania in the Delaware Estuary.

Environmental Description: This calcareous fen shrubland is characterized by hummocky microtopography and dense patches of shrubs with small interspersed graminoid openings. A portion of the water budget is comprised of strongly minerotrophic seepage water. Substrate is typically woody peat.

Vegetation Description: Shrubs such as *Cornus amomum* (silky dogwood), *Cornus sericea* (red-osier dogwood), and *Salix* (willow) spp. (*Salix candida* (hoary willow), *Salix petiolaris* (meadow willow), *Salix serissima* (autumn willow), and *Salix discolor* (pussy willow)) are dominant and very characteristic of this association. Other shrubs include *Dasiphora fruticosa* ssp. *floribunda* (shrubby-cinquefoil), *Alnus incana* (speckled alder), *Toxicodendron vernix* (poison-sumac), *Myrica gale* (sweet gale), and *Viburnum*

dentatum (southern arrow-wood). *Carex stricta* (tussock sedge) is a characteristic sedge; other herbaceous associates include *Carex aquatilis* (aquatic sedge), *Eupatorium maculatum* (spotted joe-pyeweed), *Solidago patula* (roundleaf goldenrod), *Solidago uliginosa* (bog goldenrod), *Spiranthes cernua* (nodding ladies'-tresses), *Trollius laxus* (American globeflower), *Thelypteris palustris* (eastern marsh fern), *Muhlenbergia glomerata* (spiked muhly), *Parnassia glauca* (fen grass-of-parnassus), *Drosera rotundifolia* (roundleaf sundew), *Carex lacustris* (lake sedge), *Ludwigia palustris* (marsh seedbox), *Equisetum fluviatile* (water horsetail), and *Deschampsia caespitosa* (tufted hairgrass). *Juniperus virginiana* (eastern red-cedar) occurs as scattered individuals and is characteristic of this association in New Jersey.

Characteristic Species: *Carex stricta* (tussock sedge), *Cornus amomum* (silky dogwood), *Cornus sericea* (red-osier dogwood), *Salix discolor* (pussy willow)

Reference Sites: none identified

Global and State Conservation Ranks and Reasons: G3? (23-Jan-1998). NJ: S2S3, PA: SNR. This association is restricted to wetlands of calcareous regions in New Jersey and Pennsylvania. Although it is not currently documented from other states, it is likely to occur in Connecticut, Massachusetts, and New York; however, only 150 maximum occurrences are estimated rangewide, and total acreage is not likely to exceed 4500 acres.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689618

References: Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Metzler and Barrett 2001, Metzler and Barrett 2004, Motzkin 1994, Rawinski 1984, Swain and Kearsley 2001

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>Cornus sericea</i> (red-osier dogwood)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Salix discolor</i> (pussy willow)
Herb (field)	Graminoid	<i>Carex stricta</i> (tussock sedge)

NORTHERN PIEDMONT RICH FEN

Morella pensylvanica - *Dasiphora fruticosa* ssp. *floribunda* / *Carex sterilis* - *Carex flava* Shrub
Herbaceous Vegetation

Range: This association is limited to New Jersey and Pennsylvania and possibly southwestern New York.

Environmental Description: This spring-fed calcareous fen community generally occurs with minimal peat accumulation over mineral soil or marl substrate particularly where groundwater emerges.

Vegetation Description: Although the shrubs are generally of sparse cover (less than 25%), they are characteristic of this vegetation, with *Dasiphora fruticosa* ssp. *floribunda* (shrubby-cinquefoil) and *Morella*



Photo by Pennsylvania Natural Heritage Program

pensylvanica (northern bayberry) common and *Toxicodendron vernix* (poison-sumac), *Acer rubrum* (red maple), and *Juniperus virginiana* (eastern red-cedar) as frequent associates. Wettest portions of these fens lack woody vegetation. The herbaceous flora is rich and diverse, and includes the sedges *Carex sterilis* (sterile sedge), *Carex flava* (yellow sedge), *Carex cryptolepis* (northeastern sedge), *Rhynchospora capillacea* (limestone beaksedge), *Rhynchospora alba* (white beaksedge), as well as *Parnassia glauca* (fen grass-of-parnassus), *Sanguisorba canadensis* (Canada burnet), *Drosera rotundifolia* (roundleaf sundew), *Sarracenia purpurea* (purple pitcherplant), *Lobelia kalmii* (Ontario lobelia), *Panicum flexile* (wiry panicgrass), *Deschampsia caespitosa* (tufted hairgrass), *Juncus brachycephalus* (small-head rush), *Juncus nodosus* (knotted rush), and *Spiranthes cernua* (nodding ladies'-tresses). The diagnostic characteristic is the presence of *Morella pensylvanica* (northern bayberry) in the shrub layer. This association is restricted to New Jersey, Pennsylvania, and perhaps New York.

Characteristic Species: *Dasiphora fruticosa* ssp. *floribunda* (shrubby-cinquefoil), *Morella pensylvanica* (northern bayberry)

Dynamics/Successional Trajectory: This calcareous fen association is characterized by herbaceous vegetation maintained by groundwater springs.

Management Concerns: Most occurrences are associated with areas of historic or current grazing, which apparently limits shrub establishment. In areas where grazing has been discontinued, the fens are often rapidly filling with shrubs, particularly *Cornus racemosa* (gray dogwood) or *Cornus sericea* (red-osier dogwood). In other areas, disruptions in local hydrology caused by nearby development has had a negative effect on the condition of some occurrences. These often contain many weedy species, both native and exotic.

Reference Sites: none identified

Global and State Conservation Ranks and Reasons: G2 (12-Jan-1998). NJ: S2, PA: SNR. This "fen" vegetation type is restricted in distribution to a few calcareous or limestone areas in the non glaciated regions of New Jersey and Pennsylvania. There are fewer than 15 known occurrences of this vegetation, with a potential for 5-10 more. The occurrences are generally very small in size, often only an acre or two.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689623

References: Breden et al. 2001, Eastern Ecology Working Group n.d., Fike 1999

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Dasiphora fruticosa</i> ssp. <i>floribunda</i> (shrubby-cinquefoil)
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Morella pensylvanica</i> (northern bayberry)
Herb (field)	Graminoid	<i>Carex flava</i> (yellow sedge)
Herb (field)	Graminoid	<i>Carex sterilis</i> (sterile sedge)

PASTURE FEN

Juniperus virginiana / *Dasiphora fruticosa* ssp. *floribunda* / *Carex flava* - *Carex tetanica* Shrub
Herbaceous Vegetation

Range: This association occurs in New Jersey and Pennsylvania. It occurs in the Pennsylvania portion of the Delaware Estuary.

Environmental Description: This association is a saturated wetland of turfy mineral soil occurring over calcareous bedrock, a fen supporting a number of calciphitic species.

Vegetation Description: *Juniperus virginiana* (eastern red-cedar) occurs as scattered individuals over an herbaceous understory characterized by *Carex flava* (yellow sedge), *Carex tetanica* (rigid sedge),

Juncus brachycephalus (small-head rush), *Juncus dudleyi* (dudley's rush), *Juncus nodosus* (knotted rush), *Equisetum fluviatile* (water horsetail), *Bromus kalmii* (Kalm's brome), *Castilleja coccinea* (scarlet Indian-paintbrush), *Sisyrinchium angustifolium* (narrowleaf blue-eyed-grass), *Solidago uliginosa* (bog goldenrod), *Eupatorium maculatum* (spotted joe-pyeweed), *Cypripedium parviflorum* (lesser yellow lady's-slipper), *Thelypteris palustris* (eastern marsh fern), *Lobelia kalmii* (Ontario lobelia), *Liatris spicata* (bog blazingstar), *Spiranthes lucida* (shining ladies'-tresses), *Trollius laxus* (American globeflower), *Rudbeckia fulgida* (orange coneflower), *Pedicularis canadensis* (Canadian lousewort), and *Pedicularis lanceolata* (swamp lousewort), which is intermixed with the dwarf-shrubs *Betula pumila* (bog birch) and *Dasiphora fruticosa ssp. floribunda* (shrubby-cinquefoil).

Characteristic Species: *Carex flava* (yellow sedge), *Carex tetanica* (rigid sedge), *Dasiphora fruticosa ssp. floribunda* (shrubby-cinquefoil), *Juniperus virginiana* (eastern red-cedar)

Dynamics/Successional Trajectory: This vegetation has been generally affected by grazing in the past, which in some cases continues to the present, and as such this vegetation is known locally as a pasture fen.

Management Concerns: Community historically grazed.

Reference Sites: none identified

Global and State Conservation Ranks and Reasons: G1G2 (23-Jan-1998). NJ: S1S2, PA: SNR. This association is restricted to saturated wetlands of turfy mineral soil occurring over calcareous bedrock in New Jersey and possibly Pennsylvania. Ten to twenty estimated occurrences in New Jersey, possibly the same number from Pennsylvania. These fens are 0.1-1.5 acres in size, with a total of 20-40 acres known from New Jersey. The total potential acreage of this type is well below 200 acres rangewide.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685846

References: Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Radis 1986

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Juniperus virginiana</i> (eastern red-cedar)
Herb (field)	Graminoid	<i>Carex flava</i> (yellow sedge)
Herb (field)	Graminoid	<i>Carex tetanica</i> (rigid sedge)

PRAIRIE SEDGE - TUSSOCK SEDGE FEN

Carex prairea - *Carex stricta* - *Pycnanthemum virginianum* Herbaceous Vegetation

Range: This community occurs within the Pennsylvania portion of the Delaware Estuary.

Environmental Description: These are open sedge-dominated wetlands that occur on organic soil saturated by base-rich groundwater.

Vegetation Description: Dominant sedges typically include *Carex prairea* (prairie sedge) and *Carex stricta* (tussock sedge). Associated sedges include *Carex sterilis* (sterile sedge), *Carex lacustris* (lake sedge), *Carex aquatilis* (aquatic sedge), *Carex leptalea* (bristly-stalk sedge), and *Carex lasiocarpa* (wiregrass sedge). Associate herbs include *Pycnanthemum virginianum* (Virginia mountainmint), *Verbena hastata* (swamp verbena), *Maianthemum stellatum* (starflower false Solomon's-seal), *Eupatorium maculatum* (spotted joe-pyeweed), *Epilobium leptophyllum* (bog willowherb), *Typha latifolia* (broadleaf cattail), *Galium tinctorium* (stiff marsh bedstraw), *Onoclea sensibilis* (sensitive fern), *Cirsium muticum* (swamp thistle), *Impatiens capensis* (orange jewelweed), and *Juncus balticus* (Baltic rush). A ground

layer of mosses is typical, dominated by *Campyllum stellatum* (star campyllum moss), *Thuidium delicatulum* (delicate fern moss), and *Sphagnum teres* (sphagnum).

Characteristic Species: *Campyllum stellatum* (star campyllum moss), *Carex prairea* (prairie sedge)

Dynamics/Successional Trajectory: This community is an herbaceous community with low or absent woody plant cover. Woody plants may be inhibited by saturated soil conditions, though most occurrences have had some history of grazing or other human-induced disturbance in the past. Fire events during drought years may also reduce woody plant colonization, but evidence is limited.

Management Concerns: This community is susceptible to native and non-native invasive species, including *Phragmites australis* (common reed), *Typha* (cattail) spp., *Lythrum salicaria* (purple loosestrife), and others. Periodic monitoring and weed management may be required. Maintenance of hydrology is critical and should be assessed for potential threats.

Reference Sites: Sinking Spring (Berks), PA (all known PA occurrences are on private land)

Global and State Conservation Ranks and Reasons: GNR (8-Jul-1999). PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687924

References: Eastern Ecology Working Group n.d., Fike 1999

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Carex prairea</i> (prairie sedge)
Herb (field)	Graminoid	<i>Carex stricta</i> (tussock sedge)

SEDGE - COTTONGRASS PEATLAND FEN

Carex canescens - *Eriophorum virginicum* - *Sphagnum* spp. Herbaceous Vegetation

Range: This fen community occurs in the Pennsylvania portion of the Delaware Estuary.

Environmental Description: This community consists of sedge-dominated peatlands of higher elevations in the Central Appalachians. It occurs in sandstone areas at mid to high elevations. These fens characteristically occur in a mosaic with other peatland types.

Vegetation Description: Typical dominants of this community are *Carex canescens* (silvery sedge), *Eriophorum virginicum* (tawny cotton-grass), and *Carex utriculata* (beaked sedge). Associates include *Polytrichum commune* (haircap moss), *Juncus effusus* (soft rush), *Juncus canadensis* (Canadian rush), *Scirpus cyperinus* (woolgrass bulrush), *Triadenum virginicum* (Virginia marsh St. John's-wort), *Thelypteris palustris* (eastern marsh fern), and *Photinia melanocarpa* (black chokeberry). The herbaceous layer is dominated by a well-developed *Sphagnum* (peatmoss) ground mat. It lacks the very acid-loving plants (*Drosera* (sundew), *Vaccinium oxycoccos* (small cranberry), etc.) of related associations.

Characteristic Species: *Carex canescens* (silvery sedge), *Carex utriculata* (beaked sedge), *Eriophorum virginicum* (tawny cotton-grass)

Dynamics/Successional Trajectory: Needs more study.

Management Concerns: Monitoring for invasive wetland plants, maintenance of hydrology (especially groundwater flows).

Reference Sites: Wolf Creek Reservoir Watershed, Eisenhuth Reservoir, Schuylkill County, PA

Global and State Conservation Ranks and Reasons: GNR (8-Jul-1999). PA?: SNA.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689030

References: Eastern Ecology Working Group n.d.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Carex canescens</i> (silvery sedge)
Herb (field)	Graminoid	<i>Eriophorum virginicum</i> (tawny cotton-grass)

SKUNK-CABBAGE SEEPAGE MEADOW

Symplocarpus foetidus Herbaceous Vegetation

Range: This community is found throughout the upper midwestern region of the United States and adjacent Canada, where it develops around spring heads and in broader areas of groundwater discharge. The type extends from Indiana and possibly Ontario and Ohio, west to Minnesota and Iowa. It occurs in the Pennsylvania portion of the Delaware Estuary.



Photo by Pennsylvania Natural Heritage Program

Environmental Description: This community develops around spring heads and in broader areas of groundwater discharge, where water flows to the surface in a diffuse rather than concentrated flow. Peat may be present in some areas, and perhaps locally can be as deep as 1 m, but it is typically less than 0.4 m deep. Stands can occur along the lower slopes of glacial moraines, ravines and in deep glacial meltwater-cut river valleys at the bases of slopes separating stream terraces. Soils are seasonally to more-or-less permanently saturated (MNNHP 1993).

Vegetation Description: This is an herbaceous-dominated community. Tree and shrub cover may vary, particularly from overhanging upland trees, but trees and shrubs rooted in the stand are less than 25% cover. Forbs dominate the community. *Symplocarpus foetidus* (skunk-cabbage) and *Angelica atropurpurea* (great angelica) are the leading dominant and indicator species. Other forbs and ferns present include *Caltha palustris* (yellow marsh-marigold), *Chelone glabra* (white turtlehead), *Epilobium coloratum* (purpleleaf willowherb), *Impatiens capensis* (orange jewelweed), *Impatiens capensis* (orange jewelweed), *Pedicularis lanceolata* (swamp lousewort), *Pilea pumila* (Canadian clearweed), *Saxifraga pennsylvanica* (eastern swamp saxifrage), *Solidago patula* (roundleaf goldenrod), and *Thelypteris palustris* (eastern marsh fern). Graminoid cover is generally low, less than 25%, and may include *Carex bromoides* (brome-like sedge), *Carex comosa* (longhair sedge), *Carex lacustris* (lake sedge), *Carex stricta* (tussock sedge), and *Carex trichocarpa* (hairy-fruit sedge) (White and Madany 1978, MNNHP 1993).

Noteworthy Associated Plant and/or Animal Species: *Floerkea proserpinacoides* (false mermaidweed), *Hydrocotyle americana* (American marsh pennywort), *Poa paludigena* (bog bluegrass)

Characteristic Species: *Angelica atropurpurea* (great angelica), *Symplocarpus foetidus* (skunk-cabbage)

Reference Sites: none identified

Global and State Conservation Ranks and Reasons: G4? (3-Oct-1996). NJ: SNR, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685623

References: Fike 1999, INAI unpubl. data, MNNHP 1993, Midwestern Ecology Working Group n.d., Newbold 1993, Newbold 1996, White and Madany 1978

ECOLOGICAL SYSTEM: NORTH-CENTRAL INTERIOR WET FLATWOODS

Summary: This small-patch system is found throughout the northern glaciated Midwest ranging east into Lower New England. It usually occurs on poorly drained uplands or in depressions associated with glacial features such as tillplains, lakeplains or outwash plains. Soils often have an impermeable or nearly impermeable clay layer that can create a shallow, perched water table. Saturation can vary, with ponding common during wetter seasons, and drought possible during the summer and autumn months. These fluctuating moisture levels can lead to complexes of forest upland and wetland species occurring within this system. *Quercus palustris* (pin oak) typically dominates and is often associated with *Quercus bicolor* (swamp white oak) and *Acer rubrum* (red maple). *Liquidambar styraciflua* (sweetgum) and *Nyssa sylvatica* (blackgum) are also common associates. Understory herbaceous and shrub species present in examples of this system can vary. Some common species include *Carex* (sedge) spp., *Osmunda cinnamomea* (cinnamon fern), *Cephalanthus occidentalis* (common buttonbush), *Alnus* (alder) spp., and *Ilex* (holly) spp. Flooding, drought and fire can influence this system.

High-ranked Species: *Euphyes dukesi* (G3, dukes' skipper)

Range: This system is found in the northern Midwest, southern Ontario, and southern portions of the northeastern U.S. United States: CT, IA, IL, IN, MA, MI, MN, MO, NY, OH, PA, VT, WI

Delaware Estuary Associations:

- Northeastern Pin Oak - Swamp White Oak Forest

CLASSIFIERS FOR NORTH-CENTRAL INTERIOR WET FLATWOODS

Primary Division: 202

Land Cover Class: Woody Wetland

Spatial Scale & Pattern: Small patch

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

Non-diagnostic Classifiers: Forest and Woodland (Treed); Flat; Extensive Wet Flat; Isolated Wetland [Partially Isolated]; Saturated Soil

NORTHEASTERN PIN OAK - SWAMP WHITE OAK FOREST

Quercus palustris - (*Quercus bicolor*) - *Acer rubrum* / *Osmunda cinnamomea* Forest

Range: This vegetation occurs in southern New England south to eastern Pennsylvania and New Jersey.

Environmental Description: This vegetation is found on loamy sand or clayey alluvium, muck or peat in areas that are seasonally wet (winter and early spring) with a shallow, perched water table, which tends to be dry in late summer and early fall. They may receive groundwater seepage.

Vegetation Description: This seasonally flooded pin oak community occurs in the eastern United States. The canopy is codominated by *Quercus palustris* (pin oak) and *Acer rubrum* (red maple). Common associates include *Quercus bicolor* (swamp white oak), *Nyssa sylvatica* (blackgum), and occasionally *Tsuga canadensis* (eastern hemlock) or *Carya* (hickory) spp. The shrub layer may be sparse or dense and contains *Ilex verticillata* (common winterberry), *Vaccinium corymbosum* (highbush blueberry), and *Viburnum dentatum* (southern arrow-wood). The sparse herb layer includes *Dirca palustris* (leatherwood), *Scirpus cyperinus* (woolgrass bulrush), *Thelypteris palustris* (eastern marsh fern), *Carex frankii* (Frank's sedge), *Glyceria striata* (fowl mannagrass), *Carex crinita* (fringed sedge), *Oncoclea sensibilis* (sensitive fern), and *Osmunda regalis* (royal fern).

Characteristic Species: *Quercus bicolor* (swamp white oak), *Quercus palustris* (pin oak)

Dynamics/Successional Trajectory: These are closed to partially open, deciduous, seasonally flooded forests that occur in basin areas that are seasonally wet (winter and early spring) with a shallow, perched water table, which tend to be dry in late summer and early fall. They are found on variable substrates but generally have some layer that impedes drainage and may receive groundwater seepage.

Reference Sites: Chapel Hill Forest, Valley Forge State Forest, Berks County, PA

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687748

References: Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Golet et al. 1993, Metzler and Barrett 2001, Sperduto 2000a, Sperduto 2000b, Swain and Kearsley 2000, Swain and Kearsley 2001

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>Quercus palustris</i> (pin oak)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Ilex verticillata</i> (common winterberry)
Herb (field)	Fern or fern ally	<i>Osmunda cinnamomea</i> (cinnamon fern)

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 acidic and relatively infertile but not strongly xeric. 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. 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, fort mountain sedge), *Carex polymorpha* (G3, variable sedge), *Coreopsis delphiniifolia* (G3?Q, larkspur tickseed), *Fothergilla major* (G3, mountain witch-alder), *Gaylussacia brachycera* (G3, box huckleberry), *Taenidia montana* (G3, mountain-pimpernel), *Thermopsis fraxinifolia* (G3?, ash-leaved bush-pea), *Thermopsis mollis* (G3G4, Allegheny mountain golden-banner), *Virginia valerianae pulchra* (G5T3T4, mountain earth snake)

Range: This system is found from central New England west through Ohio and Pennsylvania and south to Virginia. It does not extend to the southernmost part of Virginia, except in the Ridge and Valley. United States: CT, MA, MD, ME, NH, NJ, NY, OH, PA, RI, VA, VT, WV

Delaware Estuary Associations:

- Central Appalachian Forested Acid Seep
- Northeastern Dry Oak-Hickory Forest
- Northeastern Modified Successional Forest
- Red Maple - Blackgum Basin Swamp
- Red Maple - Tussock Sedge Wooded Marsh
- Red Maple Upland Forest
- Successional Aspen - Gray Birch Forest
- Tuliptree - Beech - Maple Forest
- Virginia Pine Successional Forest
- White Pine - Oak 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 FORESTED ACID SEEP

Acer rubrum - *Nyssa sylvatica* High Allegheny Plateau, Central Appalachian Forest

Range: This acidic deciduous swamp occurs in the central Appalachian Mountains north of the Cumberland drainage in the Central Appalachians and High Allegheny ecoregions, as well as the adjacent Cumberlands and Western Allegheny Plateau. This seep community occurs in the Pennsylvania portion of the Delaware Estuary.

Environmental Description: This community occurs on substrates which are saturated for extended periods during the growing season but which rarely have standing water, including forested seeps, hillsides, streamheads, floodplain edges, and poorly drained depressions. Occurrences tend to be small.

Vegetation Description: Characteristic trees are *Acer rubrum* (red maple) and *Nyssa sylvatica* (blackgum), with other associates including *Tsuga canadensis* (eastern hemlock) and *Betula alleghaniensis* (yellow birch). The shrub stratum includes *Alnus serrulata* (smooth alder), *Photinia pyrifolia* (red chokeberry), *Ilex verticillata* (common winterberry), *Vaccinium corymbosum* (highbush blueberry), *Rhododendron maximum* (great laurel), and *Rubus hispidus* (bristly dewberry). Characteristic herbs include *Osmunda cinnamomea* (cinnamon fern), *Osmunda regalis* (royal fern), *Carex folliculata* (northern long sedge), *Carex trisperma* (three-seed sedge), *Carex intumescens* (greater bladder sedge), *Carex stricta* (tussock sedge), and *Poa trivialis* (rough bluegrass). *Sphagnum* (peatmoss) spp. are typical.

Characteristic Species: *Acer rubrum* (red maple), *Nyssa sylvatica* (blackgum), *Osmunda cinnamomea* (cinnamon fern)

Reference Sites: none identified

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689039

References: Anderson et al. 1998, CAP pers. comm. 1998, Eastern Ecology Working Group n.d., Fike 1999, Harrison 2004

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>Nyssa sylvatica</i> (blackgum)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Alnus serrulata</i> (smooth alder)

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*



Photo by Pennsylvania Natural Heritage Program

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).

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

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

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)	Graminoid	<i>Carex pensylvanica</i> (Pennsylvania sedge)

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.

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.



Photo by Pennsylvania Natural Heritage Program

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 red-cedar), *Acer negundo* (box-elder), *Acer saccharinum* (silver maple), *Ailanthus altissima* (tree-of-heaven), *Ulmus americana* (American elm), *Quercus* (oak) spp., *Betula lenta* (sweet birch), *Amelanchier* (serviceberry) spp., 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* (blackberry) spp. 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* (hawthorn) spp., *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: *Acer rubrum* (red maple), *Fraxinus americana* (white ash), *Liriodendron tulipifera* (tuliptree), *Prunus serotina* (black cherry), *Robinia pseudoacacia* (black locust)

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* (hawthorn) spp., *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 restoration.

Global and State Conservation Ranks and Reasons: GNA (ruderal) (29-Nov-2004). NJ: SNA, PA: SNA. 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

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 subcanopy	Broad-leaved deciduous tree	<i>Acer rubrum</i> (red maple)
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Carpinus caroliniana</i> (American hornbeam)
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Lindera benzoin</i> (northern spicebush)

RED MAPLE - BLACKGUM BASIN SWAMP

Acer rubrum - *Nyssa sylvatica* - *Betula alleghaniensis* / *Sphagnum* spp. Forest

Range: This community occurs in Pennsylvania in the Delaware Estuary.

Environmental Description: This blackgum basin swamp of the northeastern United States is found from the central Appalachians north to central New England, at the northern range limit for *Nyssa sylvatica* (blackgum). It occupies saturated or seasonally wet basins, typically perched basins in small watersheds within upland forests. In most settings, the mineral soil is overlain with a shallow to deep peat layer. Conditions are highly acidic and nutrient-poor.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: The canopy is dominated by *Acer rubrum* (red maple) and *Nyssa sylvatica* (blackgum); however, even where red maple is more abundant, the longevity and stature of the blackgum trees give them a strong impact. *Betula alleghaniensis* (yellow birch), *Tsuga canadensis* (eastern hemlock), *Pinus strobus* (eastern white pine), and in the north *Picea rubens* (red spruce) may be minor canopy associates. The most abundant shrubs are *Ilex verticillata* (common winterberry) and *Vaccinium corymbosum* (highbush blueberry); associated shrub species include *Viburnum nudum* var. *cassinoides* (northern wild raisin), *Nemopanthus mucronatus* (catberry), *Kalmia angustifolia* (sheep laurel), *Lyonia ligustrina* (maleberry), and *Cephalanthus occidentalis* (common buttonbush). *Osmunda cinnamomea* (cinnamon fern) is the characteristic dominant in the herb layer, with associates including *Osmunda regalis* (royal fern), *Thelypteris palustris* (eastern marsh fern), *Woodwardia virginica* (Virginia chainfern), *Glyceria canadensis* (rattlesnake mannagrass), *Coptis trifolia* (threeleaf goldthread), *Carex trisperma* (three-seed sedge), *Carex intumescens* (greater bladder sedge), *Triadenum virginicum* (Virginia marsh St. John's-wort), and *Symplocarpus foetidus* (skunk-cabbage). Mosses are primarily *Sphagnum* (peatmoss) spp., including *Sphagnum palustre* (prairie peatmoss) and *Sphagnum magellanicum* (Magellan's peatmoss). These swamps are distinguished from other basin swamps in the Northern Appalachians by the presence of *Nyssa sylvatica* (blackgum). They are distinguished from blackgum swamps further south by the absence of more central-Appalachian species such as *Liquidambar*

styraciflua (sweetgum), *Rhododendron maximum* (great laurel), *Rhododendron viscosum* (swamp azalea), and *Magnolia virginiana* (sweetbay).

Characteristic Species: *Acer rubrum* (red maple), *Ilex verticillata* (common winterberry), *Nyssa sylvatica* (blackgum), *Osmunda cinnamomea* (cinnamon fern), *Vaccinium corymbosum* (highbush blueberry)

Dynamics/Successional Trajectory: The tree canopy varies from an open woodland to nearly complete. Shrubs are well represented and may be locally dense. Herbs are likewise patchy, and the herb layer is usually dominated by only a few species. The bryoid layer varies, but is often extensive. Hummock-and-hollow topography is often pronounced, with bryophytes common on the hummocks and in those hollows where water does not stand for long periods.

Reference Sites: near Portland Pumphouse #2, Delaware Water Gap, PA

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688103

References: Breden et al. 2001, Cain and Penfound 1938, Cowardin et al. 1979, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Gawler 2002, Golet et al. 1993, Harrison 2004, Metzler and Barrett 2001, NAP pers. comm. 1998, Rawinski 1984, Sperduto 2000b, Sperduto et al. 2000b, Swain and Kearsley 2001, Thompson 1996, Thompson and Sorenson 2000, Vogelmann 1976, Windisch 1995c, Zebryk 1990

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>Nyssa sylvatica</i> (blackgum)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Ilex verticillata</i> (common winterberry)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Vaccinium corymbosum</i> (highbush blueberry)

RED MAPLE - TUSsock SEDGE WOODED MARSH

Acer rubrum / *Carex stricta* - *Onoclea sensibilis* Woodland

Range: This wetland is found in central and northern New England, south to Pennsylvania and New Jersey. It occurs in Pennsylvania in the Delaware Estuary.

Environmental Description: This association is a partly wooded, deciduous-canopy wetland of central and northern New England. It occurs on muck soils or mineral soils with a surface organic layer, in poorly drained depressions influenced by groundwater. It is also common in those streamside and lakeside settings where the hydrology is that of a basin setting rather than a floodplain. The community is typically flooded in spring, with pools and small streams persisting throughout much of the growing season; soils may remain saturated, or may become dry on the surface over the course of the growing season. Hummock-and-hollow topography may be pronounced. In Pennsylvania this type is often associated with areas of past beaver impoundments.

Vegetation Description: The canopy consists of scattered trees, with as little as 25% overall cover. The shrub layer is patchy and may be extensive in places. The herb layer is typically well-developed, with ferns and graminoids dominant. The bryophyte cover is variable. *Acer rubrum* (red maple) is dominant in the canopy, often with many standing dead trees. Associated trees include *Fraxinus nigra* (black ash), *Nyssa sylvatica* (blackgum), *Quercus bicolor* (swamp white oak), *Quercus palustris* (pin oak), *Ulmus americana* (American elm), and occasional *Pinus strobus* (eastern white pine), *Tsuga canadensis* (eastern hemlock), or *Picea rubens* (red spruce). The shrub layer is characterized by *Vaccinium corymbosum* (highbush blueberry) and *Ilex verticillata* (common winterberry). Other shrubs may be locally common, including *Nemopanthus mucronatus* (catberry), *Viburnum nudum var. cassinoides* (northern

wild raisin), *Viburnum recognitum* (northern arrow-wood), *Lyonia ligustrina* (maleberry), *Alnus incana* (speckled alder), *Ilex laevigata* (smooth winterberry holly), *Spiraea alba* (white meadowsweet), *Spiraea tomentosa* (steeplebush), and the creeping *Rubus hispidus* (bristly dewberry). The herbaceous layer is typically dominated by the graminoids *Carex stricta* (tussock sedge), *Carex lacustris* (lake sedge), or *Calamagrostis canadensis* (bluejoint), or the ferns *Onoclea sensibilis* (sensitive fern), *Osmunda cinnamomea* (cinnamon fern), or *Osmunda claytoniana* (interrupted fern). Less abundant herbs include *Carex intumescens* (greater bladder sedge), *Carex folliculata* (northern long sedge), *Carex canescens* (silvery sedge), *Carex trisperma* (three-seed sedge), *Glyceria striata* (fowl mannagrass), *Osmunda regalis* (royal fern), *Dryopteris cristata* (crested woodfern), *Thelypteris palustris* (eastern marsh fern), *Lycopus uniflorus* (northern bugleweed), *Caltha palustris* (yellow marsh-marigold), and *Impatiens capensis* (orange jewelweed). *Sphagnum* (peatmoss) spp. are the characteristic bryophytes, with non-sphagnous mosses as associates.

Characteristic Species: *Acer rubrum* (red maple), *Ilex verticillata* (common winterberry), *Onoclea sensibilis* (sensitive fern), *Spiraea alba* var. *latifolia* (broadleaf meadowsweet), *Vaccinium corymbosum* (highbush blueberry)

Dynamics/Successional Trajectory: This plant community type is sensitive to changes in hydrology and represents a transition from a wetter, open tussock sedge marsh with low forest cover to a red maple palustrine forest with high canopy cover (and much reduced *Carex stricta* (tussock sedge) cover). Changes in hydrology will tend to shift community composition between the two types, with persistent deeper water levels favoring *Carex stricta* (tussock sedge) and drying conditions favoring *Acer rubrum* (red maple).

Reference Sites: Lake Towhee Park, Bucks County, PA (needs to be field checked); Great Swamp National Wildlife Refuge, Morris County, NJ

Global and State Conservation Ranks and Reasons: G3G5 (1-Dec-1997). NJ: SNR, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684410

References: Barrett and Enser 1997, CAP pers. comm. 1998, Cowardin et al. 1979, Eastern Ecology Working Group n.d., Edinger et al. 2002, Eyre 1980, Fike 1999, Gawler 2002, Golet et al. 1993, Hunt 1999, Metzler and Barrett 2001, Moore and Taylor 1927, Rawinski 1984, Sperduto 2000a, Sperduto 2000b, Swain and Kearsley 2001, Thompson and Sorenson 2000

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Acer rubrum</i> (red maple)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Ilex verticillata</i> (common winterberry)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Vaccinium corymbosum</i> (highbush blueberry)
Short shrub/sapling meadowsweet)	Broad-leaved deciduous shrub	<i>Spiraea alba</i> var. <i>latifolia</i> (broadleaf meadowsweet)
Herb (field)	Graminoid	<i>Calamagrostis canadensis</i> (bluejoint)
Herb (field)	Graminoid	<i>Carex lacustris</i> (lake sedge)
Herb (field)	Graminoid	<i>Carex stricta</i> (tussock sedge)
Herb (field)	Fern or fern ally	<i>Osmunda cinnamomea</i> (cinnamon fern)
Herb (field)	Fern or fern ally	<i>Osmunda claytoniana</i> (interrupted fern)

RED MAPLE UPLAND FOREST

Acer rubrum / *Dennstaedtia punctilobula* Forest

Range: This red maple upland forest occurs in the Pennsylvania portion of the Delaware Estuary.

Environmental Description: This community occurs in upland settings and tends to persist when embedded in an oak forest matrix but is ephemeral as part of a "northern hardwoods" matrix.

Vegetation Description: This is a successional to persistent closed-canopy forest dominated by *Acer rubrum* (red maple). Canopy associates include *Quercus* (oak) spp., *Betula lenta* (sweet birch), *Liriodendron tulipifera* (tuliptree), *Prunus serotina* (black cherry),



Photo by Pennsylvania Natural Heritage Program

Fraxinus americana (white ash), and *Carya* (hickory) spp. Typical shrubs include *Viburnum acerifolium* (mapleleaf viburnum), *Lindera benzoin* (northern spicebush), *Hamamelis virginiana* (American witch-hazel), *Kalmia latifolia* (mountain laurel), *Gaylussacia baccata* (black huckleberry), and *Cornus florida* (flowering dogwood). The understory is variable and dominated by *Dennstaedtia punctilobula* (eastern hay-scented fern) and *Thelypteris noveboracensis* (New York fern).

Characteristic Species: *Acer rubrum* (red maple), *Dennstaedtia punctilobula* (eastern hay-scented fern)

Dynamics/Successional Trajectory: This is a successional forest type and is becoming more common where heavy deer browse pressure following canopy disturbance favors red maple regeneration over oaks and other hardwoods. In northern hardwood forests, this type may be considered early- to mid-successional and may be expected to add typical northern hardwood canopy dominants over time (e.g., sugar maple, beech, and hemlock).

Management Concerns: None, not a conservation target. This community is heavily deer browsed.

Reference Sites: No need for reference sites as this community is not a desired target for restoration.

Global and State Conservation Ranks and Reasons: GNR (8-Jul-1999). PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685013

References: Eastern Ecology Working Group n.d., Fike 1999

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>Betula lenta</i> (sweet birch)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Viburnum acerifolium</i> (mapleleaf viburnum)

SUCCESSIONAL ASPEN - GRAY BIRCH FOREST

Populus tremuloides - *Betula populifolia* Forest

Range: This community occurs in Pennsylvania in the Delaware Estuary.

Environmental Description: This is an early-successional forest type, commonly found on former agricultural land, in areas of ice-scour along streambanks, and where there has been major disturbance resulting in areas of exposed mineral soil. This type may also result from forestry practices that maintain an early-successional stage.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: This type is frequently mixed, but sometimes occurs in nearly pure stands of one of the named species. The birch may be *Betula papyrifera* (paper birch) on more northern sites, or *Betula populifolia* (gray birch) and occasionally *Betula lenta* (sweet birch). The aspen may be *Populus grandidentata* (bigtooth aspen) or *Populus tremuloides* (quaking aspen). Associates include *Sassafras albidum* (sassafras), *Acer* (maple) spp., and *Prunus* (plum, cherry) spp.

Characteristic Species: *Betula populifolia* (gray birch), *Populus tremuloides* (quaking aspen)

Dynamics/Successional Trajectory: Successional trajectory is uncertain and may be controlled by availability of propagules from adjacent forest stands.

Management Concerns: Not a conservation target, early-successional community typical of disturbed land.

Reference Sites: Fort Indiantown Gap National Guard Training Center, Lebanon County, PA; Delaware Water Gap National Recreation Area; Valley Forge National Historical Park

Global and State Conservation Ranks and Reasons: GNR (8-Jul-1999). PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688070

References: Eastern Ecology Working Group n.d., Fike 1999

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Populus tremuloides</i> (quaking aspen)

TULIPTREE - BEECH - MAPLE FOREST

Fagus grandifolia - *Betula lenta* - *Liriodendron tulipifera* - *Acer saccharum* Forest

Range: This vegetation is currently described primarily from Pennsylvania and is also documented in New Jersey. It may occur in Maryland. This is a very common forest type in the Pennsylvania portion of the Delaware Estuary study area.

Environmental Description: This vegetation occurs on middle to lower slopes on moderately deep soils that are not extremely acidic.

Vegetation Description: The tree canopy is characterized by a mixture of *Liriodendron tulipifera* (tuliptree), *Fagus grandifolia* (American beech), *Acer saccharum* (sugar maple), *Betula lenta*



Photo by Pennsylvania Natural Heritage Program

(sweet birch), and other associated species, including *Acer rubrum* (red maple), *Nyssa sylvatica* (blackgum), and *Carya alba* (mockernut hickory). The subcanopy is characterized by *Carpinus caroliniana* (American hornbeam), *Cornus florida* (flowering dogwood), and *Ostrya virginiana* (eastern hop-hornbeam). Common species of the shrub layer include *Hamamelis virginiana* (American witch-hazel) and *Lindera benzoin* (northern spicebush), which can be abundant. The herbaceous layer is characterized by *Podophyllum peltatum* (mayapple), *Sanguinaria canadensis* (bloodroot), *Botrychium virginianum* (rattlesnake fern), *Dicentra cucullaria* (Dutchman's breeches), *Dicentra canadensis* (squirrel-corn), *Allium tricoccum* (ramps), and *Claytonia virginica* (Virginia springbeauty).

Characteristic Species: *Acer saccharum* (sugar maple), *Allium tricoccum* (ramps), *Betula lenta* (sweet birch), *Botrychium virginianum* (rattlesnake fern), *Carpinus caroliniana* (American hornbeam), *Claytonia virginica* (Virginia springbeauty), *Cornus florida* (flowering dogwood), *Dicentra cucullaria* (Dutchman's breeches), *Fagus grandifolia* (American beech), *Liriodendron tulipifera* (tuliptree), *Ostrya virginiana* (eastern hop-hornbeam), *Podophyllum peltatum* (mayapple), *Sanguinaria canadensis* (bloodroot)

Dynamics/Successional Trajectory: In successional stands of this type, *Liriodendron tulipifera* (tuliptree) may be a strong canopy dominant as a result of its early colonization after disturbance.

Management Concerns: This forest type often persists on the landscape in a degenerate form - a monotypic canopy of pure *Liriodendron tulipifera* (tuliptree), with limited subcanopy and shrub layers, and dominated by invasive exotic plants in the ground story. *Microstegium vimineum* (Japanese stiltgrass), *Berberis thunbergii* (Japanese barberry), *Rosa multiflora* (multiflora rose), and *Lonicera* (honeysuckle) spp. can be abundant in degraded examples of this type. Restoration of this type should promote diverse species composition in the canopy, subcanopy, and herbaceous layers. Management of invasive plant species should be a priority.

Reference Sites: Identifying a high-quality reference site for this type in the Pennsylvania portion of the Delaware Estuary is challenging due to land-use history, development, disturbance, and deer browse. Degraded examples of this type are abundant.

Global and State Conservation Ranks and Reasons: GNR (6-Dec-2004). NJ: SNR, PA: SNR. More information is required to determine the range and rank of this vegetation type.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.755371

References: Eastern Ecology Working Group n.d., Fike 1999, Podnieszinski et al. 2006

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Acer saccharum</i> (sugar maple)
Tree canopy	Broad-leaved deciduous tree	<i>Betula lenta</i> (sweet birch)
Tree canopy	Broad-leaved deciduous tree	<i>Fagus grandifolia</i> (American beech)
Tree canopy	Broad-leaved deciduous tree	<i>Liriodendron tulipifera</i> (tuliptree)
Tree subcanopy	Broad-leaved deciduous tree	<i>Carpinus caroliniana</i> (American hornbeam)
Tree subcanopy	Broad-leaved deciduous tree	<i>Cornus florida</i> (flowering dogwood)
Tree subcanopy	Broad-leaved deciduous tree	<i>Ostrya virginiana</i> (eastern hop-hornbeam)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Hamamelis virginiana</i> (American witch-hazel)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Lindera benzoin</i> (northern spicebush)
Herb (field)	Fern or fern ally	<i>Botrychium virginianum</i> (rattlesnake fern)

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 portion of the Delaware Estuary.

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



Photo by Pennsylvania Natural Heritage Program

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* (blueberry) spp., *Gaylussacia* (huckleberry) spp., *Kalmia latifolia* (mountain laurel), and *Rhododendron* (azalea, rhododendron) spp.

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: (Note: more inventory needs to be done to confirm that this type is in the Delaware Estuary.

Global and State Conservation Ranks and Reasons: GNA (ruderal) (13-Jun-2000). NJ: SNA, PA: SNA. 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

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 red-cedar)
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>Cornus florida</i> (flowering dogwood)
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>Cornus florida</i> (flowering dogwood)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Oxydendrum arboreum</i> (sourwood)
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> (Japanese honeysuckle)
Herb (field)	Vine/Liana	<i>Smilax glauca</i> (whiteleaf greenbrier)
Herb (field)	Vine/Liana	<i>Toxicodendron radicans</i> (eastern poison-ivy)

WHITE PINE - OAK FOREST

Pinus strobus - *Quercus* (*rubra*, *velutina*) - *Fagus grandifolia* Forest

Range: This association occurs in New England south and west to Pennsylvania, West Virginia and possibly New Jersey.

Environmental Description: This mixed white pine - oak forest is a ridge and valley community that occurs on dry-mesic to mesic, acidic, nutrient-poor, sandy loam to sandy soils along mid and lower slopes, and along the unglaciated plateau on rolling topography underlain by sandstone. In the northern glaciated portion of the range, the forest occurs on outwash plains or moraines, as well as along mid and lower slopes and within protected ravines, and on protected ridges of shale, sandstone, or other sedimentary rock, occasionally underlain by metamorphic or igneous rock. It occurs at elevations below 915 m (3000 feet) throughout the range.



Photo by Pennsylvania Natural Heritage Program

Vegetation Description: The tree canopy is dominated by *Pinus strobus* (eastern white pine) with a mixture of oaks, including *Quercus velutina* (black oak), *Quercus rubra* (northern red oak), *Quercus alba*

(white oak), *Quercus prinus* (chestnut oak), and in the southern portions of the range *Quercus coccinea* (scarlet oak). Oak species drop out at the northern extreme of the type's range, leaving only *Quercus rubra* (northern red oak). *Fagus grandifolia* (American beech) is characteristic but not always present. Other less frequent canopy associates may include *Acer rubrum* (red maple), *Carya alba* (mockernut hickory), *Populus tremuloides* (quaking aspen), *Tsuga canadensis* (eastern hemlock), and *Populus grandidentata* (bigtooth aspen). The variable subcanopy may include *Hamamelis virginiana* (American witch-hazel); other species, such as *Carpinus caroliniana* (American hornbeam), *Cornus florida* (flowering dogwood), and *Nyssa sylvatica* (blackgum), may be present in the central and southern portions of the range. The stand can contain a moderately dense to dense tall-shrub layer of *Pinus strobus* (eastern white pine) saplings. The sparse to well-developed, generally ericaceous short-shrub layer includes *Gaylussacia* (huckleberry) spp., *Kalmia latifolia* (mountain laurel), *Vaccinium* (blueberry) spp., as well as *Rubus* (blackberry) spp., *Corylus americana* (American hazelnut), *Gaultheria procumbens* (wintergreen), *Sassafras albidum* (sassafras), and *Viburnum prunifolium* (smooth blackhaw). The herb layer ranges from sparse to moderately dense cover, with species including *Aralia nudicaulis* (wild sarsaparilla), *Ageratina altissima* (white snakeroot), *Amphicarpaea bracteata* (American hog-peanut), *Brachyelytrum erectum* (bearded shorthusk), *Carex communis* (fibrous-root sedge), *Carex pensylvanica* (Pennsylvania sedge), *Carex lucorum* (Blue Ridge sedge), *Melampyrum lineare* (narrowleaf cow-wheat), *Pteridium aquilinum* (bracken fern), *Trientalis borealis* (starflower), *Chimaphila maculata* (striped pipsissewa), *Desmodium nudiflorum* (naked-flower tick-trefoil), *Goodyera pubescens* (downy rattlesnake-plantain), *Hieracium venosum* (rattlesnake-weed), *Maianthemum racemosum* (feathery false lily-of-the-valley), *Maianthemum canadense* (Canada mayflower), *Medeola virginiana* (Indian cucumber-root), *Mitchella repens* (partridgeberry), *Monotropa uniflora* (Indian-pipe), *Poa cuspidata* (early bluegrass), *Polygonatum biflorum* (smooth Solomon's-seal), *Polystichum acrostichoides* (Christmas fern), and/or *Viola hastata* (halberd-leaf yellow violet). The bryophyte layer is not well-documented but supports *Leucobryum* (leucobryum moss) sp. and *Polytrichum* (haircap moss) sp.

Characteristic Species: *Fagus grandifolia* (American beech), *Gaylussacia baccata* (black huckleberry), *Pinus strobus* (eastern white pine), *Quercus rubra* (northern red oak), *Vaccinium angustifolium* (northern lowbush blueberry), *Vaccinium pallidum* (hillside blueberry)

Reference Sites: near Adams Creek and much of the escarpment on the Pennsylvania side of the Delaware Water Gap National Recreation Area

Global and State Conservation Ranks and Reasons: G5 (1-Dec-1997). NJ?:SNA, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688827

References: Breden et al. 2001, CAP pers. comm. 1998, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1993, Eyre 1980, Fike 1999, Gawler 2002, Kuchler 1956, Lundgren 2001, Moore and Taylor 1927, Rawinski 1984, Sperduto 2000a, Sperduto and Nichols 2004, Swain and Kearsley 2001, Thompson 1996, Thompson and Jenkins 1992, Thompson and Sorenson 2000

MOST ABUNDANT SPECIES

STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus strobus</i> (eastern white pine)
Tree canopy	Broad-leaved deciduous tree	<i>Quercus alba</i> (white oak)
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)
Tree canopy	Broad-leaved deciduous tree	<i>Quercus velutina</i> (black oak)
Tree subcanopy	Broad-leaved deciduous tree	<i>Prunus serotina</i> (black cherry)
Shrub/sapling (tall & short)	Needle-leaved shrub	<i>Pinus strobus</i> (eastern white pine)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Hamamelis virginiana</i> (American witch-hazel)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Gaylussacia baccata</i> (black huckleberry)
Short shrub/sapling blueberry)	Broad-leaved deciduous shrub	<i>Vaccinium angustifolium</i> (northern lowbush
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Vaccinium pallidum</i> (hillside blueberry)
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Kalmia latifolia</i> (mountain laurel)
Herb (field)	Forb	<i>Aralia nudicaulis</i> (wild sarsaparilla)
Herb (field)	Forb	<i>Maianthemum canadense</i> (Canada mayflower)
Herb (field)	Forb	<i>Trientalis borealis</i> (starflower)
Herb (field)	Graminoid	<i>Carex pensylvanica</i> (Pennsylvania sedge)

ECOLOGICAL SYSTEM: NORTHERN ATLANTIC COASTAL PLAIN BRACKISH TIDAL MARSH

Summary: This system ranges from Massachusetts south to the Chesapeake drainage and is comprised of brackish marshes occurring on the portion of large tidal rivers and their tributaries where saltwater is mixed with freshwater. Vegetation typically exhibits zonation, with associations distributed by flooding frequency. Typical species include *Spartina alterniflora* (saltmarsh cordgrass), *Typha angustifolia* (narrowleaf cattail), *Spartina cynosuroides* (giant cordgrass), and *Schoenoplectus americanus* (chairmaker's bulrush).

Range: This system ranges from Massachusetts south to the Chesapeake drainage and the James River, Virginia. United States: CT, DE, MA, MD, NJ, NY, VA

Delaware Estuary Associations:

- Alkali Bulrush Brackish Marsh
- Atlantic Coast Brackish Tidal Marsh
- Atlantic Giant Cordgrass Marsh
- Brackish Tidal Low Marsh
- Cattail Brackish Tidal Marsh
- Central Atlantic Brackish Marsh
- Mesohaline Seepage Marsh
- North Atlantic Coast Intertidal Mud Flat
- Transitional Tidal Marsh
- Water-hemp Tidal Marsh

CLASSIFIERS FOR NORTHERN ATLANTIC COASTAL PLAIN BRACKISH 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: Herbaceous; Tidal / Estuarine [Haline]; Graminoid; Brackish (Mesohaline)

ALKALI BULRUSH BRACKISH MARSH

Schoenoplectus robustus - *Spartina alterniflora* Herbaceous Vegetation

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

Environmental Description: This marsh occurs along brackish sections of tidal rivers and creeks in Delaware and New Jersey.

Vegetation Description: This brackish marsh is dominated by *Schoenoplectus robustus* (alkali bulrush) and *Spartina alterniflora* (saltmarsh cordgrass). Other associates may include *Spartina cynosuroides* (giant cordgrass), *Borrchia frutescens* (seaside oxeye), *Symphyotrichum tenuifolium* (saline aster), *Symphyotrichum novi-belgii* (new belgium American-aster), *Typha angustifolia* (narrowleaf cattail), *Rumex verticillatus* (swamp dock), *Pontederia cordata* (pickerelweed), *Echinochloa walteri* (long-awn cock's-spur grass), *Peltandra virginica* (green arrow-arum), *Amaranthus cannabinus* (water-hemp), *Polygonum punctatum* (dotted smartweed), and *Leersia oryzoides* (rice cutgrass). In general, this association is depauperate with few other associated species.

Characteristic Species: *Schoenoplectus robustus* (alkali bulrush), *Spartina alterniflora* (saltmarsh cordgrass)

Reference Sites: Prime Hook NWR, DE; Swedesboro, Raccoon Creek, Thompson Beach, Sea Breeze -Cumberland County, NJ

Global and State Conservation Ranks and Reasons: GNR (15-Nov-2000). DE: SNR, NJ: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.683192

References: Coulling pers. comm., Eastern Ecology Working Group n.d., Fleming 2001, Fleming et al. 2001, VDNH 2003

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Schoenoplectus robustus</i> (alkali bulrush)

ATLANTIC COAST BRACKISH TIDAL MARSH

Schoenoplectus pungens Tidal Herbaceous Vegetation

Range: This association occurs along the Atlantic coast from New Hampshire to Virginia.

Environmental Description: This association occurs in oligohaline to more mesohaline reaches of tidal rivers with sandy or gravelly rivershores. It occurs in low areas where there is a longer duration of flooding. Ice scour can have a significant effect on the species composition and percent cover from year to year.



Photo by Linda Kelly

Vegetation Description: This vegetation often occurs in nearly pure stands of *Schoenoplectus pungens* (common threesquare) but can be intermixed with *Spartina alterniflora* (saltmarsh cordgrass) or *Spartina cynosuroides* (giant cordgrass) in slightly brackish areas. Species diversity tends to be low due to winter storm scour, but associates can include *Amaranthus cannabinus* (water-hemp), *Polygonum punctatum* (dotted smartweed), and *Bidens* (beggarticks) spp. *Sagittaria graminea* (grassleaf arrowhead), *Sagittaria latifolia* (broadleaf arrowhead), *Eleocharis palustris* (marsh spikerush), *Gratiola virginiana* (roundfruit hedge-hyssop), and *Cyperus bipartitus* (shining flatsedge) can occur but are absent in the northern part of the range. As the salinity decreases *Zizania aquatica* (Indian wild rice) can also be an associate. *Lilaeopsis* (grasswort) occurs on *Spartina alterniflora* (saltmarsh cordgrass) hummocks.

Noteworthy Associated Plant and/or Animal Species: *Bidens bidentoides* (delmarva beggarticks)

Characteristic Species: *Schoenoplectus pungens* (common threesquare)

Dynamics/Successional Trajectory: The species composition of brackish marsh associations is likely related to gradients in salinity and duration of tidal flooding. *Schoenoplectus pungens* (common threesquare) may dominate in areas with higher average water levels, lower salinities, and lower frequency of flooding than areas typically dominated by *Spartina patens* (saltmeadow cordgrass).

Management Concerns: Ice-scour can have a significant effect on the species composition and percent cover from year to year.

Reference Sites: Snickensons Landing, Salem County, NJ; Edgewater Park, Mercer/Burlington County, NJ

Global and State Conservation Ranks and Reasons: GNR (1-Dec-1997). NJ: S1S3.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.683291

References: Barrett 1989, Bartgis 1986, Breden 1989, Breden et al. 2001, Caldwell 1990, Eastern Ecology Working Group n.d., Fleming 2001, Fleming et al. 2001, Harrison 2004, Metzler and Barrett 2001, Metzler and Rosza 1982, Rawinski 1984, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Schoenoplectus pungens</i> (common threesquare)

ATLANTIC GIANT CORDGRASS MARSH

Spartina cynosuroides Herbaceous Vegetation

Range: This association occurs along the Atlantic coast from New Jersey to Georgia.

Environmental Description: This association occurs along tidal creeks, guts, and levees of oligohaline to mesohaline marshes in irregularly flooded high marsh situations, but in areas that are well-drained.

Vegetation Description: *Spartina cynosuroides* (giant cordgrass) is strongly dominant in this community, often occurring in pure stands. Where stands are mixed, common associates can include *Schoenoplectus robustus* (alkali bulrush), *Schoenoplectus pungens*, *Schoenoplectus americanus* (chairmaker's bulrush), *Peltandra virginica* (green arrow-arum), *Kosteletzkya virginica* (seashore mallow), *Amaranthus cannabinus* (water-hemp), *Panicum virgatum* (switchgrass), and *Polygonum punctatum* (dotted smartweed). Where more saline, *Spartina alterniflora* (saltmarsh cordgrass) and *Iva frutescens* (maritime marsh-elder) can become more frequent. Where less saline, *Schoenoplectus tabernaemontani* (softstem bulrush), *Polygonum hydropiperoides* (swamp smartweed), *Pontederia cordata* (pickerelweed), *Peltandra virginica* (green arrow-arum), *Leersia oryzoides* (rice cutgrass), *Mikania scandens* (climbing hempvine), *Rumex verticillatus* (swamp dock), *Echinochloa walteri* (long-awn cock's-spur grass), and *Typha angustifolia* (narrowleaf cattail) are also common associates.



Photo by Linda Kelly

Characteristic Species: *Spartina cynosuroides* (giant cordgrass)

Dynamics/Successional Trajectory: Brackish marsh vegetation responds to interacting gradients of salinity and inundation. This association is irregularly flooded by spring and storm tides. Natural deposition occurs adjacent to river and creek channels, which builds natural levees with coarser, more freely drained substrates than the surrounding peat and silty muds. The riverbanks are freely drained and receive regular tidal flushing, which creates silty fibrous peat substrate. As brackish conditions diminish, species composition shifts to more freshwater species and the organic matter content in soils decreases.

Management Concerns: In more disturbed areas, this association can be displaced by *Phragmites australis* (common reed).

Reference Sites: Woodland Beach WMA, Kent County, DE; Mad Horse Creek WMA, NJ

Global and State Conservation Ranks and Reasons: G4 (13-Aug-1997). DE: S3?, NJ: S3.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689750

References: Bowman 2000, Breden 1989, Breden et al. 2001, Clancy 1996, Fleming 2001, Fleming and Moorhead 1998, Fleming et al. 2001, Harrison 2001, Harrison 2004, Nelson 1986, Odum 1988, Odum

and Smith 1981, Odum et al. 1984, Schafale 2000, Schafale 2003b, Schafale and Weakley 1990, Southeastern Ecology Working Group n.d., Wharton 1978

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Spartina cynosuroides</i> (giant cordgrass)

BRACKISH TIDAL LOW MARSH

Spartina alterniflora - *Lilaeopsis chinensis* Herbaceous Vegetation

Range: This association occurs along the north and mid-Atlantic coast from New Hampshire to South Carolina.

Environmental Description: This low brackish marsh occurs in the lower reaches of tidal rivers adjacent to the river channel subject to river flooding and annual ice-scour. It receives constant freshwater input from the upstream watershed. This association is regularly flooded by diurnal tides. Substrate is coarse, fibrous peat or mud.



Photo by Linda Kelly

Vegetation Description: This association is dominated *Spartina alterniflora* (saltmarsh cordgrass). *Schoenoplectus robustus* (alkali bulrush), *Schoenoplectus pungens* (common threesquare), and *Spartina cynosuroides* (giant cordgrass) may be locally prominent, especially as salinity decreases. Characteristic species in addition to *Spartina alterniflora* (saltmarsh cordgrass) include *Schoenoplectus robustus* (alkali bulrush), *Lilaeopsis chinensis* (marsh grasswort), and *Eleocharis parvula* (dwarf spikerush). Associated species that occur in low abundance can include *Amaranthus cannabinus* (water-hemp), *Atriplex prostrata* (hastate orache), *Typha angustifolia* (narrowleaf cattail), *Schoenoplectus maritimus* (saltmarsh clubrush), *Eleocharis halophila* (saltmarsh spikerush), *Samolus valerandi* ssp. *parviflorus* (seaside brookweed), *Sagittaria calycina* (hooded arrowhead), and *Crassula aquatica* (water pygmyweed). Freshwater species increase as salinity decreases, such as *Peltandra virginica* (green arrow-arum), *Schoenoplectus fluviatilis* (river bulrush), *Sagittaria latifolia* (broadleaf arrowhead), *Leersia oryzoides* (rice cutgrass), and *Pontederia cordata* (pickerelweed).

Characteristic Species: *Eleocharis parvula* (dwarf spikerush), *Lilaeopsis chinensis* (marsh grasswort), *Schoenoplectus robustus* (alkali bulrush), *Spartina alterniflora* (saltmarsh cordgrass)

Dynamics/Successional Trajectory: Mid-tidal brackish marsh vegetation responds to interacting gradients of salinity and inundation. There is seasonal variation in inundation, with dramatic flooding events during the spring from snowmelt and precipitation in the upper watershed, which delay the growing season in these environmental settings (Barrett 1989). The brackish low marsh is regularly flooded by diurnal tides. Since the low marsh occurs adjacent to river and creek channels natural deposition occurs which builds natural levees. The riverbanks are freely drained and receive regular tidal flushing, which creates silty fibrous peat substrate. As brackish conditions diminish, species composition shifts to having more freshwater species, and the organic matter content in soils decreases.

Management Concerns: It is threatened by pollution, particularly oil spills.

Reference Sites: Augustine Beach, Pea Patch Island, New Castle County, DE; Elsinboro Point, Salem County, NJ (TNC Preserve); Fort Mott State Park, Salem County, NJ

Global and State Conservation Ranks and Reasons: G3G4 (19-Jan-2006). DE: SNR, NJ: S3. This vegetation occurs in small patches and is restricted to the tidal portions of large navigable rivers in the northeastern states.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686839

References: Bowman 2000, Breden 1989, Breden et al. 2001, Caldwell 1990, Eastern Ecology Working Group n.d., Enser 1999, Ferren et al. 1981, Lundgren 1998, Metzler and Barrett 2001, Nelson 1986, Rawinski 1984, Reschke 1990, Schafale 2000, Schafale 2003b, Schafale and Weakley 1990, Sperduto 2000a, Sperduto 2000b, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Spartina alterniflora</i> (saltmarsh cordgrass)

CATTAIL BRACKISH TIDAL MARSH

Typha angustifolia - *Hibiscus moscheutos* Herbaceous Vegetation

Range: This association occurs along the Atlantic coast from Maine to Virginia and possibly to South Carolina. It occurs in Delaware and New Jersey in the Delaware Estuary.

Environmental Description: This association occurs in oligohaline to mesohaline areas of tidal marshes (0.5-18 ppt). In estuarine systems, it can occur in the uppermost zone of brackish marshes where there is freshwater influence; it receives diurnal tidal flooding of brackish water. In salt marshes behind barrier beaches, it can occur in the upper reaches of larger tidal creeks within brackish areas and also at the upland border where there is significant freshwater input from the adjacent upland; here it receives irregular tidal flooding only during high spring tides. Substrate is muck or peat, and there is often an accumulation of *Typha* (cattail) litter.



Photo by Linda Kelly

Vegetation Description: The vegetation of this tall graminoid vegetation instead is a mixture of freshwater and saltmarsh species dominated by *Typha angustifolia* (narrowleaf cattail). *Phragmites australis* (common reed), *Typha latifolia* (broadleaf cattail), *Spartina cynosuroides* (giant cordgrass), or *Schoenoplectus pungens* (common threesquare) can codominate. The *Phragmites australis* (common reed) component is the native strain (Saltonstall 2002). Common associates include *Hibiscus moscheutos* (eastern rosemallow), *Schoenoplectus pungens* (common threesquare), *Impatiens capensis* (orange jewelweed), *Amaranthus cannabinus* (water-hemp), *Peltandra virginica* (green arrow-arum), and *Bidens* (beggarticks) spp., plus *Spartina cynosuroides* (giant cordgrass) in the south. Other infrequent associates include *Mikania scandens* (climbing hempvine), *Pluchea odorata* (sweetscent), *Polygonum punctatum* (dotted smartweed), *Eleocharis* (spikerush) spp., and *Schoenoplectus robustus* (alkali bulrush), plus *Schoenoplectus americanus* (chairmaker's bulrush) farther south. Species from adjacent high salt marsh may also be present.

Characteristic Species: *Hibiscus moscheutos* (eastern rosemallow), *Typha angustifolia* (narrowleaf cattail)

Dynamics/Successional Trajectory: Brackish marsh complexes commonly occur as mosaics of patches dominated by a single graminoid species. Patches dominated by *Typha angustifolia* (narrowleaf cattail) tend to occur where there is more freshwater influence near the upper reaches of estuaries or at the upland border of high salt marshes where there is freshwater input from the surrounding upland. As the marsh becomes more brackish, *Schoenoplectus pungens* (common threesquare) or *Spartina patens* (saltmeadow cordgrass) can become dominant. As the marsh becomes less brackish, *Peltandra virginica* (green arrow-arum), *Pontederia cordata* (pickerelweed), *Acorus calamus* (sweetflag), *Schoenoplectus tabernaemontani* (softstem bulrush), and *Zizania aquatica* (Indian wild rice) can become more prevalent.

The pattern of alternating dominance between *Typha angustifolia* (narrowleaf cattail) and *Phragmites australis* (common reed) that can occur in these environmental settings may reflect disturbance history of the site and of the surrounding watershed.

Management Concerns: Sea level rise may pose a threat to these marshes by increasing salinity levels, and thereby potentially initiating a shift in vegetation composition to more salt-tolerant species. This community is threatened by pollution and by encroachment of *Phragmites australis* (common reed).

Reference Sites: widespread, DE; Hancock Bridge on Alloway Creek, Salem County, NJ; Supawna Meadows NWR (North bank of Mill Creek), NJ

Global and State Conservation Ranks and Reasons: G4G5 (19-Jan-2006). DE: S4, NJ: S4. This common small-patch community occurs in the estuarine areas of up to 13 northeastern states, several of which rank this vegetation as S4.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.683268

References: Bowman 2000, Breden 1989, Breden et al. 2001, Cahoon and Stevenson 1986, Coulling 2002, Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Ferren et al. 1981, Fleming 2001, Fleming and Moorhead 1998, Fleming et al. 2001, Gawler 2002, Good and Good 1975b, Harrison 2001, Harrison 2004, Hill 1986, Klotz 1986, MENHP 1991, McCormick and Ashbaugh 1972, Metzler and Barrett 1992, Metzler and Barrett 2001, Odum et al. 1984, Rawinski 1984, Reschke 1990, Saltonstall 2002, Schafale 2000, Schafale 2003b, Schafale and Weakley 1990, Shreve et al. 1910, Sperduto 1994, Sperduto 1997a, Sperduto 2000b, Steury 1999, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Semi-shrub	<i>Hibiscus moscheutos</i> (eastern rosemallow)
Herb (field) threesquare)	Graminoid	<i>Schoenoplectus pungens</i> (common)
Herb (field)	Graminoid	<i>Typha angustifolia</i> (narrowleaf cattail)
Submerged aquatic	Aquatic herb (floating & submergent)	<i>Pontederia cordata</i> (pickerelweed)

CENTRAL ATLANTIC BRACKISH MARSH

Spartina alterniflora - *Amaranthus cannabinus* Herbaceous Vegetation

Range: This community type is currently described from Maryland, New Jersey and Delaware.

Environmental Description: This type occurs on oligohaline reaches of tidal rivers in New Jersey, Delaware and Maryland.

Vegetation Description: The dominant species are *Spartina alterniflora* (saltmarsh cordgrass) and *Amaranthus cannabinus* (water-hemp), with other associates, such as *Kosteletzkya virginica* (seashore mallow), *Hibiscus moscheutos* (eastern rosemallow), *Symphyotrichum subulatum* (seaside American-aster), *Schoenoplectus robustus* (alkali bulrush), *Spartina patens* (saltmeadow cordgrass), *Atriplex prostrata* (hastate orache), *Symphyotrichum tenuifolium* (saline aster), and *Pluchea odorata* (sweetscent), occurring infrequently.

The shrub *Baccharis halimifolia* (groundsel-tree) sometimes occurs at low cover.



Photo by Linda Kelly

Characteristic Species: *Amaranthus cannabinus* (water-hemp)

Reference Sites: Widespread in DE; Green Swamp, Cohansey River, Cumberland County, NJ

Global and State Conservation Ranks and Reasons: GNR (15-Nov-2000). DE: SNR, NJ: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.683922

References: Bowman 2000, Eastern Ecology Working Group n.d., Harrison 2004, Harrison and Stango 2003

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Forb	<i>Amaranthus cannabinus</i> (water-hemp)

MESOHALINE SEEPAGE MARSH

Spartina alterniflora - *Ptilimnium capillaceum* - *Polygonum punctatum* Herbaceous Vegetation

Range: This type is currently described from Delaware and Maryland. It may also occur in New Jersey.

Environmental Description: This oligohaline to mesohaline marsh occurs in silty mud along meanders in tidal rivers and creeks where there is significant freshwater seepage. It is often adjacent to uplands.

Vegetation Description: The vegetation is diverse and is codominated by *Spartina alterniflora* (saltmarsh cordgrass), *Ptilimnium capillaceum* (mock bishopweed), and *Polygonum punctatum* (dotted smartweed). Other associates include *Pluchea odorata* (sweetscent), *Bidens coronata* (crowned beggarticks), *Kosteletzkya virginica* (seashore mallow), *Eleocharis parvula* (dwarf spikerush), *Cyperus filicinus* (fern flatsedge), *Hibiscus moscheutos* (eastern rosemallow), *Amaranthus cannabinus* (water-hemp), *Eleocharis palustris* (marsh spikerush), *Asclepias incarnata* (swamp milkweed), *Sium suave* (hemlock water-parsnip), *Schoenoplectus tabernaemontani* (softstem bulrush), *Schoenoplectus americanus* (chairmaker's bulrush), *Schoenoplectus robustus* (alkali bulrush), *Echinochloa walteri* (long-awn cock's-spur grass), *Typha angustifolia* (narrowleaf cattail), *Peltandra virginica* (green arrow-arum), *Pontederia cordata* (pickerelweed), *Lobelia cardinalis* (cardinal-flower), and *Sagittaria latifolia* (broadleaf arrowhead).

Characteristic Species: *Polygonum punctatum* (dotted smartweed), *Ptilimnium capillaceum* (mock bishopweed)

Reference Sites: Blackbird Creek, New Castle County, DE

Global and State Conservation Ranks and Reasons: GNR (15-Nov-2000). DE: SNR, NJ: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686082

References: Bowman 2000, Eastern Ecology Working Group n.d., Harrison 2004, Harrison and Stango 2003

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Forb	<i>Polygonum punctatum</i> (dotted smartweed)
Herb (field)	Forb	<i>Ptilimnium capillaceum</i> (mock bishopweed)

NORTH ATLANTIC COAST INTERTIDAL MUD FLAT

Sagittaria subulata - *Limosella australis* Tidal Herbaceous Vegetation

Range: This association occurs along the Atlantic coast from Maine to Virginia. It may also occur in Canada. This community occurs in the New Jersey portion of the Delaware Estuary.

Environmental Description: These communities occur on gently sloping intertidal mud flats and occasionally in tidal creek channels exposed at low tide. The flats are fresh to brackish and are diurnally flooded by tides. These are best developed along broad, flat areas protected from direct wave action, occurring behind barrier beaches or along tidal rivers. Substrate is generally silty mud with high organic matter content and can have greater sand component in settings with relatively more water energy.

Vegetation Description: These brackish intertidal mud flats are sparsely vegetated with low-growing, rosette-forming herbs. Characteristic plants are low-growing rosette species and others such as *Sagittaria subulata* (awl-leaf arrowhead), *Sagittaria calycina* var. *spongiosa* (hooded arrowhead), *Limosella australis* (awlwort), *Lilaeopsis chinensis*, *Polygonum arifolium* (halberd-leaf tearthumb), *Polygonum hydropiperoides* (swamp smartweed), *Ptilimnium capillaceum* (mock bishopweed), *Zannichellia palustris* (horned pondweed), and *Eleocharis parvula* (dwarf spikerush).

Characteristic Species: *Sagittaria subulata* (awl-leaf arrowhead)

Dynamics/Successional Trajectory: These intertidal mud flats occur along broad, flat, gently sloping shores where sediments accumulate. They are regularly flooded by diurnal tides. The size of the flats depends on coastal morphology and tidal range. Tidal action determines sediment movement and texture; flats with greater wave activity will have coarser substrates. Tidal flats are utilized by a host of benthic and pelagic organisms as well as birds.

Reference Sites: Mannington Meadows, Salem County, NJ

Global and State Conservation Ranks and Reasons: G2G4 (19-Jan-2006). DE: SNR, NJ: S1S3. This vegetation occurs in the Chesapeake and Delaware Bay estuaries, ranging north to northern New England; presence in Canada is not confirmed and requires review. More information on classification and distribution is required to determine the global rank with more precision.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686532

References: Bowman 2000, Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Gawler 2002, Harrison 2004, Harrison and Stango 2003, Metzler and Barrett 2001, Rawinski 1984, Reschke 1990, Sperduto 2000b, Sperduto and Nichols 2004, Swain and Kearsley 2001, Whitlatch 1982

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Forb	<i>Sagittaria subulata</i> (awl-leaf arrowhead)

TRANSITIONAL TIDAL MARSH

Schoenoplectus americanus - *Spartina patens* Herbaceous Vegetation

Range: This association is currently described from mid-Atlantic states of New Jersey, Delaware, Maryland and Virginia. It possibly extends south to Georgia.

Environmental Description: This association occurs in wet depressions of high salt marshes and in the ecotone between low and high salt marsh zones. It is irregularly flooded, occurring just above the zone of regular tidal flooding, but is more frequently flooded than *Spartina patens* (saltmeadow cordgrass)-dominated high marsh. This association is best developed where the elevation gradient

across the marsh is more gradual, allowing for greater diversity of physical conditions of duration and frequency of flooding.

Vegetation Description: This community is dominated by colonies of *Schoenoplectus americanus* (chairmaker's bulrush), which often accounts for 40-75% of the total vegetation cover, or codominant with *Spartina patens* (saltmeadow cordgrass) at some sites. Associated species can include *Pluchea odorata* (sweetscent), *Spartina alterniflora* (saltmarsh cordgrass), *Spartina cynosuroides* (giant cordgrass), *Distichlis spicata* (saltgrass), and *Limonium carolinianum* (Carolina sea-lavender) plus *Typha* (cattail) spp. and *Phragmites australis* (common reed). This community often grades into *Spartina patens* (saltmeadow cordgrass)- or *Juncus roemerianus* (black needlerush)-dominated high marsh landward or *Spartina alterniflora* (saltmarsh cordgrass)- or *Spartina cynosuroides* (giant cordgrass)-dominated low marsh seaward.

Characteristic Species: *Schoenoplectus americanus* (chairmaker's bulrush)

Dynamics/Successional Trajectory: The species compositions of brackish marsh associations are likely related to gradients in salinity and duration of tidal flooding. *Schoenoplectus americanus* (chairmaker's bulrush) may dominate in areas with higher average water levels, lower salinities, and lower frequency of flooding than areas typically dominated by *Spartina patens* (saltmeadow cordgrass).

Reference Sites: Smyrna River, Route 9, Kent County, DE (This community needs investigation in the Delaware Estuary portion of NJ - it occurs on the Atlantic Coast in New Jersey.)

Global and State Conservation Ranks and Reasons: GNR (17-Apr-2000). DE: SNR, NJ: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689804

References: Bartgis 1986, Bowman 2000, Eastern Ecology Working Group n.d., Fleming 2001, Fleming et al. 2001, Harrison 2001, Harrison 2004, VDNH 2003

MOST ABUNDANT SPECIES			
STRATUM	LIFEFORM	SPECIES	
Herb (field) bulrush)	Graminoid	<i>Schoenoplectus</i>	<i>americanus</i> (chairmaker's)

WATER-HEMP TIDAL MARSH

Amaranthus cannabinus Tidal Herbaceous Vegetation

Range: This association occurs along tidal rivers from Maine to Virginia. It occurs in the Delaware and New Jersey portions of the Delaware Estuary.

Environmental Description: This association occurs along mid-tidal sections of wave- and ice-scoured riverbanks or on eroded remnants of dikes and natural levees. It occurs where tidal floodwater is oligohaline to mesohaline. The association occasionally occurs in freshwater tidal backmarsh settings in local patches where the substrate is firm and gravelly. Substrate is generally coarse but ranges from fine sand to peaty mud to gravel to rocky shores. There is regular inundation by tides, but floodwaters freely drain.



Photo by Linda Kelly

Vegetation Description: The community is predominantly comprised of annual species, especially *Amaranthus cannabinus* (water-hemp). Associated species include, but are not limited to, *Bidens connata*

(purple-stem beggarticks), *Bidens laevis* (smooth beggarticks), *Bidens cernua* (nodding beggarticks), *Polygonum punctatum* (dotted smartweed), *Sagittaria latifolia* (broadleaf arrowhead), *Zizania aquatica* (Indian wild rice), and *Schoenoplectus pungens* (common threesquare). Other species that may occur infrequently include *Polygonum arifolium* (halberd-leaf tearthumb), *Polygonum sagittatum* (arrowleaf tearthumb), *Acorus calamus* (sweetflag), *Pilea pumila* (Canadian clearweed), and *Leersia oryzoides* (rice cutgrass).

Characteristic Species: *Amaranthus cannabinus* (water-hemp)

Dynamics/Successional Trajectory: This association occurs on wave- and ice-scoured mid-tidal shores of rivers and tidal creeks. Having a strong component of annuals, the species composition and abundance can change dramatically from year to year.

Management Concerns: This community is exposed to a relatively high degree of natural disturbance from wave and ice scour.

Reference Sites: Blackbird Creek, New Castle County, DE; Manumuskin River (TNC Preserve), NJ; Trenton Marsh, Mercer County, NJ

Global and State Conservation Ranks and Reasons: G3G5 (1-Dec-1997). DE: SNR, NJ: S2S3.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689238

References: Bartgis 1986, Bowman 2000, Breden 1989, Breden et al. 2001, Caldwell 1990, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Gawler 2001, Gawler 2002, Harrison 2004, Metzler and Barrett 2001, Metzler and Barrett 2004, Rawinski 1984, Reschke 1990, Swain and Kearsley 2000, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Forb	<i>Amaranthus cannabinus</i> (water-hemp)

ECOLOGICAL SYSTEM: NORTHERN ATLANTIC COASTAL PLAIN DRY 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 possibly northern Virginia. 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 northern Virginia. United States: CT?, DE, MA, MD, ME, NH?, NJ, NY, VA

Delaware Estuary Associations:

- Coastal Oak / Laurel Forest
- Coastal Plain Chestnut Oak - Beech Forest
- Mid-Atlantic Mesic Mixed Hardwood Forest
- North Atlantic Coastal Oak - Holly Forest
- Northeastern Atlantic Coastal Oak - Beech Forest
- Northeastern Coastal Oak - Heath Forest
- Northeastern Dry Oak-Hickory Forest
- Southern Red Oak / Heath Forest
- Xeric Paleodune Oak - Sand Hickory Woodland

CLASSIFIERS FOR NORTHERN ATLANTIC COASTAL PLAIN DRY 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

COASTAL OAK / LAUREL FOREST

Quercus velutina - *Quercus coccinea* - *Quercus prinus* / *Kalmia latifolia* Forest

Range: The distribution of this type is centered in New Jersey and Long Island, New York. It may also occur in surrounding states including Delaware.

Environmental Description: These forests occur on sandy, gravelly soils of moraine and glacial outwash plains. The soils may have a higher clay content than other coastal forests. They commonly occur on convex slopes.

Vegetation Description: This coastal oak-laurel forest is dominated by *Quercus coccinea* (scarlet oak), *Quercus velutina* (black oak), *Quercus prinus* (chestnut oak), and *Quercus alba* (white oak). Pines (*Pinus rigida* (pitch pine), *Pinus echinata* (shortleaf pine), or *Pinus virginiana* (Virginia pine)) may be present at low cover in some examples. *Kalmia latifolia* (mountain laurel) is the dominant shrub forming extensive, dense patches, with other ericaceous shrubs such as *Vaccinium pallidum* (hillside blueberry), *Vaccinium stamineum* (deerberry), and *Gaylussacia baccata* (black huckleberry) contributing low cover. The herbaceous layer is sparse due to the dense *Kalmia latifolia* (mountain laurel) and may include *Pteridium aquilinum* (bracken fern), *Gaultheria procumbens* (wintergreen), *Carex pensylvanica* (Pennsylvania sedge), and *Carex albicans* (white-tinge sedge).

Characteristic Species: *Quercus prinus* (chestnut oak)

Dynamics/Successional Trajectory: This forest is similar to chestnut oak forests of the Appalachian Mountains, but is distinguished by its location on the Coastal Plain. It occurs adjacent to areas that are directly influenced by maritime processes.

Reference Sites: NJ Pine Barrens - Peaslee WMA, NJ; Brendan Byrne State Forest, NJ

Global and State Conservation Ranks and Reasons: GNR (1-Dec-1997). DE?: SNA, NJ: S3.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688806

References: Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002, Greller 1977, Hunt 1997a, Sperduto and Nichols 2004, Windisch 1995b

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
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 prinus</i> (chestnut oak)
Tree canopy	Broad-leaved deciduous tree	<i>Quercus velutina</i> (black oak)
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	<i>Kalmia latifolia</i> (mountain laurel)

COASTAL PLAIN CHESTNUT OAK - BEECH FOREST

Quercus prinus - *Quercus velutina* - *Fagus grandifolia* / *Kalmia latifolia* Forest

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

Environmental Description: This mesic mixed oak and beech forest occurs on the Coastal Plain and northern Piedmont, where it was formerly widespread, particularly on the Inner Coastal Plain. It occurs rarely on the edges of the Outer Coastal Plain.

Vegetation Description: *Quercus prinus* (chestnut oak) and *Quercus velutina* (black oak) are dominant trees, with smaller amounts of *Fagus grandifolia* (American beech), *Quercus alba* (white oak), *Quercus coccinea* (scarlet oak), and *Acer rubrum* (red maple). Rarely, *Sassafras albidum* (sassafras), *Carya* (hickory) spp., or *Liriodendron tulipifera* (tuliptree) may occur. A subcanopy stratum of *Cornus florida* (flowering dogwood) is typically also present, occasionally with *Ilex opaca* (American holly). The shrub stratum is strongly dominated by *Kalmia latifolia* (mountain laurel), with smaller amounts of *Rhododendron periclymenoides* (pink azalea), *Vaccinium corymbosum* (highbush blueberry), and *Gaylussacia baccata* (black huckleberry), or only *Gaylussacia baccata* (black huckleberry) and *Vaccinium pallidum* (hillside blueberry) in some patches. On northern exposures, *Fagus grandifolia* (American beech) may become a codominant, and *Kalmia latifolia* (mountain laurel) may reach 75-100% cover.

Characteristic Species: *Kalmia latifolia* (mountain laurel), *Quercus prinus* (chestnut oak)

Reference Sites: Drawer's Creek, DE

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.683683

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

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Quercus velutina</i> (black oak)
Tree subcanopy	Broad-leaved deciduous tree	<i>Cornus florida</i> (flowering dogwood)
Tall shrub/sapling	Broad-leaved evergreen shrub	<i>Kalmia latifolia</i> (mountain laurel)

MID-ATLANTIC MESIC MIXED HARDWOOD FOREST

Fagus grandifolia - *Quercus* (*alba*, *rubra*) - *Liriodendron tulipifera* / *Polystichum acrostichoides* Forest

Range: This association is currently described from Virginia northward to southern New England. The type is characteristic of the Coastal Plain throughout its range and of the Piedmont from south-central Virginia through much of Maryland. Small outliers of this vegetation occur at low elevations on both flanks of the Blue Ridge in Virginia and Maryland. This type occurs in the Delaware Estuary, in both New Jersey and Delaware.

Environmental Description: This forest association occurs on mesic to submesic slopes or gentle gradients. Ravines in dissected topography are particularly typical sites in the Piedmont and parts of the Inner Coastal Plain. The type also occupies rolling uplands with deep soils. Soils are typically well-drained, acidic sandy and silt loams derived from parent material of low to moderate fertility.



Photo by Keith Clancey

Vegetation Description: Rangewide, this vegetation type is characteristically a mixed mesophytic forest dominated by *Fagus grandifolia* (American beech), *Quercus alba* (white oak), *Quercus rubra* (northern red oak), and *Liriodendron tulipifera* (tuliptree) in various proportions. Overstory associates over the range include *Carya alba* (mockernut hickory), *Carya glabra* (pignut hickory), *Quercus velutina* (black oak), *Quercus falcata* (southern red oak), *Quercus coccinea* (scarlet oak), *Liquidambar styraciflua* (sweetgum), *Acer rubrum* (red maple), *Nyssa sylvatica* (blackgum), and *Fraxinus americana* (white ash). The subcanopy is characterized by young *Fagus grandifolia* (American beech), *Acer rubrum* (red maple), *Carpinus caroliniana* (American hornbeam), *Cornus florida* (flowering dogwood), *Ilex opaca* (American holly), and *Sassafras albidum* (sassafras). The shrub layer varies from very sparse to well-developed and can include *Asimina triloba* (common pawpaw), *Viburnum acerifolium* (mapleleaf viburnum), *Viburnum dentatum* (southern arrow-wood), and *Euonymus americana*. Heath shrubs, such as *Vaccinium corymbosum* (highbush blueberry) and *Vaccinium pallidum* (hillside blueberry), may be common but not abundant. Vines are common, including *Parthenocissus quinquefolia* (Virginia creeper), *Smilax glauca* (whiteleaf greenbrier), and *Toxicodendron radicans* (eastern poison-ivy). The herb layer is comprised of *Polystichum acrostichoides* (Christmas fern), *Uvularia perfoliata* (perfoliate bellwort), *Cypripedium acaule* (pink lady's-slipper), *Mitchella repens* (partridgeberry), *Tipularia discolor* (crippled crane-fly), *Goodyera pubescens* (downy rattlesnake-plantain), *Eurybia divaricata* (white wood-aster), *Chimaphila maculata* (striped pipsissewa), *Carex swanii* (swan's sedge), *Medeola virginiana* (Indian cucumber-root), *Athyrium filix-femina* (common ladyfern), *Carex digitalis* (slender wood sedge), *Carex willdenowii* (Willdenow's sedge), *Epifagus virginiana* (beechdrops), *Maianthemum canadense* (Canada mayflower), *Desmodium nudiflorum* (naked-flower tick-trefoil), *Polygonatum biflorum* (smooth Solomon's-seal), *Podophyllum peltatum* (mayapple), *Arisaema triphyllum* (Jack-in-the-pulpit), and *Maianthemum racemosum* (feathery false lily-of-the-valley). Several intergrading compositional variants have been noted in regional and local

landscape analyses. On more submesic, convex slopes, *Fagus grandifolia* (American beech), *Quercus alba* (white oak), *Cornus florida* (flowering dogwood), and *Vaccinium pallidum* (hillside blueberry) tend to be prominent, while pronounced mesophytes, such as *Carpinus caroliniana* (American hornbeam) and herbaceous species in general, are usually sparse. Coastal Plain stands tend to have understories heavily dominated by *Ilex opaca* (American holly), while Piedmont stands generally have only scattered *Ilex opaca* (American holly), as well as slightly higher herbaceous richness.

Characteristic Species: *Fagus grandifolia* (American beech), *Liriodendron tulipifera* (tuliptree), *Polystichum acrostichoides* (Christmas fern)

Reference Sites: Augustine Creek, DE; Clayton Park (Monmouth County Park), Imlaystown, NJ

Global and State Conservation Ranks and Reasons: G5 (24-Jan-2005). DE: S5, NJ: S3, PA: S1. This association is common and widespread on the eastern Coastal Plain.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684506

References: Bartgis 1986, Berdine 1998, Bernard and Bernard 1971, Bowman 2000, Breden 1989, Breden et al. 2001, Clancy 1993b, Clancy 1996, Davis et al. 1992, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fleming 2001, Fleming et al. 2001, Fleming pers. comm., Harrison 2004, Lea 2003, McCoy and Fleming 2000, Metzler and Barrett 2001, Patterson pers. comm., Rawinski 1984, Robichaud and Buell 1973, Smith 1983

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>Liriodendron tulipifera</i> (tuliptree)
Tree canopy	Broad-leaved deciduous tree	<i>Quercus alba</i> (white oak)
Tree subcanopy	Broad-leaved deciduous tree	<i>Cornus florida</i> (flowering dogwood)
Tree subcanopy	Broad-leaved evergreen tree	<i>Ilex opaca</i> (American holly)
Herb (field)	Vine/Liana	<i>Parthenocissus quinquefolia</i> (Virginia creeper)
Herb (field)	Forb	<i>Podophyllum peltatum</i> (mayapple)
Herb (field)	Forb	<i>Polygonatum biflorum</i> (smooth Solomon's-seal)
Herb (field)	Fern or fern ally	<i>Polystichum acrostichoides</i> (Christmas fern)

NORTH ATLANTIC COASTAL OAK - HOLLY FOREST

Quercus velutina / *Ilex opaca* Forest

Range: This community occurs in the New Jersey portion and possibly the Delaware portion of the Delaware Estuary.

Environmental Description: This forest occurs on mesic, moderately well-drained silts and sandy loams in low areas on the landscape that are sheltered from direct maritime influences. There are often small-scale wetter depressions within low plateaus occupied by this association.

Vegetation Description: This coastal oak-holly forest is dominated by *Quercus velutina* (black oak), *Fagus grandifolia* (American beech), *Quercus alba* (white oak), *Acer rubrum* (red maple), and *Nyssa sylvatica* (blackgum). *Ilex opaca* (American holly) is abundant in the subcanopy. Other associated species that occur at low cover include *Amelanchier canadensis* (Canada serviceberry), *Sassafras albidum* (sassafras), and *Quercus alba* (white oak). Shrubs are common and include *Vaccinium corymbosum* (highbush blueberry), *Hamamelis virginiana* (American witch-hazel), *Viburnum recognitum* (northern arrow-wood), and *Kalmia latifolia* (mountain laurel). Vines are common but not usually abundant, and include such species as *Toxicodendron radicans* (eastern poison-ivy), *Parthenocissus quinquefolia* (Virginia creeper), *Smilax rotundifolia* (roundleaf greenbrier), *Smilax glauca* (whiteleaf

greenbrier), and *Vitis* (grape) spp. Characteristic herbs include *Trientalis borealis* (starflower), *Carex swanii* (swan's sedge), and *Thelypteris noveboracensis* (New York fern).

Characteristic Species: *Carex swanii* (swan's sedge), *Ilex opaca* (American holly), *Thelypteris noveboracensis* (New York fern), *Trientalis borealis* (starflower)

Reference Sites: Lowlands Forest, Gloucester County, NJ; Mill Creek Park on Rancocas Creek, NJ; Higbee Beach WMA, Cape May, NJ

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.683341

References: Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002, Greller 1977, Hunt 1997a, Lundgren 1998, Rawinski 1984, Swain and Kearsley 2001

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>Quercus alba</i> (white oak)
Tree canopy	Broad-leaved deciduous tree	<i>Quercus velutina</i> (black oak)
Tree subcanopy	Broad-leaved evergreen tree	<i>Ilex opaca</i> (American holly)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Vaccinium corymbosum</i> (highbush blueberry)

NORTHEASTERN ATLANTIC COASTAL OAK - BEECH FOREST

Fagus grandifolia - *Quercus alba* - *Quercus rubra* Forest

Range: These forests occur along the North Atlantic Coast in Massachusetts, New York, New Jersey, and possibly Rhode Island. This vegetation community occurs in New Jersey's portion of the Delaware Estuary.

Environmental Description: These forests occur on dry, well-drained loamy sand of morainal coves and upper marl ravines on the Coastal Plain.

Vegetation Description: This coastal oak-beech forest has a mixed canopy of *Fagus grandifolia* (American beech), *Quercus alba* (white oak), and *Quercus velutina* (black oak) in varying proportions. *Quercus rubra* (northern red oak) is a common associate, although it never occurs in abundance. Occasional canopy associates that occur with low cover can include *Quercus coccinea* (scarlet oak), *Quercus prinus* (chestnut oak), and *Acer saccharum* (sugar maple). There are relatively few shrubs, and the herb layer includes tree seedlings, especially *Quercus* (oak) spp. and *Fagus grandifolia* (American beech), plus *Carex swanii* (swan's sedge), *Maianthemum canadense* (Canada mayflower), *Eurybia divaricata* (white wood-aster), *Epifagus virginiana* (beechdrops), and *Maianthemum racemosum* (feathery false lily-of-the-valley).

Characteristic Species: *Fagus grandifolia* (American beech), *Quercus alba* (white oak), *Quercus velutina* (black oak)

Dynamics/Successional Trajectory: This is a coastal forest community and, as such, is not influenced directly by maritime processes, although it is moderately influenced by minor salt spray from severe storms. This association grades into other coastal oak forest types as well as beech-maple types.

Reference Sites: Crosswicks Creek, Mantua Creek, Raccoon Creek, Oldman's Creek, NJ

Global and State Conservation Ranks and Reasons: GNR (1-Dec-1997). NJ: S2.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689277

References: Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002, Godfrey et al. 1978, Greller 1977, Greller et al. 1978, Hunt 1997a, Metzler and Barrett 2001, Rawinski 1984, Swain and Kearsley 2001

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>Quercus alba</i> (white oak)

NORTHEASTERN COASTAL OAK - HEATH FOREST

Quercus coccinea - *Quercus velutina* / *Sassafras albidum* / *Vaccinium pallidum* Forest

Range: This type occurs in coastal areas from New Hampshire to New Jersey.

Environmental Description: This association occurs on rapidly drained, nutrient-poor, sandy or gravelly soils. North of the glacial border, these soils are typically found on till or outwash.

Vegetation Description: This dry coastal oak-heath forest is dominated by *Quercus coccinea* (scarlet oak), *Quercus velutina* (black oak), and *Quercus alba* (white oak), the latter species particularly characteristic of gravel substrates. Other less abundant canopy associates include *Quercus prinus* (chestnut oak) and *Ilex opaca* (American holly) (usually less than 15% cover). *Pinus rigida* (pitch pine) is a common associate but occurs at low cover. *Sassafras albidum* (sassafras) may occur in low cover and may indicate influence by coastal (but not maritime) climate where this type occurs. (Note: in New Jersey there is a stunted *Sassafras albidum* (sassafras)-dominated woodland on xeric sand that may be a variant of this forest or a new type.) *Castanea dentata* (American chestnut) saplings can be common. A "lawn-like" dwarf-shrub heath layer dominated by *Vaccinium pallidum* (hillside blueberry), *Vaccinium angustifolium* (northern lowbush blueberry), and *Gaylussacia baccata* (black huckleberry) is characteristic. *Gaylussacia frondosa* (dangleberry) also occurs in some stands. The herbaceous layer is typically sparse, with *Carex pensylvanica* (Pennsylvania sedge), *Pteridium aquilinum* (bracken fern), and *Gaultheria procumbens* (wintergreen) being the most common. Herb diversity is greater in small canopy gaps, where *Helianthemum canadense* (long-branch frostweed), *Tephrosia virginiana* (goat's-rue), *Aureolaria* (yellow false foxglove) spp., *Lespedeza* (bushclover) spp., *Lechea* (pinweed) spp., and *Arctostaphylos uva-ursi* (bearberry) occur.



Photo by Andrew Windisch

Characteristic Species: *Gaylussacia baccata* (black huckleberry), *Quercus coccinea* (scarlet oak), *Vaccinium angustifolium* (northern lowbush blueberry), *Vaccinium pallidum* (hillside blueberry)

Dynamics/Successional Trajectory: This is a coastal forest that occurs beyond direct influence of maritime processes.

Reference Sites: NJ Pine Barrens - Brendan Byrne State Forest, NJ

Global and State Conservation Ranks and Reasons: GNR (1-Dec-1997). NJ: S1S3.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688944

References: Breden 1989, Breden et al. 2001, Clark 1986, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Greller 1977, Lundgren 2000, Metzler and Barrett 2001, Motzkin and Foster 2002, Rawinski 1984, Reschke 1990, Sperduto 1996, Swain and Kearsley 2001

MOST ABUNDANT SPECIES

STRATUM	LIFEFORM	SPECIES
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 subcanopy	Broad-leaved deciduous tree	<i>Sassafras albidum</i> (sassafras)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Gaylussacia baccata</i> (black huckleberry)
Short shrub/sapling blueberry)	Broad-leaved deciduous shrub	<i>Vaccinium angustifolium</i> (northern lowbush blueberry)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Vaccinium pallidum</i> (hillside blueberry)
Herb (field)	Graminoid	<i>Carex pensylvanica</i> (Pennsylvania sedge)

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).

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



Photo by Pennsylvania Natural Heritage Program

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

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

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)	Graminoid	<i>Carex pensylvanica</i> (Pennsylvania sedge)

SOUTHERN RED OAK / HEATH FOREST

Quercus alba - *Quercus falcata* - (*Pinus taeda*) / *Gaylussacia frondosa* Forest

Range: This association occurs on the Coastal Plain from New Jersey to Virginia and possibly northeastern North Carolina. In central and southeastern Virginia, it extends slightly into the eastern portion of the Piedmont.

Environmental Description: This community generally occurs on well-drained acidic soils, primarily loamy sands, sandy loams and silty/clay loams. Occasional stands occur on imperfectly drained, alternately wet and dry, upland flats with hardpan subsoils. Even on the latter, moisture potential of most sites supporting this vegetation can be characterized as subxeric to xeric. Soil samples collected from plots of this vegetation type in Virginia are extremely acidic, with very low base cation levels and total base saturation.

Vegetation Description: Physiognomy is generally a closed to somewhat open forest. The overstory of mid- to late-successional stands is dominated by a mixture of oaks, such as *Quercus alba* (white oak), *Quercus falcata* (southern red oak), and *Quercus velutina* (black oak). Early-successional stands recovering from recent logging or agricultural conversion usually have a strong admixture of *Pinus taeda* (loblolly pine). Other canopy associates include *Sassafras albidum* (sassafras), *Quercus coccinea* (scarlet oak) (occasionally codominant), *Quercus stellata* (post oak), *Liquidambar styraciflua* (sweetgum), *Nyssa sylvatica* (blackgum), *Carya alba* (mockernut hickory), and *Carya pallida* (sand hickory) (occasionally codominant). *Acer rubrum* (red maple), *Ilex opaca* (American holly), and *Cornus florida* (flowering dogwood) are the principal subcanopy trees. In the southern part of the range, *Oxydendrum arboreum* (sourwood) and scrambling vines of *Vitis rotundifolia* (muscadine) can be important in the understory. The shrub layer is well-developed and dominated by ericaceous species such as *Gaylussacia*

baccata (black huckleberry), *Gaylussacia frondosa* (dangleberry), *Vaccinium pallidum* (hillside blueberry), *Vaccinium stamineum* (deerberry), and occasionally *Lyonia mariana* (piedmont staggerbush). The herbaceous layer is generally sparse and characterized by xerophytes such as *Pteridium aquilinum* (bracken fern), *Cypripedium acaule* (pink lady's-slipper), *Chimaphila maculata* (striped pipsissewa), and *Gaultheria procumbens* (wintergreen).

Characteristic Species: *Gaylussacia frondosa* (dangleberry), *Pteridium aquilinum* (bracken fern)

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: Milford Neck, DE; Prime Hook, DE; Maurice River and Manumuskin River, NJ

Global and State Conservation Ranks and Reasons: G4G5 (1-Dec-1997). DE: SNR, NJ: S3S4. The type is common and widespread on the Coastal Plain from New Jersey to Virginia. Mature examples are uncommon, and all stands are vulnerable to logging disturbances and fire suppression.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689304

References: Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Fleming et al. 2001, Fleming pers. comm., Harrison 2004, Shreve et al. 1910, Sneddon et al. 1996, VDNH 2003

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
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 falcata</i> (southern red oak)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Gaylussacia baccata</i> (black huckleberry)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Vaccinium pallidum</i> (hillside blueberry)
Herb (field)	Fern or fern ally	<i>Pteridium aquilinum</i> (bracken fern)

XERIC PALEODUNE OAK - SAND HICKORY WOODLAND

Quercus (alba, velutina, stellata, falcata) / Carya pallida - Quercus prinoides / Carex pensylvanica
Woodland

Range: This community occurs along the Maurice River in New Jersey within the Delaware Estuary.

Environmental Description: This is a rare community that is unique to xeric paleodunes (Evesboro Soils) on Maurice River terraces.

Vegetation Description: Dominant trees include various combinations of *Quercus falcata* (southern red oak), *Quercus alba* (white oak), *Quercus velutina* (black oak), and *Quercus stellata* (post oak), with smaller amounts of *Sassafras albidum* (sassafras), *Carya pallida* (sand hickory), and *Pinus rigida* (pitch pine). Low shrubs occurring in small patches include *Gaylussacia baccata* (black huckleberry) and *Vaccinium pallidum* (hillside blueberry), while taller shrubs in small patches or as scattered individuals include *Quercus ilicifolia* (bear oak), *Quercus prinoides* (dwarf chinquapin oak), *Quercus stellata* (post oak), *Gaylussacia frondosa* (dangleberry), *Carya pallida* (sand hickory), and rarely *Cornus florida* (flowering dogwood). *Smilax glauca* (whiteleaf greenbrier) also occurs as scattered individuals. *Carex pensylvanica* (Pennsylvania sedge) forms a widespread herb stratum with 50-75% cover. Other herbs include *Cladina subtenuis* (dixie reindeer lichen) and *Schizachyrium scoparium* (little bluestem).

Characteristic Species: *Carya pallida* (sand hickory)

Reference Sites: Maurice River, Unexpected Preserve, NJ

Global and State Conservation Ranks and Reasons: GNR (8-Nov-2000). NJ: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688129

References: Eastern Ecology Working Group n.d.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
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)
Tree canopy	Broad-leaved deciduous tree	<i>Quercus stellata</i> (post oak)
Tree canopy	Broad-leaved deciduous tree	<i>Quercus velutina</i> (black oak)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Gaylussacia baccata</i> (black huckleberry)
Herb (field)	Graminoid	<i>Carex pensylvanica</i> (Pennsylvania sedge)

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* (Indian wild rice), marshes of lower stature dominated by forbs such as *Amaranthus cannabinus* (water-hemp), *Hibiscus moscheutos* (eastern rosemallow) and others, and vegetation characterized by short-statured and rosette-forming forbs such as *Eriocaulon parkeri* (estuary pipewort) and *Isoetes riparia* (riverbank 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 Associations:

- American Lotus Tidal Marsh
- Atlantic Coast Brackish Tidal Marsh
- Atlantic Coast Wild Rice Tidal Marsh
- Coastal Freshwater Marsh
- Estuary Pipewort Freshwater Intertidal Flat
- Estuary Quillwort Tidal Flat
- Freshwater Tidal Mixed Forbs High Marsh
- North Atlantic Fresh Tidal Shrub Swamp
- Oligohaline Mixed Forbs Tidal Marsh
- Pickerelweed Tidal Marsh
- Pond-lily Tidal Marsh
- Sweetflag Tidal Marsh
- Water-hemp Tidal Marsh
- Water-willow Shrub Swamp

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

AMERICAN LOTUS TIDAL MARSH

Nelumbo lutea Tidal Herbaceous Vegetation

Range: This community is currently observed from Delaware, New Jersey, Maryland, and Virginia.

Environmental Description: This community type occurs as a distinct zone along tidal rivers in the Coastal Plain.

Vegetation Description: *Nelumbo lutea* (American lotus) forms a thin band of vegetation along the river that is 2-3 m deep at low tide.

Noteworthy Associated Plant and/or Animal Species: *Nelumbo lutea* (American lotus)

Characteristic Species: *Nelumbo lutea* (American lotus)

Reference Sites: St. Jones River, Kent County, DE; Mannington Meadows, Salem County, NJ; Monds Island, Repaupo/Raccoon Creek, Oldman's Creek, Gloucester County, NJ

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.683563

References: Coulling pers. comm., Eastern Ecology Working Group n.d., Harrison 2004, NJNHP unpubl. data, VDNH 2003

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Forb	<i>Nelumbo lutea</i> (American lotus)

ATLANTIC COAST BRACKISH TIDAL MARSH

Schoenoplectus pungens Tidal Herbaceous Vegetation

Range: This association occurs along the Atlantic coast from New Hampshire to Virginia.

Environmental Description: This association occurs in oligohaline to more mesohaline reaches of tidal rivers with sandy or gravelly rivershores. It occurs in low areas where there is a longer duration of flooding. Ice scour can have a significant effect on the species composition and percent cover from year to year.



Photo by Linda Kelly

Vegetation Description: This vegetation often occurs in nearly pure stands of *Schoenoplectus pungens* (common threesquare) but can be intermixed with *Spartina alterniflora* (saltmarsh cordgrass) or *Spartina cynosuroides* (giant cordgrass) in slightly brackish areas. Species diversity tends to be low due to winter storm scour, but associates can include *Amaranthus cannabinus* (water-hemp), *Polygonum punctatum* (dotted smartweed), and *Bidens* (beggarticks) spp. *Sagittaria graminea* (grassleaf arrowhead), *Sagittaria latifolia* (broadleaf arrowhead), *Eleocharis palustris* (marsh spikerush), *Gratiola virginiana* (roundfruit hedge-hyssop), and *Cyperus bipartitus* (shining flatsedge) can occur but are absent in the northern part of the range. As the salinity decreases *Zizania aquatica* (Indian wild rice) can also be an associate. *Lilaeopsis* (grasswort) occurs on *Spartina alterniflora* (saltmarsh cordgrass) hummocks.

Noteworthy Associated Plant and/or Animal Species: *Bidens bidentoides* (delmarva beggarticks)

Characteristic Species: *Schoenoplectus pungens* (common threesquare)

Dynamics/Successional Trajectory: The species composition of brackish marsh associations is likely related to gradients in salinity and duration of tidal flooding. *Schoenoplectus pungens* (common threesquare) may dominate in areas with higher average water levels, lower salinities, and lower frequency of flooding than areas typically dominated by *Spartina patens* (saltmeadow cordgrass).

Management Concerns: Ice-scour can have a significant effect on the species composition and percent cover from year to year.

Reference Sites: Snickensons Landing, Salem County, NJ; Edgewater Park, Mercer/Burlington County, NJ

Global and State Conservation Ranks and Reasons: GNR (1-Dec-1997). NJ: S1S3.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.683291

References: Barrett 1989, Bartgis 1986, Breden 1989, Breden et al. 2001, Caldwell 1990, Eastern Ecology Working Group n.d., Fleming 2001, Fleming et al. 2001, Harrison 2004, Metzler and Barrett 2001, Metzler and Rosza 1982, Rawinski 1984, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Schoenoplectus pungens</i> (common threesquare)

ATLANTIC COAST WILD RICE TIDAL MARSH

Zizania aquatica Tidal Herbaceous Vegetation

Range: This association occurs along the Atlantic Coastal Plain from Maine and Massachusetts south to South Carolina, possibly extending into Georgia. This association occurs in New Jersey and possibly Delaware in the Delaware Estuary.

Environmental Description: This association occurs in the lower reaches of freshwater tidal marshes, in fresh to slightly brackish areas that are low within the marsh and are infrequently exposed at lowest tides. It occurs on alluvial soils that are commonly silts or silty clays, although occasionally have a greater sand component. *Zizania* (wild rice) flats are best developed in quiet waters conducive to sedimentation (Barrett 1989).



Photo by Linda Kelly

Vegetation Description: This freshwater tidal marsh community can be highly variable in species composition but is characterized by *Zizania aquatica* (Indian wild rice), which is dominant and monotypic in some examples, or codominant with such species as *Pontederia cordata* (pickerelweed), *Peltandra virginica* (green arrow-arum), *Polygonum arifolium* (halberd-leaf tearthumb), *Polygonum punctatum* (dotted smartweed), and/or *Bidens cernua* (nodding beggarticks), among others. Common associates are generally a mixture of freshwater and brackish species and can include *Sagittaria latifolia* (broadleaf arrowhead), *Ludwigia palustris* (marsh seedbox), *Impatiens capensis* (orange jewelweed), *Leersia oryzoides* (rice cutgrass), *Amaranthus cannabinus* (water-hemp), *Hibiscus moscheutos* (eastern rosemallow), *Sium suave* (hemlock water-parsnip), *Acorus americanus* (several-vein sweetflag), and *Schoenoplectus fluviatilis* (river bulrush). *Nuphar lutea ssp. advena* (broadleaf pond-lily) is a common associate in the southern portion of the range. This plant association shows extreme seasonal variability, with *Zizania aquatica* (Indian wild rice) becoming a conspicuous component only in mid to late summer and generally senescing by mid to late autumn. This vegetation provides an important food source for migratory birds.

Noteworthy Associated Plant and/or Animal Species: *Aeschynomene virginica* (Virginia joint-vetch)

Characteristic Species: *Zizania aquatica* (Indian wild rice)

Dynamics/Successional Trajectory: Freshwater tidal marshes are naturally dynamic systems that are best developed where there is a major input of freshwater, a daily tidal range of at least 0.5 m, and a geomorphology that tends to constrict and magnify tidal influence in the upper reaches of the estuary (Odum et al. 1984). They are subject to diurnal flooding by tides and seasonal and episodic flooding from river discharge. Plant composition of freshwater tidal marshes generally occurs as a mosaic of patches dominated by a few or a single species. Species composition is determined by species life history characteristics, especially lifeform, phenology and mode of regeneration in response to microhabitat conditions, and the frequency and duration of flooding. Plant composition has seasonal variation. Landward, this community can grade into other freshwater tidal marsh associations, especially *Peltandra virginica* - *Pontederia cordata* Tidal Herbaceous Vegetation (CEGL004706).

Reference Sites: Manumuskin River (TNC Preserve), NJ; Rancocas Creek at Mill Creek (Willingboro Township) Park, Burlington County, NJ

Global and State Conservation Ranks and Reasons: G4? (13-Aug-1997). DE: S3, NJ: S2S3.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689364

References: Barrett 1989, Barrett 1994, Bowman 2000, Breden 1989, Breden et al. 2001, Coulling 2002, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Ferren and Good 1977, Fleming et al. 2001, Gawler 2001, Gawler 2002, Glitzenstein and Streng 2004, Good and Good 1975b, Harrison 2001, Harrison 2004, McCormick and Ashbaugh 1972, McCormick et al. 1970, McCoy and Fleming 2000, Metzler and Barrett 2001, Metzler and Rosza 1982, Odum et al. 1984, Rawinski 1984, Reschke 1990, Schafale 2000, Schafale 2003b, Schafale and Weakley 1990, Swain and Kearsley 2001, VDNH 2003, Wharton 1978

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Zizania aquatica</i> (Indian wild rice)

COASTAL FRESHWATER MARSH

Schoenoplectus pungens var. *pungens* - *Juncus canadensis* Herbaceous Vegetation

Range: This association is known from Massachusetts and New Jersey but is likely to occur in other coastal states of the Northeast. It occurs in the New Jersey portion of the Delaware Estuary.

Environmental Description: This non-tidal freshwater marsh of the coastal Northeast occupies flooded depressions and swales in coastal dunes (and impoundments). This community can also occur at the mouth of large rivers, on hummocky islands in freshwater wetlands, and in transition zones. The substrate varies from sand to peat or muck, depending on hydrological regime. Water is present most of the year and does not typically exhibit a seasonal drawdown.

Vegetation Description: The vegetation is dominated by *Schoenoplectus pungens* var. *pungens* (common threesquare), in association with *Hibiscus moscheutos* ssp. *moscheutos* (eastern rosemallow), *Juncus canadensis* (Canadian rush), *Juncus effusus* (soft rush), *Eleocharis erythropoda* (bald spikerush), *Osmunda regalis* (royal fern), *Osmunda cinnamomea* (cinnamon fern), *Thelypteris palustris* (eastern marsh fern), and *Triadenum virginicum* (Virginia marsh St. John's-wort). *Typha latifolia* (broadleaf cattail) may be present but generally only occurs at low cover. A diverse range of other forbs may also be associated with this community. Shrubs may be present as sparsely distributed individuals, or more densely from the wetland edge. Typical shrubs include *Rosa palustris* (swamp rose), *Vaccinium corymbosum* (highbush blueberry), *Morella pensylvanica* (northern bayberry), and *Acer rubrum* (red maple).

Characteristic Species: *Juncus canadensis* (Canadian rush), *Schoenoplectus pungens* var. *pungens* (common threesquare)

Reference Sites: Monds Island (New Jersey Audubon Society), NJ; Raccoon Creek/Repaupo Creek, NJ; Route 44 at Birch Creek, Gloucester County, NJ; Oldman's Creek, NJ

Global and State Conservation Ranks and Reasons: GNR (8-Nov-2000). NJ: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685545

References: Eastern Ecology Working Group n.d., Martin 1959b

ESTUARY PIPEWORT FRESHWATER INTERTIDAL FLAT

Eriocaulon parkeri - *Polygonum punctatum* Herbaceous Vegetation

Range: These intertidal flats occur in New Jersey in the Delaware Estuary.

Environmental Description: This community occurs within freshwater tidal wetland complexes in upper reaches of tides where there is seasonal flushing which removes accumulated fine-grained materials. The typical substrate consists of loamy sand with about 5% gravel. The moisture regime is very wet with the community being exposed during low tide and often remaining inundated during spring tides.

Vegetation Description: This community is an herbaceous (95% cover) wetland dominated by annuals or herbaceous perennials. *Eriocaulon parkeri* (estuary pipewort) is characteristic of this association. In the northern portion of the range, associated species include *Zizania aquatica* (Indian wild rice), *Ludwigia palustris* (marsh seedbox), *Bidens eatonii* (Eaton's beggarticks), *Bidens hyperborea* (estuary beggarticks), and *Schoenoplectus pungens* (common threesquare). Farther south, associates additionally include *Sagittaria latifolia* (broadleaf arrowhead), *Pontederia cordata* (pickerelweed), *Peltandra virginica* (green arrow-arum), and *Orontium aquaticum* (golden club). In New Jersey, associates include *Eleocharis palustris* (marsh spikerush), *Schoenoplectus smithii* (Smith's clubrush), and *Sagittaria subulata* (awl-leaf arrowhead). Vegetation cover can be highly variable, with significant fluctuations in floristic composition and species density from year to year. Seasonal variability also occurs; early in the season, *Isoetes* (quillwort) spp. can predominate.

Noteworthy Associated Plant and/or Animal Species: *Bidens eatonii* (Eaton's beggarticks), *Crassula aquatica* (water pygmyweed), *Eriocaulon parkeri* (estuary pipewort), *Limosella australis* (awlwort)

Characteristic Species: *Eriocaulon parkeri* (estuary pipewort)

Management Concerns: The vegetation is threatened by damming of tidal rivers, which causes silting and reduces the flushing of fine sediments necessary to maintain this community.

Reference Sites: Rancocas Creek at Mill Creek (Willingboro Township) Park, Burlington County, NJ

Global and State Conservation Ranks and Reasons: G2 (9-Nov-1998). DE: SNR, NJ: S2?. This freshwater to brackish-tidal vegetation is restricted to sandy, gravel or cobble shores of tidal rivers from southern Maine to North Carolina, with possible peripheral occurrences in South Carolina and New Brunswick, Canada. This community is extirpated from New York. The habitat is naturally rare and occurrences are of small size (generally a few acres or less).

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687578

References: Barrett 1994, Bowman 2000, Breden 1989, Breden et al. 2001, Cowardin et al. 1979, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fleming et al. 2001, Gawler 2002, Haines 2001, Harrison 2004, MENHP 1991, Metzler and Barrett 2001, Rawinski 1984, Swain and Kearsley 2001

MOST ABUNDANT SPECIES

STRATUM	LIFEFORM	SPECIES
Herb (field)	Forb	<i>Eriocaulon parkeri</i> (estuary pipewort)
Herb (field)	Forb	<i>Gratiola aurea</i> (golden hedge-hyssop)
Herb (field)	Forb	<i>Ludwigia palustris</i> (marsh seedbox)
Herb (field)	Forb	<i>Polygonum punctatum</i> (dotted smartweed)
Herb (field)	Graminoid	<i>Leersia oryzoides</i> (rice cutgrass)

ESTUARY QUILLWORT TIDAL FLAT

Isoetes riparia Tidal Herbaceous Vegetation

Range: This community occurs in New Jersey and possibly Delaware in the Delaware Estuary.

Environmental Description: This association occurs on fresh tidal mud flats with soft to semi-soft substrates in shallow waters associated with embayments, occurring behind beaches and sand spits, as well as along margins of estuaries. These occur in quiet waters where fine sediments accumulate.

Vegetation Description: The vegetation is sparse but is characterized by *Isoetes riparia* (riverbank quillwort). Associated species include *Cyperus bipartitus* (shining flatsedge), *Elatine americana* (American waterwort), *Sagittaria graminea* (grassleaf arrowhead), *Sagittaria subulata* (awl-leaf arrowhead), *Sagittaria calycina* (hooded arrowhead), *Sagittaria montevidensis* (giant arrowhead), *Heteranthera reniformis* (kidneyleaf mud-plantain), *Crassula aquatica* (water pygmyweed), *Eriocaulon parkeri* (estuary pipewort), *Orontium aquaticum* (golden club), *Gratiola virginiana* (roundfruit hedge-hyssop), *Eleocharis obtusa* (blunt spikerush), and in more muddy areas, *Schoenoplectus smithii* (smith's clubrush). This may be the potential habitat of *Micranthemum micranthemoides* (Nuttall's mudflower). *Isoetes riparia* (riverbank quillwort) also occurs in non-tidal ponds in New Jersey.

Noteworthy Associated Plant and/or Animal Species: *Eriocaulon parkeri* (estuary pipewort)

Characteristic Species: *Isoetes riparia* (riverbank quillwort)

Dynamics/Successional Trajectory: The occurrence and extent of mud flats vary with coastline morphology and tidal amplitude. Mud flats are regularly flooded and exposed by diurnal tides (Whitlatch 1982).

Reference Sites: Rancocas Creek at Mill Creek (Willingboro Township) Park, Burlington County, NJ

Global and State Conservation Ranks and Reasons: GNR (1-Dec-1997). DE: SNR, NJ: S2S3.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.683281

References: Bartgis 1986, Bowman 2000, Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002, Harrison 2004, Rawinski 1984, Schafale 2000, Swain and Kearsley 2001, Whitlatch 1982

MOST ABUNDANT SPECIES

STRATUM	LIFEFORM	SPECIES
Herb (field)	Fern or fern ally	<i>Isoetes riparia</i> (riverbank quillwort)

FRESHWATER TIDAL MIXED FORBS HIGH MARSH

Impatiens capensis - *Peltandra virginica* - *Sagittaria latifolia* - (*Typha angustifolia*) Tidal Herbaceous Vegetation

Range: This association occurs in freshwater tidal marshes along the Atlantic coast from Maine to Virginia. It occurs in the New Jersey portion of the Delaware Estuary.

Environmental Description: This association occurs in reliably flooded swales or backmarshes within the upper reaches of freshwater tidal marshes and within naturally ice-scoured levees and creekbanks. Salinity is fresh to slightly brackish. These low-lying depressions are flooded for a longer duration than the surrounding habitat as they trap floodwaters as tides recede. Soils are highly variable, ranging from silts, silty mucks, peats, or sands.

Vegetation Description: Species composition and abundance in these small-patch wet depression are highly variable. They are best characterized by the presence and/or dominance of *Peltandra virginica* (green arrow-arum), *Impatiens capensis* (orange jewelweed), *Sagittaria latifolia* (broadleaf arrowhead), and/or *Typha angustifolia* (narrowleaf cattail). Associated species commonly include *Pontederia cordata* (pickerelweed), *Polygonum* (smartweed, knotweed) spp. (*Polygonum arifolium* (halberd-leaf tearthumb), *Polygonum sagittatum* (arrowleaf tearthumb), *Polygonum hydropiperoides* (swamp smartweed), *Polygonum punctatum* (dotted smartweed), *Bidens* (beggarticks) spp. (*Bidens laevis* (smooth beggarticks), *Bidens frondosa* (devil's pitchfork), *Schoenoplectus fluviatilis* (river bulrush), *Leersia oryzoides* (rice cutgrass), *Amaranthus cannabinus* (water-hemp), *Sium suave* (hemlock water-parsnip), *Apios americana* (groundnut), *Iris versicolor* (harlequin blueflag), *Echinochloa walteri* (long-awn cock's-spur grass), and others. The exotic *Murdannia keisak* (marsh dewflower) has been noted in this community in the southern portion of the range. Species of the surrounding oligohaline or mesohaline marshes or from palustrine setting can occur in these microhabitats, but are usually not dominant; these include *Zizania aquatica* (Indian wild rice), *Onoclea sensibilis* (sensitive fern), *Hibiscus moscheutos* (eastern rosemallow), *Cyperus strigosus* (straw-colored flatsedge), *Lindernia dubia* (yellowseed false pimpernel), *Equisetum fluviatile* (water horsetail), *Iris versicolor* (harlequin blueflag), *Boehmeria cylindrica* (small-spike false nettle), *Thelypteris palustris* (eastern marsh fern), or *Carex stricta* (tussock sedge).

Noteworthy Associated Plant and/or Animal Species: *Bidens bidentoides* (Delmarva beggarticks), *Justicia americana* (American water-willow)

Characteristic Species: *Impatiens capensis* (orange jewelweed), *Peltandra virginica* (green arrow-arum), *Sagittaria latifolia* (broadleaf arrowhead), *Typha angustifolia* (narrowleaf cattail)

Dynamics/Successional Trajectory: Freshwater tidal marshes are naturally dynamic systems that are best developed where there is a major input of freshwater, a daily tidal range of at least 0.5 m, and a geomorphology that tends to constrict and magnify tidal influence in the upper reaches of the estuary (Odum et al. 1984). They are subject to diurnal flooding by tides and seasonal and episodic flooding from river discharge. Plant composition of freshwater tidal marshes generally occurs as a mosaic of patches dominated by a few or a single species. Species composition is determined by species life history characteristics, especially lifeform, phenology and mode of regeneration in response to microhabitat conditions, and the frequency and duration of flooding. Plant composition has seasonal variation. This association occurs in microhabitats within freshwater tidal marsh systems. As the low-lying depressions fill with sediment, the vegetation shifts to reflect the surrounding association.

This association is also very similar to Water-hemp Tidal Marsh (oligohaline), *Amaranthus cannabinus* Tidal Herbaceous Vegetation (Water Hemp Tidal Marsh in this report), and may grade temporally with annual rainfall/tidal influence.

Management Concerns: The exotic *Murdannia keisak* (marsh dewflower) has been noted in this community in the southern portion of the range.

Reference Sites: Hamilton Marsh, Mercer County, NJ; Trenton Marsh, Mercer County, NJ; Pedricktown Marsh; Mill Creek (Willingboro Township) Park, Burlington County, NJ

Global and State Conservation Ranks and Reasons: GNR (1-Dec-1997). DE: S4, NJ: S3, PA?: SNA.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689421

References: Barrett 1989, Barrett 1994, Bartgis 1986, Bowman 2000, Breden 1989, Breden et al. 2001, Clancy 1996, Coulling 2002, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fleming 2001, Fleming et al. 2001, Gawler 2002, Harrison 2001, Harrison 2004, Metzler and Barrett 2001, Metzler and Barrett 2004, Rawinski 1984, Reschke 1990, Swain and Kearsley 2001, VDNH 2003

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Forb	<i>Impatiens capensis</i> (orange jewelweed)
Herb (field)	Forb	<i>Peltandra virginica</i> (green arrow-arum)
Herb (field)	Forb	<i>Sagittaria latifolia</i> (broadleaf arrowhead)

NORTH ATLANTIC FRESH TIDAL SHRUB SWAMP

Alnus (incana ssp. rugosa, serrulata) - Cornus amomum Shrubland

Range: This association is found in coastal areas with tidally influenced river systems from Maine to Delaware in the North Atlantic. It occurs in Delaware and New Jersey in the Delaware Estuary.

Environmental Description: This association occurs in freshwater tidal systems in fresh to brackish reaches of tidal rivers along the marsh-upland transition. This shrubland is best developed along major tidal river systems that have a gradual elevation gradient. The substrate is alluvial and fine silty loam, loamy sand, or fine- or medium-grained sand without significant peat deposits. There is distinct hummock-and-hollow micro-relief.

Vegetation Description: This shrubland is dominated by *Alnus serrulata* (smooth alder) and/or *Alnus incana ssp. rugosa* (speckled alder). In some examples one or both of these may be characteristically dominant or nearly so. Other examples may be more semi-open with a mixed canopy of *Alnus* (alder) with other shrubs such as *Cornus amomum* (silky dogwood), *Rosa palustris* (swamp rose), *Ilex verticillata* (common winterberry), *Viburnum dentatum* (southern arrow-wood), *Clethra alnifolia* (coastal sweet-pepperbush), and *Lindera benzoin* (northern spicebush). Other woody plants which may be present include *Sambucus canadensis* (American elder), *Salix* (willow) spp., *Amorpha fruticosa* (tall indigobush), *Cephalanthus occidentalis* (common buttonbush), *Decodon verticillatus* (swamp-loosestrife), *Toxicodendron vernix* (poison-sumac), and *Toxicodendron radicans* (eastern poison-ivy). More northern examples may contain *Viburnum recognitum* (northern arrow-wood) and *Spiraea alba var. latifolia* (broadleaf meadowsweet). *Carex stricta* (tussock sedge) may also be present, and there is a great deal of micro-relief (tussocks and furrows) leading to high species diversity. Some herbaceous associates are *Osmunda regalis var. spectabilis* (royal fern), *Thelypteris palustris var. pubescens* (eastern marsh fern), *Galium* (bedstraw) spp., *Onoclea sensibilis* (sensitive fern), *Pilea fontana* (lesser clearweed), *Polygonum punctatum* (dotted smartweed), *Apios americana* (groundnut), *Typha latifolia* (broadleaf cattail), *Peltandra virginica* (green arrow-arum), *Pontederia cordata* (pickerelweed), *Mikania scandens* (climbing hempvine), *Symphotrichum novi-belgii* (new belgium American-aster), *Boehmeria cylindrica* (small-spike false nettle), *Impatiens capensis* (orange jewelweed), *Triadenum walteri* (greater marsh-St. John's-wort), *Asclepias incarnata* (swamp milkweed), *Carex atlantica* (prickly bog sedge), *Platanthera clavellata* (small green wood orchid), and *Xyris torta* (slender yellow-eyed-grass).

Characteristic Species: *Alnus incana ssp. rugosa* (speckled alder), *Alnus serrulata* (smooth alder)

Dynamics/Successional Trajectory: This shrubland community generally occurs between mean high tide level and mean high water level of annual river flooding in the spring, and it is generally flooded irregularly by spring tides.

Reference Sites: Lewden-Greene Park, New Castle County, DE; Trenton Marsh, Mercer County, NJ; north of Old Ferry Landing, Gloucester City, NJ; Edgewater Park Coves, NJ; Maurice River, south of Millville, NJ

Global and State Conservation Ranks and Reasons: GNR (15-Aug-1997). DE: SNR, NJ: SNR, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684398

References: Bowman 2000, Breden 1989, Breden et al. 2001, Clancy 1996, Collins and Anderson 1994, Coulling pers. comm., Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Fleming pers. comm., Gawler 2001, Gawler 2002, Harrison and Stango 2003, Hart 1990, McCoy and Fleming 2000, Metzler and Barrett 2001, Metzler and Barrett 2004, Rawinski 1984, Reschke 1990, Sneddon et al. 1996, Sperduto 2000b, Swain and Kearsley 2000, Swain and Kearsley 2001, Tiner 1995

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Alnus incana</i> ssp. <i>rugosa</i> (speckled alder)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Alnus serrulata</i> (smooth alder)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Cornus amomum</i> (silky dogwood)

OLIGOHALINE MIXED FORBS TIDAL MARSH

Hibiscus moscheutos - *Polygonum arifolium* - *Leersia oryzoides* - (*Carex stricta*) Tidal Herbaceous Vegetation

Range: This community is currently described from Virginia, Maryland, and New Jersey.

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* (eastern rosemallow), *Polygonum punctatum* (dotted smartweed), *Peltandra virginica* (green arrow-arum), *Leersia oryzoides* (rice cutgrass), *Polygonum sagittatum* (arrowleaf tearthumb), *Mikania scandens* (climbing hempvine), and *Toxicodendron radicans* (eastern poison-ivy). *Bidens laevis* (smooth beggarticks), *Cicuta maculata* (spotted water-hemlock), *Cuscuta* (dodder) sp., *Impatiens capensis* (orange jewelweed), *Lycopus americanus* (American water-horehound), and *Sagittaria latifolia* (broadleaf arrowhead), and graminoids such as *Typha latifolia* (broadleaf cattail) and *Schoenoplectus fluviatilis* (river bulrush) may also be present, but only at low cover. 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* (long-awn cock's-spur grass), *Kosteletzkya virginica* (seashore mallow), *Pluchea odorata* (sweetscent), *Rumex verticillatus* (swamp dock), *Sagittaria lancifolia* (lanceleaf arrowhead), and *Teucrium canadense* (American germander). *Spartina cynosuroides* (giant cordgrass) 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). The creek border may be also be dominated by *Decodon verticillatus* (swamp-loosestrife).

Characteristic Species: *Carex stricta* (tussock sedge), *Hibiscus moscheutos* ssp. *moscheutos* (eastern rosemallow), *Polygonum arifolium* (halberd-leaf tearthumb)

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

Reference Sites: Trenton Marsh, Mercer County, NJ; Taylor's Preserve, Riverton, Burlington County, NJ; Mannington Creek, NJ; Pedricktown Marsh, NJ

Global and State Conservation Ranks and Reasons: GNR (12-May-2002). NJ: SNR.

VegBank Link for Plot Data: 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 rosemallow)	Semi-shrub	<i>Hibiscus moscheutos</i> ssp. <i>moscheutos</i> (eastern
Herb (field)	Forb	<i>Polygonum arifolium</i> (halberd-leaf tearthumb)
Herb (field)	Graminoid	<i>Leersia oryzoides</i> (rice cutgrass)

PICKERELWEED TIDAL MARSH

Peltandra virginica - *Pontederia cordata* Tidal Herbaceous Vegetation

Range: This community occurs from Maine to Virginia, excluding Rhode Island and New Hampshire. It occurs in the New Jersey and Delaware portions of the Delaware Estuary.

Environmental Description: This community occurs low within freshwater tidal marshes on muck substrates of variable depth. There is a long duration of tidal flooding, and the community is exposed only for a short period of time each day when the tide is out.



Photo by Kathleen Strakosch Walz

Vegetation Description: This community is dominated by leafy forbs. *Peltandra virginica* (green arrow-arum) and *Pontederia cordata* (pickerelweed) are codominant, and associated species can include *Zizania aquatica* (Indian wild rice), *Sagittaria latifolia* (broadleaf arrowhead), *Acorus americanus* (several-vein sweetflag), *Polygonum arifolium* (halberd-leaf tearthumb), *Polygonum hydropiperoides* (swamp smartweed), *Polygonum sagittatum* (arrowleaf tearthumb), and *Bidens* (beggarticks) spp. Species occurring less frequently can include *Typha* (cattail) spp. and *Impatiens capensis* (orange jewelweed).

Characteristic Species: *Peltandra virginica* (green arrow-arum), *Pontederia cordata* (pickerelweed)

Dynamics/Successional Trajectory: Freshwater tidal marshes are naturally dynamic systems that are best developed where there is a major input of freshwater, a daily tidal range of at least 0.5 m, and a geomorphology that tends to constrict and magnify tidal influence in the upper reaches of the estuary (Odum et al. 1984). They are subject to diurnal flooding by tides and seasonal and episodic flooding from

river discharge. Plant composition of freshwater tidal marshes generally occurs as a mosaic of patches dominated by a few or a single species. Species composition is determined by species life history characteristics, especially lifeform, phenology and mode of regeneration in response to microhabitat conditions, and the frequency and duration of flooding. Plant composition has seasonal variation. This community can grade into other freshwater tidal marsh associations, especially *Nuphar lutea ssp. advena* Tidal Herbaceous Vegetation (Pond Lily Tidal Marsh in this report) and *Zizania aquatica* Tidal Herbaceous Vegetation (Atlantic Coast Wild Rice Marsh in this report).

Management Concerns: Many element occurrences have been impacted by the damming of tidal rivers and by pollution in urban areas.

Reference Sites: Supawna Meadows NWR, NJ; Clinton WMA, NJ; Pedricktown Marsh Complex, NJ; Mannington Meadows, NJ; Manumuskin River (TNC Preserve), NJ

Global and State Conservation Ranks and Reasons: G3G4 (4-Nov-1998). DE: SNR, NJ: SNR. This community is restricted in range (Atlantic Coast from Maine to Virginia, not including New Hampshire and Rhode Island) and available habitat (freshwater tidal rivers with broad shoreline expanses subjected to moderate to high tidal fluctuation), with a liberal estimate of <200 EOs and <35,000 acres rangewide.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688713

References: Bowman 2000, Breden et al. 2001, Coulling 2002, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fleming 2001, Fleming et al. 2001, Harrison 2001, Harrison 2004, McCoy and Fleming 2000, Metzler and Barrett 2004, Odum et al. 1984, Peet et al. unpubl. data 2002

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Forb	<i>Peltandra virginica</i> (green arrow-arum)

POND-LILY TIDAL MARSH

Nuphar lutea ssp. advena Tidal Herbaceous Vegetation

Range: This association occurs along tidal rivers from New York to North Carolina. In the Delaware Estuary, this community occurs in New Jersey and Delaware.

Environmental Description: This association occurs at low elevations within freshwater tidal marshes, within tidal range but beyond the influence of salinity. It generally occurs below mean low water level where water depth is approximately 1-3 m or less. It receives a relatively long duration of flooding and is infrequently exposed at only the lowest tides. The association occurs on unconsolidated tidal mud flats and submerged point



Photo by Linda Kelly

bars of large coastal river meanders adjacent to open water of river or tidal creek channels. Substrate is silty alluvial mud that is high in organic matter content.

Vegetation Description: Vegetation of this association is characterized by large clonal stands of dense leafy forbs dominated by *Nuphar lutea ssp. advena* (broadleaf pond-lily). Associated species tend to occur as scattered individuals and include *Peltandra virginica* (green arrow-arum), which can also be locally codominant, *Pontederia cordata* (pickerelweed), *Zizania aquatica* (Indian wild rice), *Sagittaria latifolia* (broadleaf arrowhead), *Bidens laevis* (smooth beggarticks), *Acorus calamus* (sweetflag), and/or *Schoenoplectus fluviatilis* (river bulrush). *Nuphar lutea ssp. advena* (broadleaf pond-lily) forms nearly monotypic stands early in the growing season. Associated species emerge later in the season and can

eventually overtop *Nuphar* (yellow pond-lily) plants, which senesce and tend to become insect-infested in late summer. Submerged aquatic species can occur in this association, including *Potamogeton epiphydrus* (ribbonleaf pondweed), *Ceratophyllum demersum* (coontail), and the invasive exotic *Hydrilla verticillata* (hydrilla). In shallower waters, additional mud flat species can occur.

Characteristic Species: *Nuphar lutea* ssp. *advena* (broadleaf pond-lily)

Dynamics/Successional Trajectory: Freshwater tidal marshes are naturally dynamic systems that are best developed where there is a major input of freshwater, a daily tidal range of at least 0.5 m, and a geomorphology that tends to constrict and magnify tidal influence in the upper reaches of the estuary (Odum et al. 1984). They are subject to diurnal flooding by tides and seasonal and episodic flooding from river discharge. Plant composition of freshwater tidal marshes generally occurs as a mosaic of patches dominated by a few or a single species. Species composition is determined by species life history characteristics, especially lifeform, phenology and mode of regeneration in response to microhabitat conditions, and the frequency and duration of flooding. Plant composition has seasonal variation. Landward, this community can grade into other freshwater tidal marsh associations, especially *Peltandra virginica* - *Pontederia cordata* Tidal Herbaceous Vegetation (CEGL004706). Seaward, this association grades into submerged aquatic vegetation.

Management Concerns: The invasive exotic *Hydrilla verticillata* (hydrilla) often occurs in this community. This vegetation is vulnerable to pollution from coastal run-off as well as oil spills off the coast.

Reference Sites: Hamilton Marsh, Mercer County, NJ

Global and State Conservation Ranks and Reasons: G4G5 (19-Jan-2006). DE: SNR, NJ: S2S3, PA: SNR. This vegetation ranges from Delaware Bay to North Carolina, with a discontinuous range north to Maine. It occurs in the freshwater tidal portions of large rivers and embayments and can occupy large patches.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688122

References: Bowman 2000, Breden 1989, Breden et al. 2001, Brumback and Mehrhoff 1996, Coulling 2002, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fleming 2001, Fleming et al. 2001, Gawler 2002, Good and Good 1975b, Harrison 2001, Harrison 2004, McCormick and Ashbaugh 1972, McCormick et al. 1970, McCoy and Fleming 2000, Odum et al. 1984, Peet et al. unpubl. data 2002, Rawinski 1984, Reschke 1990, Schafale 2000, Schafale and Weakley 1990, VDNH 2003

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Floating aquatic	Aquatic herb (floating & submergent)	<i>Nuphar lutea</i> ssp. <i>advena</i> (broadleaf pond-lily)

SWEETFLAG TIDAL MARSH

Acorus calamus Tidal Herbaceous Vegetation

Range: This community is currently described from Massachusetts to Virginia. It occurs in New Jersey and possibly Delaware in the Delaware Estuary.

Environmental Description: The association is best developed at higher, irregularly flooded elevations within fresh and oligohaline tidal marshes but can occur in areas with a wide tidal range. Substrate is generally fine-particled, but varies from silts and silty mucks to peats and sands. The setting within the tidal marsh tends to be poorly drained; tidal flooding is ponded and of longer duration than other areas. *Acorus calamus* (sweetflag)



Photo by Linda Kelly

can occur in low mid-tidal areas, but extensive colonies do not tend to develop in these situations.

Vegetation Description: This is a tall tidally flooded grassland dominated by *Acorus calamus* (sweetflag), which can form dense colonies over extensive patches within the interior of high marshes. Associated species are variable and can include *Schoenoplectus fluviatilis* (river bulrush), *Peltandra virginica* (green arrow-arum), *Sagittaria latifolia* (broadleaf arrowhead), *Polygonum punctatum* (dotted smartweed), and *Impatiens capensis* (orange jewelweed). Species that can occasionally occur include *Pontederia cordata* (pickerelweed), *Zizania aquatica* (Indian wild rice), *Leersia oryzoides* (rice cutgrass), *Typha latifolia* (broadleaf cattail), *Polygonum arifolium* (halberd-leaf tearthumb), *Bidens coronata* (crowned beggarticks), *Hibiscus moscheutos* (eastern rosemallow), and other *Schoenoplectus* (clubrush) spp. *Acorus calamus* (sweetflag) is conspicuously dominant in spring and early summer. Later in the season, culms tend to lodge and form mats and be overtopped by other species. In Delaware, *Acorus americanus* (several-vein sweetflag), the native sweetflag, is more common.

Characteristic Species: *Acorus calamus* (sweetflag)

Dynamics/Successional Trajectory: Freshwater tidal marshes are naturally dynamic systems that are best developed where there is a major input of freshwater, a daily tidal range of at least 0.5 m, and a geomorphology that tends to constrict and magnify tidal influence in the upper reaches of the estuary (Odum et al. 1984). They are subject to diurnal flooding by tides and seasonal and episodic flooding from river discharge. Plant composition of freshwater tidal marshes generally occurs as a mosaic of patches dominated by a few or a single species. Species composition is determined by species life history characteristics, especially lifeform, phenology and mode of regeneration in response to microhabitat conditions and the frequency and duration of flooding. Plant composition has seasonal variation. *Acorus calamus* (sweetflag) forms large, clonal patches (Barrett 1989). Its rhizomes can locally raise the surface of the marsh, effectively ponding tidal waters and trapping debris and sediments in backmarsh areas (Caldwell 1990).

Management Concerns: *Phalaris arundinacea* (reed canarygrass) is present in New Jersey examples of this community.

Reference Sites: Trenton Marsh, Mercer County, NJ; Crosswicks Creek Greenway at Provinceline Road, NJ; North Branch of Rancocas Creek, NJ

Global and State Conservation Ranks and Reasons: GNR (10-May-2002). DE: SNR, NJ: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.683165

References: Barrett 1989, Barrett 1994, Caldwell 1990, Coulling 2002, Eastern Ecology Working Group n.d., Fleming 2001, Fleming et al. 2004, Harrison 2001, Harrison 2004, McCormick and Ashbaugh 1972, Metzler and Barrett 2001, Odum et al. 1984

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Forb	<i>Acorus calamus</i> (sweetflag)

WATER-HEMP TIDAL MARSH

Amaranthus cannabinus Tidal Herbaceous Vegetation

Range: This association occurs along tidal rivers from Maine to Virginia. It occurs in the Delaware and New Jersey portions of the Delaware Estuary.

Environmental Description: This association occurs along mid-tidal sections of wave- and ice-scoured riverbanks or on eroded remnants of dikes and natural levees. It occurs where tidal floodwater is oligohaline to mesohaline. The association occasionally occurs in freshwater tidal backmarsh settings in local patches where the substrate is firm and gravelly. Substrate is generally coarse but ranges from fine sand to peaty mud to gravel to rocky shores. There is regular inundation by tides, but floodwaters freely drain.



Photo by Linda Kelly

Vegetation Description: The community is predominantly comprised of annual species, especially *Amaranthus cannabinus* (water-hemp). Associated species include, but are not limited to, *Bidens connata* (purple-stem beggarticks), *Bidens laevis* (smooth beggarticks), *Bidens cernua* (nodding beggarticks), *Polygonum punctatum* (dotted smartweed), *Sagittaria latifolia* (broadleaf arrowhead), *Zizania aquatica* (Indian wild rice), and *Schoenoplectus pungens* (common threesquare). Other species that may occur infrequently include *Polygonum arifolium* (halberd-leaf tearthumb), *Polygonum sagittatum* (arrowleaf tearthumb), *Acorus calamus* (sweetflag), *Pilea pumila* (Canadian clearweed), and *Leersia oryzoides* (rice cutgrass).

Characteristic Species: *Amaranthus cannabinus* (water-hemp)

Dynamics/Successional Trajectory: This association occurs on wave- and ice-scoured mid-tidal shores of rivers and tidal creeks. Having a strong component of annuals, the species composition and abundance can change dramatically from year to year.

Management Concerns: This community is exposed to a relatively high degree of natural disturbance from wave and ice scour.

Reference Sites: Blackbird Creek, New Castle County, DE; Manumuskin River (TNC Preserve), NJ; Trenton Marsh, Mercer County, NJ

Global and State Conservation Ranks and Reasons: G3G5 (1-Dec-1997). DE: SNR, NJ: S2S3.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689238

References: Bartgis 1986, Bowman 2000, Breden 1989, Breden et al. 2001, Caldwell 1990, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Gawler 2001, Gawler 2002, Harrison 2004, Metzler and Barrett 2001, Metzler and Barrett 2004, Rawinski 1984, Reschke 1990, Swain and Kearsley 2000, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Forb	<i>Amaranthus cannabinus</i> (water-hemp)

WATER-WILLOW SHRUB SWAMP

Decodon verticillatus Semipermanently Flooded Shrubland

Range: This community occurs in the New Jersey portion of the Delaware Estuary and may also occur in Delaware.

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

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* (white water-lily), *Peltandra virginica* (green arrow-arum), *Pontederia cordata* (pickerelweed), *Utricularia* (bladderwort) spp., and *Potamogeton* (pondweed) spp.

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

Reference Sites: (NJ and DE - no sites identified)

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

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 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. 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

Delaware Estuary Associations:

- Chesapeake Bay Tall Maritime Shrubland
- Coastal Loblolly Pine Wetland Forest
- Coastal Pitch Pine / Scrub Oak Barren
- Inland Dune Ridge Forest
- Loblolly Pine Dune Woodland
- Lower New England Red Maple - Blackgum Swamp
- Maritime Holly Forest
- Maritime Red-cedar Woodland
- Northern Bayberry Dune Shrubland
- Pitch Pine Dune Woodland
- Successional Maritime Forest

Similar Ecological Systems in the Delaware Estuary:

- Atlantic Coastal Plain Northern 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

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* (Canada serviceberry), *Sassafras albidum* (sassafras), *Photinia pyrifolia* (red chokeberry), and *Diospyros virginiana* (eastern persimmon) in varying proportions. *Pinus taeda* (loblolly pine) is a common associate in examples of this community south of New Jersey. *Morella 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* (whiteleaf 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.

Characteristic Species: *Morella cerifera* (wax-myrtle), *Prunus serotina* (black cherry), *Smilax rotundifolia* (roundleaf greenbrier)

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 and State Conservation Ranks and Reasons: G1G2 (18-Nov-1997). DE: SNR, NJ: S1. 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.

VegBank Link for Plot Data: 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)

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

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)

COASTAL PITCH PINE / SCRUB OAK BARREN

Pinus rigida / *Quercus ilicifolia* / *Morella pennsylvanica* Woodland

Range: This community occurs in coastal areas of Massachusetts, Rhode Island, New York, and New Jersey.

Environmental Description: This community includes pine barrens in the North Atlantic Coast ecoregion characterized by droughty, fire-prone vegetation, sandy soils and maritime influence.

Vegetation Description: *Pinus rigida* (pitch pine) is strongly dominant in the canopy. *Quercus ilicifolia* (bear oak) forms a dense, 1- to 2-m tall shrub layer with occasional *Quercus prinoides* (dwarf chinquapin oak). Dwarf-shrubs, such as *Gaylussacia baccata* (black huckleberry), *Morella pensylvanica* (northern bayberry), *Vaccinium pallidum* (hillside blueberry), and *Vaccinium angustifolium* (northern lowbush blueberry), intermingle with the tall shrubs. Herbs tend to be sparse, although more open areas may support patches of *Schizachyrium scoparium* (little bluestem) and *Deschampsia flexuosa* (wavy hairgrass), or *Carex pensylvanica* (Pennsylvania sedge) and *Carex swanii* (swan's sedge). Additional scattered herbs include *Comptonia peregrina* (sweet-fern), *Pteridium aquilinum* (bracken fern), *Gaultheria procumbens* (wintergreen), and *Arctostaphylos uva-ursi* (bearberry). Diagnostic characteristics include the presence of *Morella pensylvanica* (northern bayberry) to indicate coastal setting. In New Jersey, *Morella pensylvanica* (northern bayberry) occurs more in the Atlantic coastal areas, but this type also occurs inland and lacks the local maritime influence.

Characteristic Species: *Morella pensylvanica* (northern bayberry)

Dynamics/Successional Trajectory: These are fire-maintained systems.

Reference Sites: Brendan Byrne SF, NJ

Global and State Conservation Ranks and Reasons: G3 (1-Dec-1997). NJ: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688963

References: Breden et al. 2001, Eastern Ecology Working Group n.d., Lundgren et al. 2000, Motzkin and Foster 2002, Rawinski 1984, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Quercus ilicifolia</i> (bear oak)
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Morella pensylvanica</i> (northern bayberry)
Herb (field)	Graminoid	<i>Schizachyrium scoparium</i> (little bluestem)

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), *Dichanthelium commutatum* (variable rosette grass), *Dichanthelium 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

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)

LOBLOLLY PINE DUNE WOODLAND

Pinus taeda / *Hudsonia tomentosa* Woodland

Range: This maritime woodland occurs on sand dunes of barrier islands in Delaware, Maryland, and Virginia.

Environmental Description: This community is a maritime woodland of sand dunes. Soils in this community are sandy and rapidly drained. This community often occurs directly adjacent to actively shifting foredune and is exposed to salt spray, winds, and storms. The community also occurs on unstable sands of protected backdunes.

Vegetation Description: This community is characterized by a very open canopy created by sparsely distributed *Pinus taeda* (loblolly pine). Hardwoods such as *Quercus falcata* (southern red oak), *Quercus phellos* (willow oak), and *Ilex opaca* (American holly) are frequent. Pines make up a sparse subcanopy. Tall shrubs are also sparse, although an occasional *Morella cerifera* (wax-myrtle), *Pinus taeda* (loblolly pine) sapling, or *Vaccinium corymbosum* (highbush blueberry) can be found. Sparse low shrubs of *Hudsonia tomentosa* (woolly beach-heather) are common. *Smilax glauca* (whiteleaf greenbrier) and *Toxicodendron radicans* (eastern poison-ivy) are typical vine species but make up less than 5% cover. Herbs are sparse, yet much varied. *Andropogon virginicus* (broomsedge bluestem) and *Smilax rotundifolia* (roundleaf greenbrier) are commonly present. The typical pattern of herb distribution is on dry open sand, in direct sunlight. Here, small patches of *Dichanthelium acuminatum* (tapered rosette grass), *Dichanthelium scoparium* (broom witchgrass), *Andropogon virginicus* (broomsedge bluestem), *Eupatorium rotundifolium* (roundleaf thoroughwort), *Erigeron* (fleabane) sp., *Euthamia caroliniana* (slender goldentop), *Solidago sempervirens* (seaside goldenrod), *Aristida tuberculosa* (seabeach three-awn), *Polygonella articulata* (coastal jointweed), and *Pseudognaphalium obtusifolium* are typically mixed with scattered *Hudsonia tomentosa* (woolly beach-heather) and *Smilax rotundifolia* (roundleaf greenbrier). In total, herb cover ranges from 5-40%, generally near the lower end of the scale.

Characteristic Species: *Pinus taeda* (loblolly pine)

Dynamics/Successional Trajectory: This community is exposed to salt spray, winds, and storms. In the denser woodlands, more pine duff accumulates and herb diversity and cover are generally higher. Where woodlands are more open and trees sparse, growing conditions are harsh, less duff accumulates, and vast areas of exposed white sand are characteristic.

Management Concerns: The community occurs on a restricted habitat, on back dunes protected from the direct influence of wind and salt spray. This community is threatened by many of the same threats common to coastal dune systems: dune stabilization, commercial and residential development, and road expansion.

Reference Sites: Cape Henlopen State Park, Sussex County, DE

Global and State Conservation Ranks and Reasons: G1G2 (2-Dec-1998). DE: S1?. This maritime woodland community is restricted to major coastal dune systems of the mid-Atlantic region. Only 10-20 occurrences are estimated or known from Maryland, Virginia, and Delaware. Size ranges from about an acre to perhaps 30 acres.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689830

References: Berdine 1998, Bowman 2000, Bratton and Davison 1987, Clampitt 1991, Clancy 1996, Eastern Ecology Working Group n.d., Fleming et al. 2001, Harrison 2004, Harrison and Stango 2003, Higgins et al. 1971, Hill 1986, Klotz 1986, Schafale and Weakley 1990, TNC 1995c

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus taeda</i> (loblolly pine)
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Hudsonia tomentosa</i> (woolly beach-heather)
Herb (field grass)	Graminoid	<i>Dichanthelium acuminatum</i> (tapered rosette grass)

LOWER NEW ENGLAND RED MAPLE - BLACKGUM SWAMP

Acer rubrum / *Rhododendron viscosum* - *Clethra alnifolia* Forest

Range: This type includes red maple basin swamps of Lower New England and adjacent areas. It occurs in the New Jersey portion of the Delaware Estuary.

Environmental Description: These swamps occur in poorly drained depressions characterized by acidic, tannic water that does not receive substantial nutrient input from overland flow or groundwater seepage. The soils are comprised of peat.

Vegetation Description: *Acer rubrum* (red maple) dominates the canopy. Other common species that generally occur in low abundance include *Betula alleghaniensis* (yellow birch), *Fraxinus* (ash) spp., *Ulmus americana* (American elm), and *Nyssa sylvatica* (blackgum). The shrub layer is well-developed and often dense. *Vaccinium corymbosum* (highbush blueberry) and *Ilex verticillata* (common winterberry) are common and abundant. *Clethra alnifolia* (coastal sweet-pepperbush), *Alnus incana* (speckled alder), *Lindera benzoin* (northern spicebush), *Viburnum dentatum* (southern arrow-wood), *Viburnum nudum* var. *cassinoides* (northern wild raisin), *Spiraea alba* var. *latifolia* (broadleaf meadowsweet), *Rosa palustris* (swamp rose), and *Rhododendron viscosum* (swamp azalea) are frequent but less abundant, and on the Atlantic Coastal Plain *Ilex glabra* (inkberry or little gallberry), *Rhododendron maximum* (great laurel), and *Leucothoe racemosa* (swamp doghobble) may also be present. The herbaceous layer has scattered herbs and commonly includes *Osmunda cinnamomea* (cinnamon fern), *Symplocarpus foetidus* (skunk-cabbage), *Thelypteris palustris* (eastern marsh fern), *Dryopteris cristata* (crested woodfern), *Lycopus uniflorus* (northern bugleweed), *Impatiens capensis* (orange jewelweed), *Carex folliculata* (northern long sedge), *Carex stricta* (tussock sedge), *Carex intumescens* (greater bladder sedge),

Osmunda regalis (royal fern), and *Onoclea sensibilis* (sensitive fern). Hummock-and-hollow microtopography is evident; tree seedlings and upland species occur on the hummocks, including *Coptis trifolia* (threeleaf goldthread) (a northern affiliate in NJ), *Aralia nudicaulis* (wild sarsaparilla), *Trientalis borealis* (starflower), and *Gaultheria procumbens* (wintergreen). *Sphagnum* (peatmoss) mosses are dominant or abundant in hollows and at the bases of hummocks. This community is differentiated from *Acer rubrum* - *Nyssa sylvatica* - *Betula alleghaniensis* / *Sphagnum* spp. Forest (CEGL006014), that occurs in Pennsylvania's portion of the estuary, by the absence or low abundance of *Nyssa sylvatica* (blackgum) and *Picea rubens* (red spruce).

Characteristic Species: *Acer rubrum* (red maple), *Ilex verticillata* (common winterberry), *Vaccinium corymbosum* (highbush blueberry)

Dynamics/Successional Trajectory: These are poorly drained basins with acidic, nutrient-poor peat soils. There is little overland flow or groundwater contribution to the water budget.

Reference Sites: Brendan Byrne State Forest, NJ

Global and State Conservation Ranks and Reasons: GNR (1-Dec-1997). NJ: S4S5.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689957

References: Breden 1989, Breden et al. 2001, Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Golet et al. 1993, Metzler and Barrett 1996, Metzler and Barrett 2001, Rawinski 1984, Reschke 1990, Sperduto 2000a, Swain and Kearsley 2000, Thompson and Jenkins 1992

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Acer rubrum</i> (red maple)
Tree subcanopy	Broad-leaved deciduous tree	<i>Betula alleghaniensis</i> (yellow birch)
Tree subcanopy	Broad-leaved deciduous tree	<i>Quercus bicolor</i> (swamp white oak)
Tree subcanopy	Broad-leaved deciduous tree	<i>Ulmus americana</i> (American elm)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Ilex verticillata</i> (common winterberry)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Vaccinium corymbosum</i> (highbush blueberry)
Herb (field)	Forb	<i>Symplocarpus foetidus</i> (skunk-cabbage)
Herb (field)	Fern or fern ally	<i>Osmunda cinnamomea</i> (cinnamon fern)

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.



Photo by Kathleen Strakosch Walz

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.

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

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.



Photo by Robert Cox

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 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

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 red-cedar)	Needle-leaved tree	<i>Juniperus virginiana</i> var. <i>virginiana</i> (eastern
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 poison-ivy)
Herb (field)	Graminoid	<i>Schizachyrium scoparium</i> (little bluestem)

NORTHERN BAYBERRY DUNE SHRUBLAND

Morella pensylvanica - *Prunus maritima* Shrubland

Range: This association occurs from Maine to New Jersey. It occurs in New Jersey and Delaware portions of the Delaware Estuary.

Environmental Description: This association occurs on protected slopes and hollows of dry, stabilized maritime backdunes where the water table is greater than 1 m from the surface.

Vegetation Description: This shrubland vegetation is dominated by *Morella pensylvanica* (northern bayberry) and *Prunus maritima* (beach plum). Additional shrubs that are commonly present but with low cover can include *Rosa carolina* (Carolina rose), *Rosa rugosa* (rugosa rose), *Baccharis halimifolia* (groundsel-tree), or *Juniperus virginiana* (eastern red-cedar). The herbaceous layer tends to be sparse and can include dune grassland or adjacent upland species such as *Ammophila breviligulata* (American beachgrass), *Solidago sempervirens* (seaside goldenrod), *Hudsonia tomentosa* (woolly beach-heather), *Lechea maritima* (beach pinweed), *Juncus greenei* (greene's rush), *Carex silicea* (beach sedge), *Polygonella articulata* (coastal jointweed), *Symphotrichum subulatum* (seaside American-aster), *Solidago rugosa* (wrinkleleaf goldenrod), *Achillea millefolium* (common yarrow), *Oenothera parviflora* (northern evening-primrose), *Euthamia* (goldentop) spp., *Cyperus grayi* (Gray's flatsedge), *Cyperus polystachyos* (many-spike flatsedge), and others. Typical vine associates are *Toxicodendron radicans* (eastern poison-ivy) and *Smilax* (greenbrier) spp.



Photo by Kathleen Strakosch Walz

Characteristic Species: *Morella pensylvanica* (northern bayberry), *Prunus maritima* (beach plum)

Dynamics/Successional Trajectory: This vegetation can be a probable intermediate in succession between beach dune and sunken forest; further dune development and protection from salt spray allow development of sunken forest vegetation (Art 1976). Large patches of open unvegetated or sparsely vegetated sand are present in some examples. Depending on exposure, these shrublands range from over 2 m tall in sheltered areas to less than 1 m tall in areas with greater exposure to winds and storms.

Reference Sites: dunes on DE Bay eastern shore; Bowers Beach south to Broadkill Beach, DE; Bowers Beach south to Lewes, DE; Kent County, DE; Higbee Beach, NJ

Global and State Conservation Ranks and Reasons: G4 (1-Dec-1997). DE: SNR, NJ: S1S2.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685486

References: Art 1976, Breden 1989, Breden et al. 2001, Chrysler 1930, Conard 1935, Dunlop and Crow 1985, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Gawler 2001, Gawler 2002, Lundgren 2000, Martin 1959b, McDonnell 1979, Metzler and Barrett 2001, Metzler and Barrett 2004, Moul 1969, Nelson and Fink 1980, Nichols 1920, Rawinski 1984, Reschke 1990, Sneddon and Lundgren 2001, Sperduto 1997b, Sperduto 2000a, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Prunus maritima</i> (beach plum)
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	<i>Morella pensylvanica</i> (northern bayberry)
Herb (field)	Graminoid	<i>Ammophila breviligulata</i> (American beachgrass)

PITCH PINE DUNE WOODLAND

Pinus rigida / *Hudsonia tomentosa* Woodland

Range: This association occurs along the north Atlantic coast from southern Maine to Cape Henlopen, Delaware.

Environmental Description: The community occurs on backdunes that are more stabilized than foredunes. It occurs on stabilized, parabolic dunes. The substrate is wind- and wave-deposited sand which is characteristically excessively well-drained and nutrient-poor.

Vegetation Description: There is generally significant cover of bare sand, but where more stabilized, species diversity tends to increase. *Pinus rigida* (pitch pine) dominates the canopy and averages 10-15 m in height, but is quite variable, ranging from 1 m in an unusual shrub form in Delaware to over 20 m. Canopy associates are few but include *Juniperus virginiana* (eastern red-cedar), and occasionally *Sassafras albidum* (sassafras), with scattered individuals of *Quercus velutina* (black oak) in the northern part of the range, and *Quercus falcata* (southern red oak) and *Pinus virginiana* (Virginia pine) to the south. At Cape Henlopen, the subcanopy is sparse but may also include *Quercus marilandica* (blackjack oak), *Quercus stellata* (post oak), *Nyssa sylvatica* (blackgum), and *Prunus serotina* (black cherry). The shrub layer, if present, may include *Hudsonia tomentosa* (woolly beach-heather), *Morella pensylvanica* (northern bayberry), *Gaylussacia baccata* (black huckleberry), *Gaylussacia frondosa* (dangleberry), *Vaccinium pallidum* (hillside blueberry), and occasionally *Hudsonia ericoides* (pine barren golden-heather), or *Viburnum nudum* var. *cassinoides* (northern wild raisin). Vines may be present but scarce and include *Smilax rotundifolia* (roundleaf greenbrier), *Smilax glauca* (whiteleaf greenbrier), *Parthenocissus quinquefolia* (Virginia creeper), and *Toxicodendron radicans* (eastern poison-ivy). The herbaceous layer is sparse but can include *Aralia nudicaulis* (wild sarsaparilla), *Dichanthelium ovale* var. *addisonii* (eggleaf rosette grass), *Solidago odora* (anise-scented goldenrod), *Chimaphila maculata* (striped pipsissewa), *Lechea maritima* (beach pinweed), *Pteridium aquilinum* (bracken fern), and *Trientalis borealis* (starflower), *Maianthemum canadense* (Canada mayflower), *Deschampsia flexuosa* (wavy hairgrass), *Carex lucorum* (Blue Ridge sedge), and *Arctostaphylos uva-ursi* (bearberry) in the north. Lichens are common; at Cape Henlopen State Park, Delaware, species included *Cladonia strepsillis* (olive cladonia), *Cladina terrae-novae* (reindeer lichen), *Lepraria incana* (dust lichen), and *Cladonia squamosa* (dragon cladonia).

Noteworthy Associated Plant and/or Animal Species: *Carex silicea* (beach sedge)

Characteristic Species: *Hudsonia tomentosa* (woolly beach-heather), *Morella pensylvanica* (northern bayberry), *Pinus rigida* (pitch pine)

Dynamics/Successional Trajectory: Active sand movement occurs with storm activity, causing the boundaries of the community to migrate over time. Maritime occurrences are subjected to a number of environmental stresses such as high winds, "sand-blasting" by salt spray, shifting substrate, and both water and nutrient stress. All of these factors appear to be important in structuring the form and composition of the community.

Management Concerns: This community is threatened by a host of threats common to coastal dune systems in general: dune stabilization, residential and commercial development, and road expansion.

Reference Sites: Cape Henlopen State Park, Sussex County, DE

Global and State Conservation Ranks and Reasons: G2 (8-Dec-1998). DE: S1, NJ: S1?. This maritime woodland community is restricted to major coastal sand dune systems. It ranges from southern Maine to Cape Henlopen, Delaware; it does not occur in Connecticut or Rhode Island. Occurrences are generally small, ranging from 5 or 10 acres to a few hundred acres at maximum. 25-30 occurrences covering 1000-1200 acres are estimated rangewide.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687760

References: Art 1976, Bennett et al. 1998, Bowman 2000, Breden 1989, Breden et al. 2001, Clancy 1996, DNHP 1998, Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Gawler 2001, Gawler 2002, Godfrey et al. 1978, Johnson 1985b, MENHP 1991, Martin 1959b, McDonnell 1979, Motzkin and Foster 2002, Nelson and Fink 1980, RINHP n.d., Rawinski 1984, Reschke 1990, Swain and Kearsley 2001, Trudeau et al. 1977

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus rigida</i> (pitch pine)
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Hudsonia tomentosa</i> (woolly beach-heather)

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 orbiculata* (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

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	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>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)

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 Associations:

- Black Locust Successional Forest
- Coastal Pitch Pine / Scrub Oak Barren
- Coastal Plain Mesic Pine Barrens
- Mid-Successional Pine - Oak Woodland
- New Jersey Pitch Pine / Scrub Oak Barren
- Pine Barrens Hilltop Forest
- Pitch Pine - Oak Forest
- Pitch Pine / Pennsylvania Sedge Woodland
- Southern New Jersey Mesic Pine Barrens

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

BLACK LOCUST SUCCESSIONAL FOREST

Robinia pseudoacacia Forest

Range: This black locust semi-natural forest is found locally throughout the eastern United States. Its distribution is not completely known because many state ecologists have not developed lists of semi-natural types in their state. It occurs in New Jersey, Pennsylvania and Delaware in the Delaware Estuary.

Environmental Description: This type often establishes on old fields abandoned after agricultural cropping.

Vegetation Description: The vegetation is dominated by *Robinia pseudoacacia* (black locust).

Characteristic Species: *Robinia pseudoacacia* (black locust)

Dynamics/Successional Trajectory: Uncertain. This is an early-successional forest type dominated by black locust. Overtime the black locust will be replaced by other, more shade-tolerant species (species composition will depend on available local species pool). The understory of this community is typically dominated by a dense growth of non-native invasive species which may retard colonization by mid- and late-successional forest species.



Photo by Pennsylvania Natural Heritage Program

Management Concerns: This is a disturbed forest type and is not typically managed for conservation purposes.

Reference Sites: Not a conservation target; reference sites not provided.

Global and State Conservation Ranks and Reasons: GNA (ruderal) (24-Oct-2002). DE: SNA, NJ: SNA, PA: SNA. Although *Robinia pseudoacacia* is a native species found in the Central Appalachian and Ozark Mountains, it does not typically become a dominant species in these natural habitats (Elias 1980). It is now widespread in the eastern U.S. in disturbed habitats. This forest represents early successional vegetation and is thus not of conservation concern and does not receive a conservation status rank.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684159

References: Baalman 1965, CAP pers. comm. 1998, Elias 1980, Fleming and Coulling 2001, Gaertner 1955, Hoagland 2000, INAI unpubl. data, McDonald 1938, Rawinski et al. 1996, Southeastern Ecology Working Group n.d., TDNH unpubl. data

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Robinia pseudoacacia</i> (black locust)

COASTAL PITCH PINE / SCRUB OAK BARREN

Pinus rigida / *Quercus ilicifolia* / *Morella pensylvanica* Woodland

Range: This community occurs in coastal areas of Massachusetts, Rhode Island, New York, and New Jersey.

Environmental Description: This community includes pine barrens in the North Atlantic Coast ecoregion characterized by droughty, fire-prone vegetation, sandy soils and maritime influence.

Vegetation Description: *Pinus rigida* (pitch pine) is strongly dominant in the canopy. *Quercus ilicifolia* (bear oak) forms a dense, 1- to 2-m tall shrub layer with occasional *Quercus prinoides* (dwarf chinquapin oak). Dwarf-shrubs, such as *Gaylussacia baccata* (black huckleberry), *Morella pensylvanica* (northern bayberry), *Vaccinium pallidum* (hillside blueberry), and *Vaccinium angustifolium* (northern lowbush blueberry), intermingle with the tall shrubs. Herbs tend to be sparse, although more open areas may support patches of *Schizachyrium scoparium* (little bluestem) and *Deschampsia flexuosa* (wavy hairgrass), or *Carex pensylvanica* (Pennsylvania sedge) and *Carex swanii* (Swan's sedge). Additional scattered herbs include *Comptonia peregrina* (sweet-fern), *Pteridium aquilinum* (bracken fern), *Gaultheria procumbens* (wintergreen), and *Arctostaphylos uva-ursi* (bearberry). Diagnostic characteristics include the presence of *Morella pensylvanica* (northern bayberry) to indicate coastal setting. In New Jersey, *Morella pensylvanica* (northern bayberry) occurs more in the Atlantic coastal areas, but this type also occurs inland and lacks the local maritime influence.

Characteristic Species: *Morella pensylvanica* (northern bayberry)

Dynamics/Successional Trajectory: These are fire-maintained systems.

Reference Sites: Brendan Byrne SF, NJ

Global and State Conservation Ranks and Reasons: G3 (1-Dec-1997). NJ: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688963

References: Breden et al. 2001, Eastern Ecology Working Group n.d., Lundgren et al. 2000, Motzkin and Foster 2002, Rawinski 1984, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Quercus ilicifolia</i> (bear oak)
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Morella pensylvanica</i> (northern bayberry)
Herb (field)	Graminoid	<i>Schizachyrium scoparium</i> (little bluestem)

COASTAL PLAIN MESIC PINE BARRENS

Pinus rigida / *Quercus ilicifolia* - *Kalmia angustifolia* / *Pyxidantha barbulata* Woodland

Range: This community occurs in the area of the New Jersey Pine Barrens present in the Delaware Estuary.

Environmental Description: This association occurs on sandy soils that also have some clay component in them and/or occur in close proximity to the water table or near a wetland. These factors create more mesic conditions than seen in other pine barren communities.

Vegetation Description: This community comprises mesic pine barrens vegetation dominated by *Pinus rigida* (pitch pine) with a shrub layer dominated by *Quercus ilicifolia* (bear oak).

The presence of mesic species, such as *Kalmia angustifolia* (sheep laurel), *Ilex glabra* (inkberry or little



Photo by Andrew Windisch

gallberry), *Lyonia mariana* (piedmont staggerbush), *Leucothoe racemosa* (swamp doghobble), *Clethra alnifolia* (coastal sweet-pepperbush), and *Vaccinium corymbosum* (highbush blueberry), indicate more mesic conditions such as the higher clay content of the soils, the position adjacent to a wetland, or a water table below the soil surface. Other associates include *Pyxidantha barbulata* (pyxie-moss), *Morella pensylvanica* (northern bayberry), *Photinia melanocarpa* (black chokeberry), *Gaultheria procumbens* (wintergreen), *Carex pensylvanica* (Pennsylvania sedge), and *Pteridium aquilinum* (bracken fern). In New Jersey, *Xerophyllum asphodeloides* (eastern turkeybeard) and *Calamovilfa brevopilis* (pinebarren sandreed) are also found in this vegetation.

Noteworthy Associated Plant and/or Animal Species: *Calamovilfa brevopilis* (pinebarren sandreed)

Characteristic Species: *Kalmia angustifolia* (sheep laurel), *Pyxidantha barbulata* (pyxie-moss)

Reference Sites: Brendan Byrne State Forest, NJ

Global and State Conservation Ranks and Reasons: G2? (30-Apr-1998). NJ: S3.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686217

References: Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus rigida</i> (pitch pine)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Quercus ilicifolia</i> (bear oak)
Short shrub/sapling	Broad-leaved evergreen shrub	<i>Kalmia angustifolia</i> (sheep laurel)

MID-SUCCESSIONAL PINE - OAK WOODLAND

Pinus rigida - (*Pinus echinata*) / *Quercus* (*marilandica*, *ilicifolia*) / *Vaccinium pallidum* Woodland

Range: This woodland occurs in the New Jersey Pine Barrens.

Environmental Description: This community occurs on well-drained xeric sandy soils in the Pine Barrens.

Vegetation Description: *Pinus rigida* (pitch pine) and occasionally *Pinus echinata* (shortleaf pine) are dominant, but the characteristic presence of tree oaks (*Quercus alba* (white oak), *Quercus coccinea* (scarlet oak), *Quercus velutina* (black oak), *Quercus prinus* (chestnut oak), *Quercus stellata* (post oak)) forming up to 35% of the canopy is an indication of a fire frequency that is less than that of the classic pine barrens type *Pinus rigida* / *Quercus* (*marilandica*, *ilicifolia*) / *Pyxidantha barbulata* Woodland (CEGL006051). The ground layer is characterized by heaths, generally *Vaccinium pallidum* (hillside blueberry) and *Gaylussacia baccata* (black huckleberry). Herbs are sparse and may include *Gaultheria procumbens* (wintergreen) and *Pteridium aquilinum* (bracken fern).



Photo by Andrew Windisch

Characteristic Species: *Gaylussacia baccata* (black

huckleberry), *Quercus alba* (white oak), *Quercus coccinea* (scarlet oak), *Quercus prinus* (chestnut oak), *Quercus stellata* (post oak), *Quercus velutina* (black oak), *Vaccinium pallidum* (hillside blueberry)

Dynamics/Successional Trajectory: This is a fire-dependent community. The characteristic presence of tree oaks in the canopy is an indication of a fire frequency that is less than that of the classic pine barrens type. The presence of a well-developed shrub oak layer indicates a fire frequency greater than that of oak forests.

Management Concerns: Fire suppression and residential development are common threats to this community.

Reference Sites: Brendan Byrne State Forest, NJ

Global and State Conservation Ranks and Reasons: G2? (30-Apr-1998). NJ: S3.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686109

References: Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Windisch 1995b

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus rigida</i> (pitch pine)
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)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Gaylussacia baccata</i> (black huckleberry)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Vaccinium pallidum</i> (hillside blueberry)
Herb (field)	Fern or fern ally	<i>Pteridium aquilinum</i> (bracken fern)

NEW JERSEY PITCH PINE / SCRUB OAK BARREN

Pinus rigida / *Quercus (marilandica, ilicifolia)* / *Pyxidanthera barbulata* Woodland

Range: The association is restricted to the New Jersey Coastal Plain.

Environmental Description: This community is restricted to the New Jersey Pine Barrens. It occurs on well-drained xeric sandy soils.

Vegetation Description: The open canopy is strongly dominated by *Pinus rigida* (pitch pine), with very low cover of deciduous trees. Oaks, when present, may include *Quercus stellata* (post oak) or *Quercus velutina* (black oak). The understory is dominated by *Quercus marilandica* (blackjack oak), with lesser cover of *Quercus ilicifolia* (bear oak). A low heath shrub layer is dominated by *Vaccinium pallidum* (hillside blueberry) and *Gaylussacia baccata* (black huckleberry). The herbaceous layer is of variable cover, depending on fire frequency and intensity. *Pyxidanthera barbulata* (pyxie-moss) is characteristic of the type, although it may not be present in all stands. Other herbaceous associates include *Schizachyrium scoparium* (little bluestem), *Andropogon virginicus* (broomsedge bluestem), *Carex pensylvanica* (Pennsylvania sedge), *Minuartia caroliniana* (pine-barren sandwort), *Gaultheria procumbens* (wintergreen), *Pteridium aquilinum* (bracken fern), *Tephrosia virginiana* (goat's-rue), *Helianthemum canadense* (long-branch frostweed), and *Lechea* (pinweed) spp.



Photo by Andrew Windisch

Characteristic Species: *Pyxidanthera barbulata* (pyxie-moss), *Quercus marilandica* (blackjack oak)

Dynamics/Successional Trajectory: This is a highly fire-dependent community, occurring most frequently on warmer microclimates of knoll crests and slopes where it is least effected by cold-air drainage.

Management Concerns: The habitat of well-drained to xeric sands is vulnerable to housing development. This community is dependent on the maintenance of a fire regime for regeneration.

Reference Sites: West Plains Fireshed, NJ

Global and State Conservation Ranks and Reasons: G2 (2-Dec-1998). NJ: S2. This association has fewer than 20 occurrences, with a total rangewide acreage of fewer than 10,000 acres. The range of this association is restricted to the New Jersey coastal plain.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688343

References: Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Windisch 1995b

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus rigida</i> (pitch pine)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Quercus marilandica</i> (blackjack oak)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Gaylussacia baccata</i> (black huckleberry)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Vaccinium pallidum</i> (hillside blueberry)

PINE BARRENS HILLTOP FOREST

Quercus prinus - *Quercus velutina* / *Gaylussacia frondosa* Forest

Range: This forest occurs on hilltops in the New Jersey Pine Barrens.

Environmental Description: This small-patch forest of low hilltops of the New Jersey Pine Barrens and of New York occurs on sandy soils.

Vegetation Description: *Quercus prinus* (chestnut oak) and *Quercus velutina* (black oak) form 90% of the canopy cover. The understory is sparse, characterized by *Gaylussacia frondosa* (dangleberry), *Gaylussacia baccata* (black huckleberry), *Quercus ilicifolia* (bear oak), and *Vaccinium pallidum* (hillside blueberry). The herb layer is sparse to absent; leaf litter is abundant. Mosses and lichens form a substantial bryophyte layer.

Characteristic Species: *Gaylussacia frondosa* (dangleberry), *Quercus prinus* (chestnut oak)

Reference Sites: Brendan Byrne State Forest, NJ

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685301

References: Breden 1989, Breden et al. 2001, Cain 1936, Conard 1935, Eastern Ecology Working Group n.d., Edinger et al. 2002, McCormick 1979, Metzler and Barrett 2001, Reschke 1990, Windisch 1995b

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 velutina</i> (black oak)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Gaylussacia frondosa</i> (dangleberry)

PITCH PINE - OAK FOREST

Pinus rigida - *Quercus coccinea* / *Vaccinium pallidum* - (*Morella pensylvanica*) Woodland

Range: This matrix forest type is found in coastal and adjacent inland areas from Massachusetts to New Jersey.

Environmental Description: This is a matrix woodland type that occurs on very well-drained sandy outwash or moraine deposits.

Vegetation Description: The canopy is dominated by *Pinus rigida* (pitch pine) plus the following oaks in variable proportions: *Quercus coccinea* (scarlet oak), *Quercus velutina* (black oak), *Quercus alba* (white oak), and *Quercus rubra* (northern red oak) and occasionally *Quercus stellata* (post oak).

Tall shrubs such as *Quercus ilicifolia* (bear oak) can be sporadic to locally well-developed. Heaths tend to form a dense dwarf-shrub layer, especially *Gaylussacia baccata* (black huckleberry), *Vaccinium angustifolium* (northern lowbush blueberry), and *Vaccinium pallidum* (hillside blueberry). *Morella pensylvanica* (northern bayberry) can also commonly occur. The herb layer is often sparse and characterized by *Pteridium aquilinum* (bracken fern), *Gaultheria procumbens* (wintergreen), and *Carex pensylvanica* (Pennsylvania sedge).

Characteristic Species: *Carex pensylvanica* (Pennsylvania sedge), *Gaultheria procumbens* (wintergreen), *Pteridium aquilinum* (bracken fern)

Dynamics/Successional Trajectory: This mixed conifer-deciduous woodland is a fire-dependent community with a proportion of canopy species dependent on the fire regime.

Management Concerns: This community is dependent on the maintenance of a fire regime for regeneration.

Reference Sites: Brendan Byrne State Forest, NJ

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

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689535

References: Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Jordan et al. 2003, Metzler and Barrett 2001, Motzkin and Foster 2002, Rawinski 1984, Reschke 1990, Swain and Kearsley 2001, Windisch 1995b



Photo by Andrew Windisch

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus rigida</i> (pitch pine)
Tree canopy	Broad-leaved deciduous tree	<i>Quercus coccinea</i> (scarlet oak)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Gaylussacia baccata</i> (black huckleberry)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Vaccinium angustifolium</i> (northern lowbush blueberry)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Vaccinium pallidum</i> (hillside blueberry)
Herb (field)	Fern or fern ally	<i>Pteridium aquilinum</i> (bracken fern)

PITCH PINE / PENNSYLVANIA SEDGE WOODLAND

Pinus rigida / *Carex pensylvanica* Woodland

Range: This association occurs in the New Jersey Pine Barrens in the Delaware Estuary.

Environmental Description: This pitch pine woodland of xeric sandy soils occurs in the New Jersey Pine Barrens.

Vegetation Description: *Pinus rigida* (pitch pine) is the dominant tree, with *Sassafras albidum* (sassafras) a common associate. The sparse shrub layer is made up of *Vaccinium pallidum* (hillside blueberry), *Gaylussacia baccata* (black huckleberry), and *Quercus ilicifolia* (bear oak). Vines may be common, including *Smilax glauca* (whiteleaf greenbrier) and *Smilax rotundifolia* (roundleaf greenbrier). *Carex pensylvanica* (Pennsylvania sedge) forms a well-developed herbaceous layer, with *Hudsonia ericoides* (pine barren golden-heather) and bryophytes *Leucobryum glaucum* (pincushion moss), *Cladina subtenuis* (dixie reindeer lichen), and *Cladonia squamosa* (dragon cladonia) also contributing cover.

Characteristic Species: *Carex pensylvanica* (Pennsylvania sedge), *Cladina subtenuis* (dixie reindeer lichen), *Cladonia squamosa* (dragon cladonia), *Leucobryum glaucum* (pincushion moss)

Management Concerns: This community is anthropogenic in origin but is also known to occur on paleodunes in the New Jersey Pine Barrens.

Reference Sites: Brendan Byrne State Forest, NJ

Global and State Conservation Ranks and Reasons: GNR (1-Dec-1997). NJ: S2S3.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689988

References: Breden et al. 2001, Eastern Ecology Working Group n.d., Rawinski 1984, Windisch 1995a, Windisch 1995b

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus rigida</i> (pitch pine)
Tree canopy	Broad-leaved deciduous tree	<i>Sassafras albidum</i> (sassafras)
Shrub/sapling (tall & short)	Vine/Liana	<i>Smilax glauca</i> (whiteleaf greenbrier)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Vaccinium pallidum</i> (hillside blueberry)
Herb (field)	Graminoid	<i>Carex pensylvanica</i> (Pennsylvania sedge)

SOUTHERN NEW JERSEY MESIC PINE BARRENS

Pinus (rigida, echinata) - Quercus coccinea / Ilex opaca Woodland

Range: The primary distribution of this forest is south of the Mullica River in southern New Jersey.

Environmental Description: This association occurs on sandy soils in the southern New Jersey Pine Barrens.

Vegetation Description: This closed, mixed woodland is characterized by *Pinus rigida* (pitch pine), *Quercus coccinea* (scarlet oak), *Quercus alba* (white oak), *Quercus stellata* (post oak), and *Acer rubrum* (red maple). A subcanopy of *Ilex opaca* (American holly) and *Cornus florida* (flowering dogwood) is particularly characteristic of this type. The shrub layer is made up of *Gaylussacia baccata* (black huckleberry), *Vaccinium pallidum* (hillside blueberry), *Clethra alnifolia* (coastal sweet-pepperbush), *Ilex glabra* (inkberry or little gallberry), and at lower frequencies *Carya pallida* (sand hickory) and *Rhododendron viscosum* (swamp azalea). The herbaceous layer is sparse; generally, *Chimaphila maculata* (striped pipsissewa) and *Pteridium aquilinum* (bracken fern) are present at low cover.

Characteristic Species: *Cornus florida* (flowering dogwood), *Ilex opaca* (American holly)

Dynamics/Successional Trajectory: This woodland experiences lower fire frequency than other types of the Pine Barrens, as it is more protected and more mesic.

Reference Sites: Cape May, NJ

Global and State Conservation Ranks and Reasons: GNR (1-Dec-1997). NJ: S3.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685812

References: Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Windisch 1995b

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Needle-leaved tree	<i>Pinus rigida</i> (pitch pine)
Tree canopy	Broad-leaved deciduous tree	<i>Quercus coccinea</i> (scarlet oak)
Tree subcanopy	Broad-leaved deciduous tree	<i>Cornus florida</i> (flowering dogwood)
Tree subcanopy	Broad-leaved evergreen tree	<i>Ilex opaca</i> (American holly)
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Gaylussacia baccata</i> (black huckleberry)
Herb (field)	Fern or fern ally	<i>Pteridium aquilinum</i> (bracken fern)

ECOLOGICAL SYSTEM: NORTHERN ATLANTIC COASTAL PLAIN SANDY BEACH

Summary: This system includes sparsely vegetated ocean beaches constituting the outermost zone of coastal vegetation ranging from northern North Carolina (north of Bodie Island) northward to the terminus of extensive sandy coastlines and the beginning of rocky coasts. Examples generally extend seaward from foredunes but may include flats behind breached foredunes. Although these habitats are situated just above the mean high tide limit, they are constantly impacted by waves and may be flooded by high spring tides and storm surges (Fleming et al. 2001). Constant salt spray and rainwater maintain generally moist conditions. Substrates consist of unconsolidated sand and shell sediments that are constantly shifted by winds and floods. Dynamic disturbance regimes largely limit vegetation to pioneering, salt-tolerant, succulent annuals. *Cakile edentula ssp. edentula* (sea-rocket) and *Salsola kali* (russian-thistle) are usually most numerous and characteristic. Other scattered associates include *Sesuvium maritimum* (slender sea-purslane), *Polygonum glaucum* (seaside knotweed), *Polygonum ramosissimum var. prolificum* (bushy knotweed), *Suaeda linearis* (southern sea-blite) and *Suaeda maritima* (herbaceous seepweed), and *Atriplex cristata* (crested saltbush).

High-ranked Species: *Cicindela dorsalis dorsalis* (G4T2, northeastern beach tiger beetle)

Range: This system ranges from northern North Carolina northward to the terminus of extensive sandy coastlines and the beginning of rocky coasts in southern Maine. United States: CT, DE, MA, MD, ME, NC, NH, NJ, NY, RI, VA

Delaware Estuary Associations:

- Coastal Bay Shore / Succulent Beach
- North Atlantic Upper Ocean Beach

CLASSIFIERS FOR NORTHERN ATLANTIC COASTAL PLAIN SANDY BEACH

Primary Division: 203

Land Cover Class: Barren

Spatial Scale & Pattern: Linear

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

Diagnostic Classifiers: Coast; Beach (Substrate); Graminoid

COASTAL BAY SHORE / SUCCULENT BEACH

Sesuvium portulacastrum - *Atriplex* spp. - *Suaeda* spp. Sparse Vegetation

Range: This community occurs along the Atlantic Ocean and portions of the northern Gulf of Mexico. It occurs in the Delaware portion of the Delaware Estuary.

Environmental Description: This vegetation tends to occur on the back side of the ends of barrier islands; it is irregularly flooded by wind and storm tides, but does not accumulate salt like *Salicornia* (saltwort)- or *Distichlis* (saltgrass)-dominated areas. It is especially prevalent on low-energy, protected shorelines.

Vegetation Description: Vegetation consists of widely scattered to fairly continuous mats of various succulent species, including most characteristically *Sesuvium portulacastrum* (shoreline sea-purslane), *Sesuvium maritimum* (slender sea-purslane), *Atriplex patula* (halberd-leaf orache), and *Suaeda linearis* (southern sea-blite). Other species which may occur are *Spartina patens* (saltmeadow cordgrass), *Panicum amarum* (bitter panicgrass), *Vigna luteola* (hairy-pod cowpea), *Ipomoea imperati* (beach morning-glory), *Ipomoea sagittata* (glade morning-glory), *Sporobolus virginicus* (saltmarsh dropseed), and *Cyperus* (flatsedge) spp.

Noteworthy Associated Plant and/or Animal Species: *Amaranthus pumilus* (seaside amaranth)

Characteristic Species: *Atriplex patula* (halberd-leaf orache), *Sesuvium maritimum* (slender sea-purslane), *Sesuvium portulacastrum* (shoreline sea-purslane), *Suaeda linearis* (southern sea-blite)

Dynamics/Successional Trajectory: This community develops on low-energy shores protected from strong wave action. It is, however, occasionally flooded by wind and storm tides, and strong storms destroy the vegetation, "resetting the clock."

Management Concerns: Sea level rise may influence the vegetation composition of this community.

Reference Sites: Woodland Beach, Kent County, DE

Global and State Conservation Ranks and Reasons: G3 (11-Aug-1997). DE: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687160

References: Fleming et al. 2001, Harrison 2004, Harrison and Stango 2003, Lea 2002b, Nelson 1986, Schafale and Weakley 1990, Schotz pers. comm., Southeastern Ecology Working Group n.d.

NORTH ATLANTIC UPPER OCEAN BEACH

Cakile edentula ssp. *edentula* - *Chamaesyce polygonifolia* Sparse Vegetation

Range: This association ranges from southern Maine to North Carolina. It occurs on the Delaware and New Jersey coasts in the Delaware Estuary.

Environmental Description: This association occurs on unstable sands and often gravels and cobbles just above mean high tide on beaches and foredunes washed over by spring and storm tides and impacted by wind erosion.

Vegetation Description: This is a sparsely vegetated association characterized by annuals and biennials. Species composition is variable, but frequently includes *Cakile edentula* ssp. *edentula* (sea-rocket), *Honckenya peploides* (seabeach sandwort), *Salsola kali* (russian-thistle), *Atriplex patula* (halberd-leaf orache), *Cenchrus tribuloides* (dune sandbur), *Chamaesyce polygonifolia* (northern seaside spurge), *Atriplex cristata* (crested saltbush), *Xanthium strumarium* (rough cocklebur), and *Chenopodium* (goosefoot) spp. Globally rare species such as *Polygonum glaucum* (seaside knotweed) and *Amaranthus pumilus* (seaside amaranth) occur in this habitat. *Ammophila breviligulata* (American beachgrass) can occur sporadically, colonizing from the adjacent beachgrass community. Additional infrequent species can include *Chenopodium rubrum* (red goosefoot), *Chenopodium album* (lamb's-quarters), *Chenopodium berlandieri* var. *macrocalyrium* (pit-seed goosefoot), *Cyperus filicinus* (fern flatsedge), *Triplasis purpurea* (purple sandgrass), and *Sesuvium maritimum* (slender sea-purslane). Bare substrate can comprise greater than 95% cover in this association.

Noteworthy Associated Plant and/or Animal Species: *Amaranthus pumilus* (seaside amaranth), *Charadrius melodus* (piping plover), *Polygonum glaucum* (seaside knotweed), *Sterna antillarum* (least tern)

Characteristic Species: *Cakile edentula* ssp. *edentula* (sea-rocket), *Chamaesyce polygonifolia* (northern seaside spurge), *Salsola kali* ssp. *kali* (russian-thistle)

Dynamics/Successional Trajectory: This association occurs at the wrack line; there is regular deposition of wave-deposited flotsam. It is irregularly flooded by very high tides, scoured by storm tides, and is constantly reworked by wind. Species composition is dominated by annuals and biennials and can change dramatically from year to year. If the habitat is protected from regular disturbance, perennial-dominated dune grass communities tend to develop.

Management Concerns: Perennial-dominated dune grass communities tend to develop in habitat protected from regular disturbance

Reference Sites: Fowlers Beach, Sussex County, DE; Cape May Point State Park, NJ; Higbee Beach, NJ

Global and State Conservation Ranks and Reasons: G4G5 (1-Dec-1997). DE: SNR, NJ: S1S2.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684786

References: Bartgis 1986, Baumann 1978b, Berdine 1998, Boule 1979, Bowman 2000, Breden 1989, Breden et al. 2001, Clancy 1993b, Clovis 1968, Conard 1935, Dowhan and Rozsa 1989, Eastern Ecology

Working Group n.d., Edinger et al. 2002, Enser 1999, Fender 1937, Fleming et al. 2001, Gawler 2001, Gawler 2002, Godfrey et al. 1978, Harrison 2004, Harrison pers. comm., Harshberger 1900, Higgins et al. 1971, Hill 1986, Jenkins 1974, Johnson 1985b, Klotz 1986, MENHP 1991, McDonnell 1979, Metzler and Barrett 1992, Metzler and Barrett 2001, Moul 1973, Nichols 1920, Rawinski 1984, Reschke 1990, Schafale and Weakley 1990, Shreve et al. 1910, Sperduto 1994, Sperduto 2000a, Sperduto 2000b, Stalter 1990, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Forb	<i>Atriplex cristata</i> (crested saltbush)
Herb (field)	Forb	<i>Cakile edentula</i> ssp. <i>edentula</i> (sea-rocket)
Herb (field) spurge)	Forb	<i>Chamaesyce polygonifolia</i> (northern seaside)
Herb (field)	Forb	<i>Salsola kali</i> ssp. <i>kali</i> (russian-thistle)

ECOLOGICAL SYSTEM: NORTHERN ATLANTIC COASTAL PLAIN SEAGRASS BED

Summary: This ecological system represents submerged aquatic vegetation found in marine environments from Chesapeake Bay northward to the Maine coast. In contrast to Atlantic Coastal Plain Embayed Region Seagrass Bed (CES203.243) to the south, which can be generally characterized as *Zostera - Halodule*, this system is more typically characterized as *Zostera - Ruppia* (Thayer et al. 1984). A host of marine algae is also an important component of this system.

Range: The southern boundary may need clarification. The conceptual boundary occurs where *Halodule* beds become important; it is presumed that this transition occurs at or around Cape Hatteras, North Carolina. United States: CT, DE, MA, MD, ME, NH, NJ, NY, RI, VA

Delaware Estuary Associations:

- Northern Atlantic Coast Beaked Ditch-grass Bed

CLASSIFIERS FOR NORTHERN ATLANTIC COASTAL PLAIN SEAGRASS BED

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; Aquatic Herb; Saltwater (Polyhaline)

Non-diagnostic Classifiers: Herbaceous

NORTHERN ATLANTIC COAST BEAKED DITCH-GRASS BED

Ruppia maritima Acadian/Virginian Zone Temperate Herbaceous Vegetation

Range: This association occurs along the mid- and north Atlantic coast from Maine to North Carolina. It occurs in the New Jersey portion of the Delaware Estuary and possibly in Delaware.

Environmental Description: This association occurs in habitats that are continuously flooded by brackish water; it occurs in subtidal situations, deepwater pools and pannes, tidal creeks, and flats within salt marshes, or along tidal rivers. It also occurs in coastal salt ponds with polyhaline to mesohaline salinity levels. Except in pannes or pools, which are more irregularly flooded, water levels fluctuate with diurnal tides and are generally less than 2 m deep at low tide, although certain areas may be exposed at extremely low tides. Substrate varies from sand to mud.

Vegetation Description: *Ruppia maritima* (beaked ditch-grass) is strongly dominant in this association. It has a wide range of salinity tolerance and overlaps with other species, although generally not in the same locations. Common associates include *Zannichellia palustris* (horned pondweed), *Stuckenia pectinata* (sago pondweed), and *Potamogeton perfoliatus* (clasping-leaf pondweed) in brackish to fresh areas and *Zostera marina* (eel-grass) as waters get deeper and more saline. There can also be a diverse array of macroalgae. This association grades into eelgrass beds as salinity increases.

Characteristic Species: *Ruppia maritima* (beaked ditch-grass)

Dynamics/Successional Trajectory: In several habitats, this association occurs where water levels and salinity can fluctuate with daily tides.

Management Concerns: As salinity decreases, *Ruppia maritima* (beaked ditch-grass) becomes less prominent, and the community grades into fresh/brackish subtidal associations.

Reference Sites: Reed's Beach, NJ

Global and State Conservation Ranks and Reasons: GNR (1-Dec-1997). DE: S4?, NJ: S3S4.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688727

References: Bartgis 1986, Bowman 2000, Breden 1989, Breden et al. 2001, Cowardin et al. 1979, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Fleming 2001, Fleming et al. 2001, Gawler 2002, Harrison 2004, Metzler and Barrett 2001, Metzler and Barrett 2004, Moore et al. 2000, Orth and Moore 1988, Rawinski 1984, Reschke 1990, Schafale and Weakley 1990, Sperduto 2000a, Sperduto 2000b, Swain and Kearsley 2001, Thayer et al. 1984

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Submerged aquatic	Aquatic herb	<i>Ruppia maritima</i> (beaked ditch-grass)

ECOLOGICAL SYSTEM: NORTHERN ATLANTIC COASTAL PLAIN SUBTIDAL AQUATIC BED

Summary: This system represents submerged aquatic beds of brackish - freshwater tidal upper bays, rivers, and tributaries, ranging from Chesapeake Bay northward to the Massachusetts coast. Typical species include *Stuckenia pectinata* (sago pondweed), *Potamogeton perfoliatus* (clasping-leaf pondweed), *Zannichellia palustris* (horned pondweed), and others.

Range: Ranges from Chesapeake Bay northward to the Massachusetts coast. United States: VA

Delaware Estuary Associations:

- Central Atlantic Freshwater Subtidal River Bed

CLASSIFIERS FOR NORTHERN ATLANTIC COASTAL PLAIN SUBTIDAL AQUATIC BED

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; Aquatic Herb

Non-diagnostic Classifiers: Herbaceous

CENTRAL ATLANTIC FRESHWATER SUBTIDAL RIVER BED

Stuckenia pectinata - *Potamogeton perfoliatus* - (*Zannichellia palustris*) Tidal Herbaceous Vegetation

Range: This association occurs along the mid- and north Atlantic coast from Massachusetts to Virginia. It occurs in New Jersey and possibly Delaware in the Delaware Estuary.

Environmental Description: This association occurs on fresh to slightly brackish flats that are continuously flooded, although certain areas can be exposed briefly during very low tides.

Vegetation Description: This association includes beds of aquatic vegetation in fresh to slightly brackish waters. Common and dominant species include *Stuckenia pectinata* (sago pondweed), *Potamogeton perfoliatus* (clasping-leaf pondweed), *Zannichellia palustris* (horned pondweed), *Vallisneria americana* (tape-grass), *Najas guadalupensis* (common water nymph), *Elodea nuttallii* (western waterweed), and *Ceratophyllum demersum* (coontail). *Ruppia maritima* (beaked ditch-grass) may occur sporadically, but it is more prevalent in brackish and saline habitats. This community occurs in Delaware without *Potamogeton perfoliatus* (clasping-leaf pondweed).

Characteristic Species: *Potamogeton pectinatus* (sago pondweed)

Dynamics/Successional Trajectory: This association grades almost imperceptibly into brackish/saline aquatic bed vegetation.

Management Concerns: Invasive exotics often occur in this habitat, including *Myriophyllum spicatum* (Eurasian water-milfoil) and *Trapa natans* (water chestnut).

Reference Sites: This community needs further investigation (one known site is privately owned on the Salem River, NJ).

Global and State Conservation Ranks and Reasons: G3G5 (1-Dec-1997). DE: S1, NJ: S2S3.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686704

References: Bartgis 1986, Berdine 1998, Bowman 2000, Breden 1989, Breden et al. 2001, Clancy 1996, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Fleming 2001, Fleming et al. 2001, Harrison 2004, Metzler and Barrett 2001, Moore et al. 2000, Rawinski 1984, Reschke 1990, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Submerged aquatic	Aquatic herb (floating & submergent)	<i>Potamogeton pectinatus</i> (sago pondweed)

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* (saltmarsh cordgrass); a higher irregularly flooded marsh dominated by *Spartina patens* (saltmeadow cordgrass) and *Distichlis spicata* (saltgrass); low hypersaline pannes characterized by *Salicornia* (saltwort) spp.; and a salt scrub ecotone characterized by *Iva frutescens* (maritime marsh-elder), *Baccharis halimifolia* (groundsel-tree), and *Panicum virgatum* (switchgrass). Salt marsh "islands" of slightly higher elevation also support *Juniperus virginiana* (eastern red-cedar). 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 Associations:

- Brackish Meadow
 - Eastern Reed Marsh
 - Mid-Atlantic High Salt Marsh
 - North Atlantic High Salt Marsh
 - Reed-grass Tidal Marsh
 - Salt Panne Pool
- Cattail Brackish Tidal Marsh
Maritime Red-cedar Woodland
Mid-Atlantic Maritime Salt Shrub
North Atlantic Low Salt Marsh
Salt Panne (Salicornia Type)

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

BRACKISH MEADOW

Panicum virgatum - *Spartina patens* Herbaceous Vegetation

Range: This association occurs from New Hampshire to Delaware. It occurs in Delaware and New Jersey in the Delaware Estuary.

Environmental Description: This association occurs at the upland border of salt marshes on moist, sandy, shallow peat over glacial till or quartzite sand. This is the highest elevation within the salt marsh; it is irregularly flooded by tides, high spring tides and storm tides, but is freely drained. It is also subject to salt spray. Soil salinity is low (oligohaline to mesohaline, 0.5-18 ppt). Similar vegetation can occur on anthropogenic dredge spoils where similar environmental conditions are created. Small patches of this



Photo by Linda Kelly

association may also occur around coastal salt ponds.

Vegetation Description: This association is a tall grassland occupying brackish meadows at the upland border of high salt marshes. Vegetation is dominated by *Panicum virgatum* (switchgrass) and occasionally codominated by *Spartina patens* (saltmeadow cordgrass). Common associates include *Schoenoplectus americanus* (chairmaker's bulrush), *Solidago sempervirens* (seaside goldenrod), *Teucrium canadense* (American germander), *Distichlis spicata* (saltgrass), *Carex silicea* (beach sedge), and *Juncus* (rush) spp. (*Juncus gerardii* (black-grass) in the north, *Juncus roemerianus* (black needlerush) in the south). Shrubs may occur sporadically, especially *Baccharis halimifolia* (groundsel-tree), *Morella pensylvanica* (northern bayberry), *Prunus maritima* (beach plum), and *Iva frutescens* (maritime marsh-elder). Vegetation can be quite diverse and is a mixture of freshwater and brackish species. In addition to the common associates, other graminoids can include *Setaria parviflora* (yellow foxtail grass), *Elymus virginicus* (Virginia wild rye), *Panicum amarum* (bitter panicgrass), *Cladium mariscoides* (twig-rush), *Cyperus polystachyos* (many-spike flatsedge), *Cyperus dentatus* (bulblet flatsedge), *Schoenoplectus pungens* (common threesquare), and *Fimbristylis castanea* (chestnut fimbry), and other forbs can include *Polygala verticillata* (whorled milkwort), *Solidago sempervirens* (seaside goldenrod), *Euthamia caroliniana* (slender goldentop), *Agalinis maritima* (saltmarsh false foxglove), *Artemisia campestris* ssp. *caudata* (tailed wormwood), *Sabatia stellaris* (rose-of-Plymouth), *Sabatia dodecandra* (marsh rose-gentian), and Asteraceae spp.

Characteristic Species: *Panicum virgatum* (switchgrass)

Dynamics/Successional Trajectory: This association generally forms as a band of vegetation between high salt marsh and upland vegetation. It is best developed in salt marshes with a gradual elevation gradient that lend themselves to vegetation zonation. In the northern part of the geographic range, this band gets progressively narrower as the transition to the upland border is more abrupt. With more frequent flooding, the community likely transitions to high salt marsh. Where salt spray and salinity influence decreases, shrubs tend to invade or the community can transition to maritime grasslands. Where tidal flooding becomes ponded, vegetation is classified as an interdunal swale. Vegetation can be more sparse, grading into sand flats.

Management Concerns: *Phragmites australis* (common reed) invades this ecotonal association. Sea level rise may play a role in the ecology of this community. Marshes may be drowned or experience increases in salinity that could influence the vegetation composition of this type.

Reference Sites: Fort Mott, NJ; Cape May Point, NJ

Global and State Conservation Ranks and Reasons: GNR (1-Dec-1997). DE: S3?, NJ: S2S3.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688411

References: Bowman 2000, Breden 1989, Breden et al. 2001, Clancy 1996, Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Fender 1937, Harrison 2001, Harrison 2004, Heckscher et al. 1995, Higgins et al. 1971, Hill 1986, Hunt 2000, Johnson 1985b, Lundgren et al. 2000, Metzler and Barrett 2001, Nixon 1982, Rawinski 1984, Sperduto 2000b, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Panicum virgatum</i> (switchgrass)

CATTAIL BRACKISH TIDAL MARSH

Typha angustifolia - *Hibiscus moscheutos* Herbaceous Vegetation

Range: This association occurs along the Atlantic coast from Maine to Virginia and possibly to South Carolina. It occurs in Delaware and New Jersey in the Delaware Estuary.

Environmental Description: This association occurs in oligohaline to mesohaline areas of tidal marshes (0.5-18 ppt). In estuarine systems, it can occur in the uppermost zone of brackish marshes where there is freshwater influence; it receives diurnal tidal flooding of brackish water. In salt marshes behind barrier beaches, it can occur in the upper reaches of larger tidal creeks within brackish areas and also at the upland border where there is significant



Photo by Linda Kelly

freshwater input from the adjacent upland; here it receives irregular tidal flooding only during high spring tides. Substrate is muck or peat, and there is often an accumulation of *Typha* (cattail) litter.

Vegetation Description: The vegetation of this tall graminoid vegetation instead is a mixture of freshwater and saltmarsh species dominated by *Typha angustifolia* (narrowleaf cattail). *Phragmites australis* (common reed), *Typha latifolia* (broadleaf cattail), *Spartina cynosuroides* (giant cordgrass), or *Schoenoplectus pungens* (common threesquare) can codominate. The *Phragmites australis* (common reed) component is the native strain (Saltonstall 2002). Common associates include *Hibiscus moscheutos* (eastern rosemallow), *Schoenoplectus pungens* (common threesquare), *Impatiens capensis* (orange jewelweed), *Amaranthus cannabinus* (water-hemp), *Peltandra virginica* (green arrow-arum), and *Bidens* (beggarticks) spp., plus *Spartina cynosuroides* (giant cordgrass) in the south. Other infrequent associates include *Mikania scandens* (climbing hempvine), *Pluchea odorata* (sweetscent), *Polygonum punctatum* (dotted smartweed), *Eleocharis* (spikerush) spp., and *Schoenoplectus robustus* (alkali bulrush), plus *Schoenoplectus americanus* (chairmaker's bulrush) farther south. Species from adjacent high salt marsh may also be present.

Characteristic Species: *Hibiscus moscheutos* (eastern rosemallow), *Typha angustifolia* (narrowleaf cattail)

Dynamics/Successional Trajectory: Brackish marsh complexes commonly occur as mosaics of patches dominated by a single graminoid species. Patches dominated by *Typha angustifolia* (narrowleaf cattail) tend to occur where there is more freshwater influence near the upper reaches of estuaries or at the upland border of high salt marshes where there is freshwater input from the surrounding upland. As the marsh becomes more brackish, *Schoenoplectus pungens* (common threesquare) or *Spartina patens* (saltmeadow cordgrass) can become dominant. As the marsh becomes less brackish, *Peltandra virginica* (green arrow-arum), *Pontederia cordata* (pickerelweed), *Acorus calamus* (sweetflag), *Schoenoplectus tabernaemontani* (softstem bulrush), and *Zizania aquatica* (Indian wild rice) can become more prevalent. The pattern of alternating dominance between *Typha angustifolia* (narrowleaf cattail) and *Phragmites australis* (common reed) that can occur in these environmental settings may reflect disturbance history of the site and of the surrounding watershed.

Management Concerns: Sea level rise may pose a threat to these marshes by increasing salinity levels, and thereby potentially initiating a shift in vegetation composition to more salt-tolerant species. This community is threatened by pollution and by encroachment of *Phragmites australis* (common reed).

Reference Sites: widespread, DE; Hancock Bridge on Alloway Creek, Salem County, NJ; Supawna Meadows NWR (North bank of Mill Creek), NJ

Global and State Conservation Ranks and Reasons: G4G5 (19-Jan-2006). DE: S4, NJ: S4. This common small-patch community occurs in the estuarine areas of up to 13 northeastern states, several of which rank this vegetation as S4.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.683268

References: Bowman 2000, Breden 1989, Breden et al. 2001, Cahoon and Stevenson 1986, Coulling 2002, Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Ferren et al. 1981, Fleming 2001, Fleming and Moorhead 1998, Fleming et al. 2001, Gawler 2002, Good and Good 1975b, Harrison 2001, Harrison 2004, Hill 1986, Klotz 1986, MENHP 1991, McCormick and Ashbaugh 1972, Metzler and Barrett 1992, Metzler and Barrett 2001, Odum et al. 1984, Rawinski 1984, Reschke 1990, Saltonstall 2002, Schafale 2000, Schafale 2003b, Schafale and Weakley 1990, Shreve et al. 1910, Sperduto 1994, Sperduto 1997a, Sperduto 2000b, Steury 1999, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Semi-shrub	<i>Hibiscus moscheutos</i> (eastern rosemallow)
Herb (field)	Graminoid	<i>Schoenoplectus pungens</i> (common threesquare)
Herb (field)	Graminoid	<i>Typha angustifolia</i> (narrowleaf cattail)
Submerged aquatic	Aquatic herb (floating & submergent)	<i>Pontederia cordata</i> (pickerelweed)

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.

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.



Photo by Linda Kelly

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: 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

References: Bailey 1997, Bailey 1998, 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)

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.



Photo by Robert Cox

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 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

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 red-cedar)	Needle-leaved tree	<i>Juniperus virginiana</i> var. <i>virginiana</i> (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 poison-ivy)
Herb (field)	Graminoid	<i>Schizachyrium scoparium</i> (little bluestem)

MID-ATLANTIC HIGH SALT MARSH

Spartina patens - *Distichlis spicata* - *Juncus roemerianus* Herbaceous Vegetation

Range: This association occurs along the Atlantic coast from Delaware to Florida. It occurs in New Jersey and possibly Delaware in the Delaware Estuary.

Environmental Description: This high salt marsh association generally occurs behind barrier beaches, but also in the outer reaches of estuaries, occupying the zone extending from mean high tide landward approximately to the limit of high spring tides. They are often adjacent to low salt marshes dominated by *Spartina alterniflora* (saltmarsh cordgrass) (tall form), which are regularly flooded by diurnal tides. *Spartina patens* (saltmeadow cordgrass)-dominated high marshes form very dense peat with high organic matter content. Peat forms over sand, silt or bedrock.

Vegetation Description: This high salt marsh is dominated by *Spartina patens* (saltmeadow cordgrass) with *Distichlis spicata* (saltgrass) occurring as a common associate or a codominant species. Associated species that generally occur in low abundance can include *Limonium carolinianum* (Carolina

sea-lavender), *Agalinis maritima* (saltmarsh false foxglove), *Salicornia virginica* (pickleweed), *Sabatia stellaris* (rose-of-Plymouth), *Borrchia frutescens* (seaside oxeye), *Lythrum lineare* (saltmarsh loosestrife), *Juncus roemerianus* (black needlerush), *Solidago sempervirens* (seaside goldenrod), *Pluchea odorata* (sweetscent), *Hibiscus moscheutos* ssp. *moscheutos* (eastern rosemallow), and/or *Atriplex prostrata* (hastate orache). Shrub seedlings of *Baccharis halimifolia* (groundsel-tree), *Iva frutescens* (maritime marsh-elder), and/or *Morella cerifera* (wax-myrtle) may occur sporadically.

Characteristic Species: *Distichlis spicata* (saltgrass), *Spartina patens* (saltmeadow cordgrass)

Dynamics/Successional Trajectory: Vegetation of this association occurs as a shifting mosaic of patches dominated by single graminoid species. Species composition results from hydroperiod, nutrient availability, salinity gradients, soil oxygen, concentrations of growth inhibitors in the soil, and interspecific competition. As sedimentation increases marsh elevation, vegetation shifts to upland border communities dominated by *Panicum virgatum* (switchgrass) and *Juncus gerardii* (black-grass). Local disturbance, i.e., from ice scouring, can cause invasion by *Spartina alterniflora* (saltmarsh cordgrass), or can lead to the formation of salt pannes.

Management Concerns: Sea level rise may lead to the drowning of these marshes and/or a shift to low marsh species depending on the dynamics of the specific marsh. Ditching, dredging and filling, mosquito spraying, and other activities threaten these marshes.

Reference Sites: Prime Hook NWR, Sussex County, DE?; Great Marsh, Sussex County, DE?

Global and State Conservation Ranks and Reasons: G4G5 (13-May-2002). DE: S4, NJ: SNR. Although widespread on the eastern seaboard, examples of this community that have not been impacted by ditching, dredging and filling, mosquito spraying, and other activities are relatively uncommon.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684204

References: Adams 1963, Bowman 2000, Clancy 1993b, Clancy 1996, Cooper 1974, Cooper and Waits 1973, Eastern Ecology Working Group n.d., Fleming 2001, Fleming et al. 2001, Harrison 2001, Harrison 2004, Higgins et al. 1971, Hill 1986, Nelson 1986, Peet et al. unpubl. data 2002, Penfound 1952, Schafale 2000, Schafale 2003b, Schafale and Weakley 1990

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Spartina patens</i> (saltmeadow cordgrass)

MID-ATLANTIC MARITIME SALT SHRUB

Baccharis halimifolia - *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 shrubland of the mid-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. 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: This tidal shrubland is dominated by *Iva frutescens* (maritime marsh-elder) and *Baccharis halimifolia* (groundsel-tree). Other associated shrubs include *Morella pensylvanica* (northern bayberry) in the northern portion of the range, while *Borrchia frutescens* (seaside oxeye), *Morella cerifera* (wax-myrtle), and *Juniperus virginiana* var. *silicicola* (coastal red-cedar) are frequent associates in the southern part of the range. *Spartina patens* (saltmeadow cordgrass) is a characteristic and usually

abundant grass; other common herbaceous associates include *Distichlis spicata* (saltgrass), *Hibiscus moscheutos* (eastern rosemallow), *Toxicodendron radicans* (eastern poison-ivy), *Teucrium canadense* (American germander), *Festuca rubra* (red fescue), *Limonium carolinianum* (Carolina sea-lavender), and in the south, *Setaria parviflora* (yellow foxtail grass). This community often forms an abrupt transition from salt marsh to upland reflecting the relatively higher elevation and less frequent tidal flooding. Shrub cover in this situation tends to be fairly dense, and herbs are sparsely distributed. Where the topographic relief is more gradual, the community is characterized by an open and relatively evenly spaced shrub stratum with a well-developed herbaceous layer, reflecting an intergrading of this community with the adjacent high salt marsh.

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

Dynamics/Successional Trajectory: This association occurs above mean high tide but 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: Hansey Creek WMA, NJ; Dias Creek NWR, NJ; Moore's Beach and Thompson Beach, NJ

Global and State Conservation Ranks and Reasons: G5 (1-Dec-1997). DE: S5, NJ: S2S3.

VegBank Link for Plot Data: 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	Broad-leaved evergreen shrub	<i>Baccharis halimifolia</i> (groundsel-tree)
Short shrub/sapling	Semi-shrub	<i>Iva frutescens</i> (maritime marsh-elder)
Herb (field)	Graminoid	<i>Spartina patens</i> (saltmeadow cordgrass)

NORTH ATLANTIC HIGH SALT MARSH

Spartina patens - *Distichlis spicata* - (*Juncus gerardii*) Herbaceous Vegetation

Range: This high salt marsh association occurs from the Canadian maritime provinces south to Delaware. It occurs in both New Jersey and Delaware in the Delaware Estuary.

Environmental Description: This high salt marsh association generally occurs behind barrier beaches, but also in the outer reaches of estuaries, occupying the zone extending from mean high tide landward approximately to the limit of spring tides. They are often adjacent to low salt marshes dominated by *Spartina alterniflora* (saltmarsh cordgrass) (tall form), which are regularly flooded by diurnal tides. *Spartina patens* (saltmeadow cordgrass)-dominated high marshes form very dense peat with high organic matter content. Peat forms over sand, silt or bedrock.

Vegetation Description: Vegetation of this marsh community occurs in mosaics of patches generally dominated by a single graminoid species, such as *Spartina patens* (saltmeadow cordgrass), *Distichlis spicata* (saltgrass), or *Juncus gerardii* (black-grass). Other characteristic associates that occur in low abundance include *Symphotrichum tenuifolium* (saline aster), *Limonium carolinianum* (Carolina sea-lavender), *Solidago sempervirens* (seaside goldenrod), *Symphotrichum subulatum* (seaside American-aster), *Polygonum ramosissimum* (yellow-flower knotweed), *Atriplex patula* (halberd-leaf orache), *Lythrum lineare* (saltmarsh loosestrife), and *Panicum virgatum* (switchgrass).

Characteristic Species: *Distichlis spicata* (saltgrass), *Juncus gerardii* (black-grass), *Spartina patens* (saltmeadow cordgrass)

Dynamics/Successional Trajectory: Vegetation of this association occurs as a shifting mosaic of patches dominated by a single graminoid species. Species composition at a particular site results from the interaction of hydroperiod, nutrient availability, salinity gradients, soil oxygen, concentrations of growth inhibitors in the soil, and interspecific competition. As sedimentation increases marsh elevation, vegetation may shift to upland border communities dominated by *Panicum virgatum* (switchgrass) and *Juncus gerardii* (black-grass). Local disturbance, i.e., from ice scouring, can cause invasion by *Spartina alterniflora* (saltmarsh cordgrass), or can lead to the formation of salt pannes.

Management Concerns: Sea level rise may influence this community through increased salinity levels that could alter the vegetation composition.

Reference Sites: Woodland Beach WMA, Kent County, DE; Jake's Landing WMA, Cape May County, NJ; Dennis Creek WMA, NJ

Global and State Conservation Ranks and Reasons: G5 (1-Dec-1997). DE: SNR, NJ: S5.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689496

References: Bertness et al. 1992, Breden 1989, Breden et al. 2001, Coulling pers. comm., Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Fleming 2001, Gawler 2001, Gawler 2002, Harrison 2001, Hill 1923, Metzler and Barrett 2001, Nixon 1982, Rawinski 1984, Reschke 1990, Sperduto 2000a, Sperduto 2000b, Swain and Kearsley 2001

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Distichlis spicata</i> (saltgrass)
Herb (field)	Graminoid	<i>Spartina patens</i> (saltmeadow cordgrass)

NORTH ATLANTIC LOW SALT MARSH

Spartina alterniflora / (*Ascophyllum nodosum*) Acadian/Virginian Zone Herbaceous Vegetation

Range: This association occurs along the Atlantic coastline from Nova Scotia and New Brunswick south to Cape Hatteras, North Carolina.

Environmental Description: This low salt marsh community occurs in the regularly flooded intertidal zone, approximately from mean high tide to mean sea level; they are diurnally flooded by tides and are classified as polyhaline (18-30 ppt). This low marsh occurs in areas sheltered from direct wave action, such as behind barrier beaches, as pocket marshes at the heads of bays, or in the outer reaches of estuaries. Low salt marshes occur landward of intertidal flats and subtidal communities and seaward of high salt marsh communities.



Photo by Keith Clancey

Low salt marshes dominated by *Spartina alterniflora* (saltmarsh cordgrass) generally occur on mucky silt to silty coarse fibrous peat, often with high organic matter content. However, peat in the low marsh is generally less dense than farther landward (Bertness 1988). Peat depth ranges from a few feet, if the community formed over a mud flat, to 80 feet in drowned river valleys at the mouths of estuaries.

Vegetation Description: This community is a tall grassland dominated by *Spartina alterniflora* (saltmarsh cordgrass) occurring in regularly flooded intertidal zones. *Spartina alterniflora* (saltmarsh cordgrass) dominates this physically stressful zone due to limited competition and its ability to tolerate salinity and flooding. It also requires moderately high levels of iron (7-15 ppm) (Adams 1963). *Spartina alterniflora* (saltmarsh cordgrass) is strongly dominant, forming a nearly monotypic tallgrass layer. There is little variation in vascular plant composition across the range. Tall-form *Spartina alterniflora* (saltmarsh cordgrass) occurs adjacent to saltwater and colonizes unvegetated flats. This association also grades into short-form *Spartina alterniflora* (saltmarsh cordgrass) landward where tidal range is more restricted. Common associates, occurring in low abundance, include *Limonium carolinianum* (Carolina sea-lavender), *Salicornia virginica* (pickleweed), *Salicornia bigelovii* (dwarf glasswort), *Spergularia maritima* (satin-flower), *Spergularia canadensis* (Canada sandspurry), and *Suaeda maritima* (herbaceous seepweed). *Distichlis spicata* (saltgrass), *Agalinis maritima* (saltmarsh false foxglove), *Symphytotrichum tenuifolium* (saline aster), and *Spartina patens* (saltmeadow cordgrass) can also sporadically occur but are more common in high salt marsh. Brown algae can form extensive mats at the bases of the grass culms, especially *Ascophyllum nodosum*, *Fucus vesiculosus*, and *Ulva* spp. *Enteromorpha* spp. can occur early in the growing season. Macroalgae associates may be sparse or absent at the southern edge of the range. Microscopic algae, especially diatoms, can be abundant on the marsh surface (Teal 1986). In New Jersey, *Bassia scoparia* (mexican fireweed) (waif) occurs on the upper edge of this low salt marsh.

Characteristic Species: *Spartina alterniflora* (saltmarsh cordgrass)

Dynamics/Successional Trajectory: Salt marshes are dynamic habitats. *Spartina alterniflora* (saltmarsh cordgrass) readily colonizes soft sediments off the seaward edge of the salt marsh (Bertness 1988). Grass culms and algal mats trap sediments brought in by the tides and begin the process of marsh peat accumulation. As peat development raises marsh elevation, low marsh succeeds to high marsh communities; *Spartina alterniflora* (saltmarsh cordgrass) performance declines as peat accumulates and becomes more dense. Flotsam and jetsam brought in by tides can smother local patches of vegetation and form unvegetated to sparsely vegetated pannes, a phenomenon that occurs regularly on high marshes. Tidal creeks form sinuous patterns throughout the low marsh draining the diurnal tides.

Management Concerns: Sea level rise may influence the dynamics of this marsh through drowning and/or increasing salinity levels.

Reference Sites: widespread in DE and NJ; Hansey Creek WMA, NJ

Global and State Conservation Ranks and Reasons: G5 (1-Dec-1997). DE: S5, NJ: S5.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.689365

References: Adams 1963, Bertness 1988, Bowman 2000, Breden 1989, Breden et al. 2001, Chapman 1937, Clancy 1993b, Clancy 1996, Cowardin et al. 1979, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1993, Enser 1999, Fleming et al. 2001, Gawler 2001, Gawler 2002, Gosner 1979, Harrison 2001, Harrison 2004, Higgins et al. 1971, Hill 1986, MENHP 1991, Metzler and Barrett 1992, Metzler and Barrett 2001, Moul 1973, Rawinski 1984, Reschke 1990, Schafale 2000, Schafale 2003b, Schafale and Weakley 1990, Sperduto 1994, Sperduto 2000a, Sperduto 2000b, Stalter 1979, Swain and Kearsley 2001, Teal 1986

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Graminoid	<i>Spartina alterniflora</i> (saltmarsh cordgrass)

REED-GRASS TIDAL MARSH

Phragmites australis Tidal Herbaceous Vegetation

Range: This community has a broad geographic range, including coastal areas of the eastern and southeastern United States and Canada. It occurs in Delaware and New Jersey in the Delaware Estuary.

Environmental Description: This community is a dense tall grassland indicative of disturbance. It occurs in a range of tidal wetland habitats from fresh to brackish in salinity.

Vegetation Description: Spreading in large colonies, *Phragmites* (reed) eventually dominates disturbed areas at coverage up to 100%. More typically though, scattered individuals of other species may occur, such as sparse *Morella cerifera* (wax-myrtle) shrubs, *Kosteletzkya virginica* (seashore mallow), *Calystegia sepium* (hedge false bindweed), *Boehmeria cylindrica* (small-spike false nettle), *Typha angustifolia* (narrowleaf cattail), *Apocynum cannabinum* (Indian-hemp), *Rosa palustris* (swamp rose), *Polygonum* (smartweed, knotweed) sp., and *Mikania scandens* (climbing hempvine). Vines of *Toxicodendron radicans* (eastern poison-ivy) are also frequent but typically occur at low cover.



Photo by Kathleen Strakosch Walz

Characteristic Species: *Phragmites australis* (common reed)

Dynamics/Successional Trajectory: This community is a broadly defined reed marsh. It is characterized by dense stands of *Phragmites australis* (common reed), a species which tends to grow in colonies of tall, stout, leafy plants often to the exclusion of all other vascular plant species. Associated species are highly variable, depending on the community that has been invaded.

Management Concerns: *Phragmites australis* (common reed) is invasive globally, and the formation of these extensive monocultures are often considered fire hazards.

Reference Sites: Supawna Meadows NWR, NJ; Mad Horse Creek WMA, NJ

Global and State Conservation Ranks and Reasons: GNA (invasive) (22-Nov-1997). DE: SNA, NJ: SNA, PA: SNA.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688034

References: Bowman 2000, Breden 1989, Clancy 1993b, Edinger et al. 2002, Fleming 1998, Harrison 2001, Metzler and Barrett 1992, Metzler and Barrett 1996, Metzler and Barrett 2001, Nelson 1986, Niering and Warren 1977, Odum et al. 1984, Rawinski 1984, Saltonstall 2002, 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)

SALT PANNE (SALICORNIA TYPE)

Salicornia (virginica, bigelovii, maritima) - Spartina alterniflora Herbaceous Vegetation

Range: This association occurs along the Mid- and North Atlantic Coast from the Canadian maritime provinces south to North Carolina. It occurs in New Jersey and Delaware in the Delaware Estuary.

Environmental Description: Vegetation of this association tends to develop in shallow depressions in salt marshes where drainage is poor. They tend to occur more frequently on the high marsh but occur within low marsh as well. Pannes form in depressions that range from 2-30 cm lower than the elevation of the marsh. The depressions are regularly to irregularly flooded by tides, and as the water evaporates during low tide, the salinity concentration increases forming "salt pannes." Substrate is soft, silty muck or peat of variable density.



Photo by Kathleen Strakosch Walz

Vegetation Description: This association includes tidally flooded hypersaline flats or very shallow depressions (pannes) dominated by halophytic herbs. Total vegetative cover is quite variable in pannes, from near total absence of vascular plants to a dense cover of *Salicornia virginica* (pickleweed), *Salicornia bigelovii* (dwarf glasswort), *Salicornia maritima* (sea saltwort), *Sarcocornia perennis* (woody glasswort), or *Spartina alterniflora* (saltmarsh cordgrass) (short form). Common associates include *Limonium carolinianum* (Carolina sea-lavender), *Plantago maritima* var. *juncooides* (seaside plantain), *Triglochin maritima* (seaside arrow-grass), *Suaeda maritima* (herbaceous seepweed), and *Atriplex* (saltbush) spp. Algal mats are characteristically present, visible even in densely vegetated pannes. Blue-green algae are an important component of these mats, in some cases contributing significantly more biomass to the community than do vascular species. The following algae were noted to occur in association with *Spartina alterniflora* (saltmarsh cordgrass) in the littoral zone of a Massachusetts salt marsh: *Oscillatoria subuliformis*, *Oscillatoria amphibia*, *Lyngbea* spp., *Microcoleus chthonoplastes*, *Nodularia harveyana*, *Hydrocoleum lyngbyaceum*, and *Symploca* spp. (Webber 1967).

Characteristic Species: *Salicornia bigelovii* (dwarf glasswort), *Salicornia maritima* (sea saltwort), *Salicornia virginica* (pickleweed), *Sarcocornia perennis* (woody glasswort)

Dynamics/Successional Trajectory: Salt pannes are part of the shifting mosaic of plant communities of the salt marsh complex. They tend to occur more frequently on the high marsh but are present in the low marsh as well. Pannes are variable in shape and likely variable in origin. Formation can result from ice-scouring or rafting flotsam that scrapes away or smothers existing vegetation, or from peat compaction, mosquito ditch levees, or tidal creekbank erosion that blocks or impedes drainage. Lack of vegetation decreases local sedimentation, which also maintains lower micro-relief (Redfield 1972). Evaporation from these poorly drained shallow depressions leads to hypersaline conditions (Niering and Warren 1980, Bertness et al. 1992). Gradients of salinity and standing water depth and duration correlate to vegetative cover and composition. The lowest portions of pannes tend to be wetter and more saline and can have little or no vegetation. As duration of wetness and salinity decreases across the micro-relief, forb-dominated species assemblages tend to dominate, followed by mixed graminoid-forb assemblages at the outer higher edges (Redfield 1972). Pannes can be ephemeral features on the marsh, and vegetation cover and composition can vary from year to year. Unvegetated, soft-bottomed pannes generally have plentiful worm and crab burrows (Godfrey et al. 1978).

Management Concerns: This community may be susceptible to sea level rise and potential drowning.

Reference Sites: Great Marsh, Sussex County, DE; Hansey Creek WMA, NJ

Global and State Conservation Ranks and Reasons: G5 (1-Dec-1997). DE: S3, NJ: S3S4.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.686149

References: Bartgis 1986, Baumann 1978b, Berdine 1998, Bertness et al. 1992, Bowman 2000, Breden 1989, Breden et al. 2001, Clancy 1993b, Clancy 1996, Clovis 1968, Conard 1935, Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Fleming 2001, Fleming et al. 2001, Gawler 2001, Gawler 2002, Godfrey et al. 1978, Good 1965, Harrison 2004, Harvill 1965, Higgins et al. 1971, Hill 1986, Klotz 1986, Metzler and Barrett 1992, Metzler and Barrett 2001, Miller and Egler 1950, Nichols 1920, Niering and Warren 1980, Peet et al. unpubl. data 2002, Rawinski 1984, Redfield 1972, Reschke 1990, Schafale 2000, Schafale and Weakley 1990, Sperduto 2000b, Swain and Kearsley 2001, VDNH 2003, Webber 1967

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Herb (field)	Semi-shrub	<i>Salicornia virginica</i> (pickleweed)
Herb (field)	Semi-shrub	<i>Sarcocornia perennis</i> (woody glasswort)
Herb (field)	Forb	<i>Salicornia bigelovii</i> (dwarf glasswort)
Herb (field)	Graminoid	<i>Spartina alterniflora</i> (saltmarsh cordgrass)

SALT PANNE POOL

Ruppia maritima - *Schoenoplectus maritimus* Herbaceous Vegetation

Range: This association is currently described in New England from New Hampshire to Connecticut. It also occurs in New Jersey.

Environmental Description: This type occurs in permanently or semipermanently flooded salt pools or pannes within high and low salt marshes.

Vegetation Description: Vegetation is characterized by *Ruppia maritima* (beaked ditch-grass). Associated species can include *Stuckenia pectinata* (sago pondweed), *Zannichellia palustris* (horned pondweed), and purple-sulfur bacteria. *Schoenoplectus maritimus* (saltmarsh clubrush) borders the standing water in the northern portion of the range. (Note: *Schoenoplectus maritimus* (saltmarsh clubrush) is ranked SH (state historic) in New Jersey.)

Noteworthy Associated Plant and/or Animal Species: *Schoenoplectus maritimus* (saltmarsh clubrush)

Characteristic Species: *Ruppia maritima* (beaked ditch-grass)

Reference Sites: Sea Breeze, NJ

Global and State Conservation Ranks and Reasons: GNR (14-Apr-1998). NJ: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687881

References: Eastern Ecology Working Group n.d., Edinger et al. 2002, Godfrey et al. 1978, Metzler and Barrett 2001, Miller and Egler 1950, Niering and Warren 1980, Sperduto 2000b, Swain and Kearsley 2000, Thayer et al. 1984

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Submerged aquatic	Aquatic herb (floating & submergent)	<i>Ruppia maritima</i> (beaked ditch-grass)

ECOLOGICAL SYSTEM: NORTHERN ATLANTIC COASTAL PLAIN TIDAL SWAMP

Summary: This system encompasses tidally flooded deciduous forests and shrublands in lower river floodplains and edges of estuaries of the North Atlantic Coastal Plain. This system is restricted to narrow zones along upper tidal reaches of Inner Coastal Plain rivers and tributaries which have sufficient volumes of fresh water and short flooding to be able to support tree canopies. According to Fleming et al. (2001) these areas are influenced by lunar tides up to 1 m (3 feet), but diluting freshwater flows from upstream keep salinity levels below 0.5 ppt. Deciduous hardwood species predominate, especially *Nyssa* (blackgum) and/or *Fraxinus* (ash).

Range: This system ranges from the James River, Virginia, northward to the New Jersey Coastal Plain. Examples are probably most common in the Chesapeake Bay region. United States: DE, MD, NJ, NY, VA

Delaware Estuary Associations:

- Ash - Swamp Blackgum Freshwater Tidal Swamp
- Freshwater Tidal Woodland
- North Atlantic Fresh Tidal Shrub Swamp

CLASSIFIERS FOR NORTHERN ATLANTIC COASTAL PLAIN TIDAL SWAMP

Primary Division: 203

Land Cover Class: Woody Wetland

Spatial Scale & Pattern: Small patch

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

Diagnostic Classifiers: Forest and Woodland (Treed); Tidal / Estuarine

ASH - SWAMP BLACKGUM FRESHWATER TIDAL SWAMP

Fraxinus (profunda, pennsylvanica) - (Nyssa biflora) / Polygonum arifolium Forest

Range: This association is restricted to tidal rivers in Delaware, Maryland, and Virginia.

Environmental Description: This association occurs along fresh reaches of tidal rivers, usually receiving diurnal or irregular tidal flooding. There is distinct hummock-and-hollow microtopography with hollows flooded during higher tides.

Vegetation Description: The canopy of this freshwater tidal swamp is dominated by few tree species, generally *Fraxinus profunda* (pumpkin ash), *Fraxinus pennsylvanica* (green ash), and *Nyssa biflora* (swamp blackgum). Other canopy associates vary among occurrences and often include *Nyssa sylvatica* (blackgum), *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), *Magnolia virginiana* (sweetbay), *Fraxinus profunda* (pumpkin ash), *Ulmus americana* (American elm), and *Pinus taeda* (loblolly pine). The shrub layer is well-developed and includes *Lindera benzoin* (northern spicebush), *Clethra alnifolia* (coastal sweet-pepperbush), *Leucothoe racemosa* (swamp doghobble), *Ilex verticillata* (common winterberry), *Ilex opaca* (American holly), *Ilex laevigata* (smooth winterberry holly), *Alnus serrulata* (smooth alder), *Rhododendron viscosum* (swamp azalea), *Viburnum dentatum* (southern arrow-wood), *Viburnum nudum* (wild raisin), *Morella cerifera* (wax-myrtle), *Vaccinium corymbosum* (highbush blueberry), *Vaccinium fuscatum* (black highbush blueberry), *Itea virginica* (Virginia-willow), *Rosa palustris* (swamp rose), and *Cornus foemina* (stiff dogwood). *Alnus maritima* (seaside alder) is also characteristic in Delaware and Maryland. Vines may be dense and include *Smilax rotundifolia* (roundleaf greenbrier), *Toxicodendron radicans* (eastern poison-ivy), *Apios americana* (groundnut), *Parthenocissus quinquefolia* (Virginia creeper), *Bignonia capreolata* (crossvine), and *Dioscorea villosa* (wild yam). The herbaceous layer is variable in composition and richness. Common associates include *Polygonum arifolium* (halberd-leaf tearthumb), *Polygonum sagittatum* (arrowleaf tearthumb), *Peltandra virginica*

(green arrow-arum), *Saururus cernuus* (lizard's-tail), *Carex bromoides* (brome-like sedge), *Carex intumescens* (greater bladder sedge), *Impatiens capensis* (orange jewelweed), *Boehmeria cylindrica* (small-spike false nettle), *Leersia oryzoides* (rice cutgrass), *Commelina virginica* (swamp dayflower), *Cicuta maculata* (spotted water-hemlock), *Arisaema triphyllum* (Jack-in-the-pulpit), *Thalictrum pubescens* (king-of-the-meadow), *Thelypteris palustris* (eastern marsh fern), *Woodwardia areolata* (netted chainfern), *Carex stricta* (tussock sedge), *Zizania aquatica* (Indian wild rice), *Cinna arundinacea* (sweet woodreed), *Osmunda cinnamomea* (cinnamon fern), and *Osmunda regalis* (royal fern). The invasive exotic *Murdannia keisak* (marsh dewflower) can also occur in this association.

Noteworthy Associated Plant and/or Animal Species: *Alnus maritima* (seaside alder)

Characteristic Species: *Alnus maritima* (seaside alder), *Fraxinus pennsylvanica* (green ash), *Fraxinus profunda* (pumpkin ash), *Nyssa biflora* (swamp blackgum)

Dynamics/Successional Trajectory: *Fraxinus pennsylvanica* (green ash) and *Nyssa biflora* (swamp blackgum) tend to sort out where there is longer inundation and a mean water table near the hummock surface. *Acer rubrum* (red maple) and *Liquidambar styraciflua* (sweetgum) tend to occur where the mean water table is relatively lower (Rheinhardt 1992). Duration of flooding is a poorer predictor of canopy composition than mean depth of flooding. Certain sites exhibit crown stress and tree mortality from sea level rise.

Management Concerns: Sea level rise can contribute to tree mortality. The community is threatened by damming of rivers which results in restricting tidal influence and thus community structure and composition. It is also threatened by agricultural practices, particularly by pesticide and fertilizer runoff. The invasive exotic *Murdannia keisak* (marsh dewflower) can also occur in this association.

Reference Sites: Murderkill River, Kent County, DE

Global and State Conservation Ranks and Reasons: G3 (3-Dec-1998). DE: S3S4. This tidal woodland community has a restricted range, being confined to tidal rivers of Virginia, Maryland, and Delaware. It is estimated that there are fewer than 100 occurrences and 85,000 acres rangewide.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.685830

References: Bartgis 1986, Berdine 1998, Bowman 2000, Clancy 1996, Eastern Ecology Working Group n.d., Fleming 2001, Fleming et al. 2001, Harrison 2004, Harrison pers. comm., Rheinhardt 1991, Rheinhardt 1992, Tiner 1985a, VDNH 2003

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Fraxinus pennsylvanica</i> (green ash)
Tree canopy	Broad-leaved deciduous tree	<i>Fraxinus profunda</i> (pumpkin ash)
Tree canopy	Broad-leaved deciduous tree	<i>Nyssa biflora</i> (swamp blackgum)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Lindera benzoin</i> (northern spicebush)
Shrub/sapling (tall & short)	Vine/Liana	<i>Smilax rotundifolia</i> (roundleaf greenbrier)
Herb (field)	Forb	<i>Polygonum arifolium</i> (halberd-leaf tearthumb)

FRESHWATER TIDAL WOODLAND

Acer rubrum - *Fraxinus pennsylvanica* / *Polygonum* spp. Forest

Range: This association is confined to tidal rivers of Massachusetts, New York, and New Jersey and possibly Delaware.

Environmental Description: This freshwater tidal swamp occurs at the upper limit of tidal influence along coastal rivers. They are best developed along larger rivers with a gradual elevation gradient such

that tidal influence occurs over considerable distance. There is diurnal flooding with freshwater. Substrate is continuously wet and there is distinct hummock-and-hollow microtopography.

Vegetation Description: The canopy is characterized by *Acer rubrum* (red maple) and *Fraxinus pennsylvanica* (green ash), with *Ulmus rubra* (slippery elm), *Ulmus americana* (American elm), *Fraxinus nigra* (black ash), and *Carpinus caroliniana* (American hornbeam) being frequent associates and with *Chamaecyparis thyoides* (Atlantic white-cedar), *Thuja occidentalis* (northern white-cedar), or *Quercus bicolor* (swamp white oak) occurring locally in some occurrences. The shrub layer is characterized by *Ilex verticillata* (common winterberry), *Alnus serrulata* (smooth alder), *Alnus incana* (speckled alder), *Clethra alnifolia* (coastal sweet-pepperbush), *Rhododendron viscosum* (swamp azalea), *Vaccinium corymbosum* (highbush blueberry), *Lindera benzoin* (northern spicebush), *Cornus racemosa* (gray dogwood), *Cornus amomum* (silky dogwood), *Cornus sericea* (red-osier dogwood), *Cephalanthus occidentalis* (common buttonbush), and others. The herbaceous layer is a very diverse mixture of freshwater tidal marsh species and palustrine species and is characterized by *Peltandra virginica* (green arrow-arum), *Pontederia cordata* (pickerelweed), *Impatiens capensis* (orange jewelweed), *Leersia oryzoides* (rice cutgrass), *Onoclea sensibilis* (sensitive fern), *Pilea pumila* (Canadian clearweed), *Polygonum punctatum* (dotted smartweed), *Polygonum hydropiper* (marsh-pepper knotweed), *Polygonum hydropiperoides* (swamp smartweed), *Polygonum sagittatum* (arrowleaf tearthumb), *Zizania aquatica* (Indian wild rice), *Asclepias incarnata* (swamp milkweed), and *Arisaema triphyllum* (Jack-in-the-pulpit), among many others.

Characteristic Species: *Acer rubrum* (red maple), *Fraxinus pennsylvanica* (green ash)

Dynamics/Successional Trajectory: This swamp receives diurnal flooding with fresh tidal waters and occurs at the upper limit of tidal flooding. The tidal swamp forest transitions to tidal shrubland or to freshwater tidal marsh associations.

Reference Sites: Trenton Marsh, Mercer County, NJ; there is possibly a site on Slaughter Creek in DE

Global and State Conservation Ranks and Reasons: G2 (3-Dec-1998). DE?: SNA, NJ: S1S2. This freshwater tidal swamp community is restricted to the freshwater tidal portions of rivers in Massachusetts, New York, and New Jersey. Size range of individual occurrences is a few acres to 100 acres in the larger examples. The average size is likely to be 5-20 acres.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.683445

References: Breden 1988, Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Edinger et al. 2002, Metzler and Barrett 2001, Rawinski 1984, Reschke 1990, Swain and Kearsley 2001

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)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Ilex verticillata</i> (common winterberry)
Herb (field)	Forb	<i>Peltandra virginica</i> (green arrow-arum)

NORTH ATLANTIC FRESH TIDAL SHRUB SWAMP

Alnus (incana ssp. rugosa, serrulata) - Cornus amomum Shrubland

Range: This association is found in coastal areas with tidally influenced river systems from Maine to Delaware in the North Atlantic. It occurs in Delaware and New Jersey in the Delaware Estuary.

Environmental Description: This association occurs in freshwater tidal systems in fresh to brackish reaches of tidal rivers along the marsh-upland transition. This shrubland is best developed along major tidal river systems that have a gradual elevation gradient. The substrate is alluvial and fine silty loam,

loamy sand, or fine- or medium-grained sand without significant peat deposits. There is distinct hummock-and-hollow micro-relief.

Vegetation Description: This shrubland is dominated by *Alnus serrulata* (smooth alder) and/or *Alnus incana* ssp. *rugosa* (speckled alder). In some examples one or both of these may be characteristically dominant or nearly so. Other examples may be more semi-open with a mixed canopy of *Alnus* (alder) with other shrubs such as *Cornus amomum* (silky dogwood), *Rosa palustris* (swamp rose), *Ilex verticillata* (common winterberry), *Viburnum dentatum* (southern arrow-wood), *Clethra alnifolia* (coastal sweet-pepperbush), and *Lindera benzoin* (northern spicebush). Other woody plants which may be present include *Sambucus canadensis* (American elder), *Salix* (willow) spp., *Amorpha fruticosa* (tall indigobush), *Cephalanthus occidentalis* (common buttonbush), *Decodon verticillatus* (swamp-loosestrife), *Toxicodendron vernix* (poison-sumac), and *Toxicodendron radicans* (eastern poison-ivy). More northern examples may contain *Viburnum recognitum* (northern arrow-wood) and *Spiraea alba* var. *latifolia* (broadleaf meadowsweet). *Carex stricta* (tussock sedge) may also be present, and there is a great deal of micro-relief (tussocks and furrows) leading to high species diversity. Some herbaceous associates are *Osmunda regalis* var. *spectabilis* (royal fern), *Thelypteris palustris* var. *pubescens* (eastern marsh fern), *Galium* (bedstraw) spp., *Onoclea sensibilis* (sensitive fern), *Pilea fontana* (lesser clearweed), *Polygonum punctatum* (dotted smartweed), *Apios americana* (groundnut), *Typha latifolia* (broadleaf cattail), *Peltandra virginica* (green arrow-arum), *Pontederia cordata* (pickerelweed), *Mikania scandens* (climbing hempvine), *Symphotrichum novi-belgii* (new belgium American-aster), *Boehmeria cylindrica* (small-spike false nettle), *Impatiens capensis* (orange jewelweed), *Triadenum walteri* (greater marsh-St. John's-wort), *Asclepias incarnata* (swamp milkweed), *Carex atlantica* (prickly bog sedge), *Platanthera clavellata* (small green wood orchid), and *Xyris torta* (slender yellow-eyed-grass).

Characteristic Species: *Alnus incana* ssp. *rugosa* (speckled alder), *Alnus serrulata* (smooth alder)

Dynamics/Successional Trajectory: This shrubland community generally occurs between mean high tide level and mean high water level of annual river flooding in the spring, and it is generally flooded irregularly by spring tides.

Reference Sites: Lewden-Greene Park, New Castle County, DE; Trenton Marsh, Mercer County, NJ; north of Old Ferry Landing, Gloucester City, NJ; Edgewater Park Coves, NJ; Maurice River, south of Millville, NJ

Global and State Conservation Ranks and Reasons: GNR (15-Aug-1997). DE: SNR, NJ: SNR, PA: SNR.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.684398

References: Bowman 2000, Breden 1989, Breden et al. 2001, Clancy 1996, Collins and Anderson 1994, Coulling pers. comm., Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Fleming pers. comm., Gawler 2001, Gawler 2002, Harrison and Stango 2003, Hart 1990, McCoy and Fleming 2000, Metzler and Barrett 2001, Metzler and Barrett 2004, Rawinski 1984, Reschke 1990, Sneddon et al. 1996, Sperduto 2000b, Swain and Kearsley 2000, Swain and Kearsley 2001, Tiner 1995

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Alnus incana</i> ssp. <i>rugosa</i> (speckled alder)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Alnus serrulata</i> (smooth alder)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Cornus amomum</i> (silky dogwood)

ECOLOGICAL SYSTEM: SOUTHERN AND CENTRAL APPALACHIAN COVE FOREST

Summary: This system consists of mesophytic hardwood forests of sheltered topographic positions in the Southern Blue Ridge and central Appalachian Mountains. Examples are generally found on concave slopes that promote moist conditions. The system includes a mosaic of acidic and "rich" coves that may be distinguished by individual plant communities based on perceived differences in soil fertility and species richness (rich examples have higher diversity and density in the herbaceous layer). Both acidic and rich coves may occur in the same site, with the acidic coves potentially creeping out of the draw-up to at least midslope on well-protected north-facing slopes. Characteristic species in the canopy include *Aesculus flava* (yellow buckeye), *Acer saccharum* (sugar maple), *Fraxinus americana* (white ash), *Tilia americana* (American basswood), *Liriodendron tulipifera* (tuliptree), *Halesia tetraptera* (mountain silverbell), *Tsuga canadensis* (eastern hemlock), *Fagus grandifolia* (American beech), and *Magnolia fraseri* (fraser magnolia).

High-ranked Species: *Aconitum reclinatum* (G3, white monkshood), *Actaea rubifolia* (G3, Appalachian bugbane), *Aneides aeneus* (G3G4, green salamander), *Arabis patens* (G3, spreading rockcress), *Brachythecium rotaeanum* (G3G4, rota's feather moss), *Bryoerythrophyllum ferruginascens* (G3G4), *Calystegia catesbeiana* ssp. *sericata* (G3T2T3Q, Blue Ridge bindweed), *Canis rufus* (G1Q, red wolf), *Cardamine clematitidis* (G3, small mountain bittercress), *Cardamine flagellifera* (G3, Blue Ridge bittercress), *Carex manhartii* (G3G4, manhart's sedge), *Carex radfordii* (G2, radford's sedge), *Carex roanensis* (G2, roan mountain sedge), *Catocala marmorata* (G3G4, marbled underwing), *Clematis addisonii* (G2, addison's leatherflower), *Collinsonia verticillata* (G3, stoneroot), *Delphinium alabamicum* (G2, alabama larkspur), *Desmognathus aeneus* (G3G4, seepage salamander), *Desmognathus imitator* pop. 1 (G3G4T1Q, waterrock knob salamander), *Desmognathus santeetlah* (G3G4Q, santeetlah dusky salamander), *Desmognathus wrightii* (G3G4, pygmy salamander), *Diervilla rivularis* (G3, mountain bush-honeysuckle), *Drepanolejeunea appalachiana* (G2?), *Entodon sullivantii* (G3G4, sullivant's entodon), *Euphorbia purpurea* (G3, glade spurge), *Hygrohypnum closteri* (G3, closter's brook-hypnum), *Juglans cinerea* (G3G4, butternut), *Lejeunea blomquistii* (G1G2, blomquist leafy liverwort), *Lophocolea appalachiana* (G1G2Q), *Marsupella emarginata* var. *latiloba* (G5T1T2), *Megaceros aenigmaticus* (G2G3), *Metzgeria fruticulosa* (G2Q), *Metzgeria uncigera* (G3), *Microtus chrotorrhinus carolinensis* (G4T3, southern rock vole), *Nesticus sheari* (G2?, a cave spider), *Neviusia alabamensis* (G2, alabama snow-wreath), *Panax quinquefolius* (G3G4, American ginseng), *Plagiochila austinii* (G3), *Plagiochila caduciloba* (G2, gorge leafy liverwort), *Plagiochila sharpii* (G2G4, sharps leafy liverwort), *Plagiochila virginica* var. *virginica* (G3T3), *Plagiomnium carolinianum* (G3, mountain wavy-leaf moss), *Platyhypnidium pringlei* (G2G3), *Plethodon aureolus* (G2G3, tellico salamander), *Plethodon hubrichti* (G2, peaks of otter salamander), *Plethodon punctatus* (G3, white-spotted salamander), *Plethodon teyahalee* (G3, southern Appalachian salamander), *Plethodon welleri* (G3, weller's salamander), *Polymnia laevigata* (G3, green leafcup), *Prosartes maculata* (G3G4, yellow mandarin), *Riccardia jugata* (G2), *Schisandra glabra* (G3, magnolia-vine), *Scutellaria alabamensis* (G2, alabama skullcap), *Scutellaria pseudoserrata* (G3, annie's skullcap), *Scutellaria saxatilis* (G3, rock skullcap), *Silene ovata* (G3, Blue Ridge catchfly), *Sorex palustris punctulatus* (G5T3, southern water shrew), *Speyeria diana* (G3G4, diana fritillary), *Thaspium pinnatifidum* (G2G3, cutleaf meadow-parsnip), *Trechus luculentus luculentus* (GHTH, a carabid beetle), *Trillium discolor* (G2, mottled wakerobin), *Trillium lancifolium* (G3, lanceleaf wakerobin), *Trillium rugelii* (G3, ill-scented wakerobin), *Trillium simile* (G3, jeweled wakerobin), *Triphora trianthophora* (G3G4, threebirds), *Viola appalachiensis* (G3, Appalachian blue violet), *Viola tripartita* var. *tripartita* (G5T3?, three-parted violet), *Virginia valeriae pulchra* (G5T3T4, mountain earth snake)

Range: This system occurs in the southern and central Appalachian Mountains, ranging into the Cumberland Mountains of Kentucky and Tennessee. This range is more-or-less consistent with the "Oak-Chestnut" forest region of Braun (1950) and Greller (1988), versus the "Mixed Mesophytic" and

"Western Mesophytic" forest regions to the west. Distribution in Ecoregion 61 needs review. United States: GA, KY, MD, NC, PA, SC, TN, VA, WV

Delaware Estuary Associations:

- Calcareous Slope Forest
- Central Appalachian Rich Cove Forest

CLASSIFIERS FOR SOUTHERN AND CENTRAL APPALACHIAN COVE FOREST

Primary Division: 202

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); Broad-Leaved Tree

CALCAREOUS SLOPE FOREST

Acer saccharum - *Fraxinus americana* - *Juglans cinerea* / *Staphylea trifolia* Forest

Range: This community is reported to occur in the northern and central Appalachian regions, from Vermont and New Hampshire south to Virginia and West Virginia. It occurs in the Pennsylvania portion of the Delaware Estuary.



Photo by Pennsylvania Natural Heritage Program

Environmental Description: Sites include talus slopes or shallow rocky soils weathered from calcareous or circumneutral bedrock. Habitats are situated on lower to middle slopes subtending streams in low-elevation montane valleys and gorges. Slopes are steep, usually with north to east aspects. Bedrock outcrops are frequent. Exposed rock (boulder and outcrop) cover can be up to 50%, which reduces both species richness and herbaceous cover. However, due to the relatively rapid weathering of carbonate materials and extremely fertile soils, these habitats are typically well vegetated with herbaceous plants. High cover of mosses provides a foothold for many species, while organic mats and soil pockets are also numerous.

However, due to the relatively rapid weathering of carbonate materials and extremely fertile soils, these habitats are typically well vegetated with herbaceous plants. High cover of mosses provides a foothold for many species, while organic mats and soil pockets are also numerous.

Vegetation Description: In the northern part of this unit's range, canopy dominants are *Acer saccharum* (sugar maple) and *Fraxinus americana* (white ash), with typical associates of *Juglans cinerea* (butternut), *Quercus rubra* (northern red oak), *Tilia americana* (American basswood), *Carya cordiformis* (bitternut hickory), and *Quercus muehlenbergii* (chinquapin oak). *Betula alleghaniensis* (yellow birch), *Fagus grandifolia* (American beech), and *Ulmus* (elm) spp. may also occur locally. *Ostrya virginiana* (eastern hop-hornbeam) and *Carpinus caroliniana* (American hornbeam) are typical small trees. The shrub layer is open and characterized by *Staphylea trifolia* (American bladdernut), *Corylus* (hazelnut) spp., *Hamamelis virginiana* (American witch-hazel), *Rubus odoratus* (purple-flowering raspberry), *Parthenocissus quinquefolia* (Virginia creeper), *Toxicodendron radicans* (eastern poison-ivy), and *Vitis* (grape) spp. Typical species of the fairly diverse herb layer include *Actaea pachypoda* (white baneberry), *Allium tricoccum* (ramps), *Aralia nudicaulis* (wild sarsaparilla), *Aralia racemosa* (American spikenard), *Asplenium platyneuron* (ebony spleenwort), *Asarum canadense* (Canadian wild ginger), *Eurybia divaricata* (white wood-aster), *Circaea lutetiana* ssp. *canadensis* (broadleaf enchanter's-nightshade), *Cystopteris fragilis* (fragile fern), *Cystopteris bulbifera* (bulblet bladderfern), *Dryopteris* (woodfern) spp., *Polystichum acrostichoides* (Christmas fern), *Sanguinaria canadensis* (bloodroot), *Solidago flexicaulis* (zigzag goldenrod), *Trillium erectum* (stinking benjamin), *Woodsia obtusa* (common cliff fern), and others.

Characteristic graminoids include *Carex laxiflora* (loose-flower sedge), *Carex sprengelii* (longbeak sedge), *Carex virescens* (ribbed sedge), *Elymus hystrix* (bottlebrush grass), and *Piptatherum racemosum* (black-seed mountain ricegrass).

Characteristic Species: *Acer saccharum* (sugar maple), *Carex laxiflora* (loose-flower sedge), *Fraxinus americana* (white ash), *Juglans cinerea* (butternut), *Staphylea trifolia* (American bladdernut)

Dynamics/Successional Trajectory: Exposed rock (boulder and outcrop) cover can be up to 50%, which reduces both species richness and herbaceous cover. However, due to the relatively rapid weathering of carbonate materials and extremely fertile soils, these habitats are typically well vegetated with herbaceous plants. High cover of mosses provides a foothold for many species, while organic mats and soil pockets are also numerous.

Management Concerns: This community type has a wide geographic range and occupies rugged habitats that are not prone to many anthropogenic disturbances. Invasive exotic weeds do not appear to be particularly troublesome, but windthrow, slumping or landsliding of unstable colluvium, and other erosional disturbances appear to be relatively frequent in the habitats of this type.

Reference Sites: none identified

Global and State Conservation Ranks and Reasons: G4? (1-Oct-2001). NJ: S2, PA: S2?. This community occurs mostly in small, local patches. There are likely >50 occurrences in Virginia, and many in West Virginia (D. Walton pers. comm.).

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.688340

References: Breden 1989, Breden et al. 2001, CAP pers. comm. 1998, Eastern Ecology Working Group n.d., Eyre 1980, Fike 1999, Fleming 1999, Fleming and Coulling 2001, Fleming et al. 2001, Harrison 2004, Lundgren 2000, Metzler and Barrett 1996, Metzler and Barrett 2001, Rawinski 1984, Swain and Kearsley 2001, Thompson 1996, Thompson and Sorenson 2000, VDNH 2003, Walton pers. comm.

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Acer saccharum</i> (sugar maple)
Tree canopy	Broad-leaved deciduous tree	<i>Fraxinus americana</i> (white ash)
Tree canopy	Broad-leaved deciduous tree	<i>Juglans cinerea</i> (butternut)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Ostrya virginiana</i> (eastern hop-hornbeam)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Staphylea trifolia</i> (American bladdernut)
Herb (field)	Fern or fern ally	<i>Polystichum acrostichoides</i> (Christmas fern)

CENTRAL APPALACHIAN RICH COVE FOREST

Acer saccharum - *Fraxinus americana* - *Tilia americana* - *Liriodendron tulipifera* / *Actaea racemosa*
Forest

Range: This forest is found in the High Alleghenies, Western Allegheny Plateau, Central Appalachians, and Cumberlands from New York and New Jersey south to West Virginia, Virginia, and eastern Kentucky. This community occurs in Pennsylvania in the Delaware Estuary.

Environmental Description: This community type occupies cool (northwest- to east-facing), mesic, lower to middle slopes, ravines, and coves at elevations from 425 to about 1050 m (1400-3450 feet). Sites may be underlain by a number of bedrock types, including limestone, dolomite,

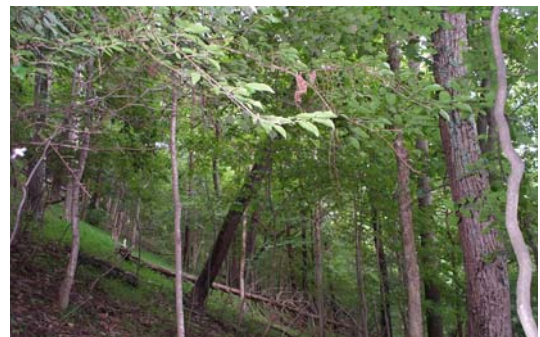


Photo by Pennsylvania Natural Heritage Program

metabasalt (greenstone), granitic rocks, and sandstone. Slopes are typically steep (mean in plots = 23 degrees) and concave in at least one direction. Soils are deep, dark, and fertile, although frequently stony or bouldery. Samples collected from plots range from very strongly acidic to circumneutral (pH range = 4.2-6.8, mean pH = 5.3) but consistently have high calcium levels (mean = 1978 ppm) and moderately high magnesium and manganese levels.

Vegetation Description: The canopy is dominated by *Acer saccharum* (sugar maple) with *Fraxinus americana* (white ash) and *Tilia americana* (American basswood) being very characteristic. Associated canopy trees include *Quercus rubra* (northern red oak), *Ostrya virginiana* (eastern hop-hornbeam), *Ulmus rubra* (slippery elm), *Acer rubrum* (red maple), *Betula alleghaniensis* (yellow birch), *Betula lenta* (sweet birch), *Fagus grandifolia* (American beech), *Juglans nigra* (black walnut), *Liriodendron tulipifera* (tuliptree), *Magnolia acuminata* (cucumber-tree), *Carya cordiformis* (bitternut hickory), and *Prunus serotina* (black cherry). The shrub layer is of variable composition, characterized by *Cornus alternifolia* (alternate-leaf dogwood), *Hamamelis virginiana* (American witch-hazel), *Lindera benzoin* (northern spicebush), *Asimina triloba* (common pawpaw), *Lonicera canadensis* (fly honeysuckle), *Rhododendron periclymenoides* (pink azalea), and *Viburnum acerifolium* (mapleleaf viburnum). The herb layer is diverse and made up of *Adiantum pedatum* (northern maidenhair), *Asarum canadense* (Canadian wild ginger), *Actaea racemosa* (black cohosh), *Cardamine* (bittercress, toothwort) spp., *Hepatica nobilis var. obtusa* (round-lobe liverleaf), *Hydrophyllum virginianum* (Shawnee salad), *Elymus hystrix* (bottlebrush grass), *Osmorhiza* (sweet-cicely) spp., *Trillium grandiflorum* (white trillium), *Viola* (violet) spp., *Dryopteris marginalis* (marginal woodfern), *Botrychium virginianum* (rattlesnake fern), *Anemone quinquefolia* (nightcaps), *Geranium maculatum* (spotted geranium), *Caulophyllum thalictroides* (blue cohosh), *Sanguinaria canadensis* (bloodroot), *Claytonia virginica* (Virginia springbeauty), *Allium tricoccum* (ramps), *Cardamine concatenata* (cutleaf toothwort), *Arisaema triphyllum* (Jack-in-the-pulpit), and *Laportea canadensis* (Canadian wood-nettle).

Noteworthy Associated Plant and/or Animal Species: *Aconitum reclinatum* (white monkshood)

Characteristic Species: *Actaea racemosa* (black cohosh), *Cornus alternifolia* (alternate-leaf dogwood), *Fraxinus americana* (white ash), *Tilia americana* (American basswood)

Management Concerns: Because of excellent site conditions for tree growth, stands are very vulnerable to logging and are further threatened by shade-tolerant exotic weeds.

Reference Sites: None referenced.

Global and State Conservation Ranks and Reasons: G4? (28-Sep-2001). NJ: SNR, PA: SNR. This unit has a fairly wide geographic range, within which it is regularly distributed as a small- to large-patch vegetation type in suitably fertile habitats.

VegBank Link for Plot Data: http://vegbank.org/natureserve/element_global.2.687966

References: Anderson et al. 1998, Breden et al. 2001, CAP pers. comm. 1998, Campbell 2001, Coulling and Rawinski 1999, Damman and Kershner 1977, Eastern Ecology Working Group n.d., Edinger et al. 2002, Eyre 1980, Fike 1999, Fleming 1999, Fleming and Coulling 2001, Fleming et al. 2001, Harrison 2004, Lundgren 2000, Martin 1975, Rawinski et al. 1996

MOST ABUNDANT SPECIES		
STRATUM	LIFEFORM	SPECIES
Tree canopy	Broad-leaved deciduous tree	<i>Acer saccharum</i> (sugar maple)
Tree canopy	Broad-leaved deciduous tree	<i>Fraxinus americana</i> (white ash)
Tree canopy	Broad-leaved deciduous tree	<i>Tilia americana</i> (American basswood)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Hamamelis virginiana</i> (American witch-hazel)
Herb (field)	Fern or fern ally	<i>Adiantum pedatum</i> (northern maidenhair)

BIBLIOGRAPHY

- Adams, Bill. Personal communication. U.S. Army Corps of Engineers.
<William.F.Adams@saw02.usace.army.mil>
- Adams, D. A. 1963. Factors influencing vascular plant zonation in North Carolina salt marshes. *Ecology* 44:445-456.
- Adamus, P. R. 1978. The natural regions of Maine. Prep. for Maine Critical Areas Program. Miscellaneous Publication #6. Center for Natural Areas, South Gardiner, ME. 125 pp.
- 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.
- Allard, H. A., and E. C. Leonard. 1943. The vegetation and floristics of Bull Run Mountain, Virginia. *Castanea* 8:1-64.
- Ambrose, J. 1990a. Georgia's natural communities--A preliminary list. Unpublished document. Georgia Natural Heritage Inventory. 5 pp.
- Anderson, D. M. 1982. Plant communities of Ohio: A preliminary classification and description. Division of Natural Areas and Preserves, Ohio Department of Natural Resources, Columbus, OH. 182 pp.
- Anderson, D. M. 1996. The vegetation of Ohio: Two centuries of change. Draft. Ohio Biological Survey.
- Anderson, M., F. Biasi, and S. Buttrick. 1998. Conservation site selection: Ecoregional planning for biodiversity. The Nature Conservancy, Eastern Regional Office, Boston, MA. 18 pp.
- Anderson, M., P. Comer, D. Grossman, C. Groves, K. Poiani, M. Reid, R. Schneifer, B. Vickery, and A. Weakley. 1999. Guidelines for Representing Ecological Communities in Ecoregional Plans. The Nature Conservancy. 74 pp.
- Anderson, R. D., and J. E. Schwegman. 1991. Twenty years of vegetational change on a Southern Illinois Barren. *Natural Areas Journal* 11(2):100-107.
- 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.
- Apfelbaum, S. I., and C. E. Sams. 1987. Ecology and control of reed canary grass (*Phalaris arundinacea* L.). *Natural Areas Journal* 7(2):69-74.
- Art, H. W. 1976. Ecological studies of the Sunken Forest, Fire Island National Seashore, New York. National Park Service Scientific Monograph Series No. 7, Publication No. NPS 123. 237 p.
- Art, H. W. 1987. Patterns of community dynamics in the Sunken Forest: 1967 to 1985 and 1985 to 1986. National Park Service, North Atlantic Regional Office. 66 pp.
- Art, H. W. 1992. The impacts of Hurricane Gloria on deer and trails, the Sunken Forest, Fire Island National Seashore, Fire Island, NY. National Park Service, North Atlantic region, Boston, MA 168 pp.
- Baalman, R. J. 1965. Vegetation of the Salt Plains National Wildlife Refuge, Jet, Oklahoma. Unpublished Ph.D. dissertation, University of Oklahoma, Norman.
- 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. 1998. Ecoregion map of North America: Explanatory note. Miscellaneous Publication Number 1548, USDA Forest Service. 10 pp.

- Bakowsky, W. D., and H. T. Lee. 1996. Vegetation communities of southern Ontario (draft). Ontario Natural Heritage Information Centre and Southern Region STTU, Ontario Ministry of Natural Resources, Peterborough, Ontario. 87 pp.
- Baldwin, H. I. 1977. The induced timberline of Mount Monadnock, NH. *Bulletin of the Torrey Botanical Club* 104:324-333.
- Barden, L. S. 1977. Self-maintaining populations of *Pinus pungens* Lam. in the southern Appalachian Mountains. *Castanea* 42:316-323.
- Barnes, W. J. 1999. The rapid growth of a population of reed canarygrass (*Phalaris arundinacea* L.) and its impact on some riverbottom herbs. *Journal of the Torrey Botanical Society* 126:133-138.
- Barrett, N. E. 1989. Vegetation of the tidal wetlands of the lower Connecticut River: Ecological relationships of plant community-types with respect to flooding and habitat. M.S. thesis, University of Connecticut, Storrs. 209 pp.
- Barrett, N. E. 1994. Vegetation patch dynamics in freshwater tidal wetlands. Ph.D. dissertation, University of Connecticut. 277 pp.
- Barrett, N. E. 1996. *Chamaecyparis thyoides* wetlands: An overview of the community-types. Submitted to the Connecticut Natural Diversity Database, Connecticut Department of Environmental Protection. The Nature Conservancy, Middletown, CT.
- Barrett, N., and R. Enser. 1997. Alluvial plant communities within the Wood-Pawcatuck Major Basin, Rhode Island, May 12, 1997. The Nature Conservancy, Connecticut Field office, Middletown, CT, and The Rhode Island Natural Heritage Program, Department of Environmental Management, Providence, RI.
- 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.
- Baumann, C. 1978b. The effects of overwash on the vegetation of a Virginia barrier island. M.A. thesis. College of William and Mary, Williamsburg, VA. 104 pp.
- Bellis, V. J. 1992. Floristic continuity among the maritime forests of the Atlantic Coast of the United States. Pages 21-29 in: C. A. Cole and F. K. Turner, editors. Barrier island ecology of the mid-Atlantic Coast: A symposium. Technical Report NPS/SERCAHA/NRTR-93/04.
- Bennett, K. A., K. E. Clancy, C. M. Heckscher, W. A. McAvoy, E. F. Zuelke, and L. E. Broaddus. 1998. A Natural Heritage Survey of Cape Henlopen State Park, Sussex County, Delaware. Delaware Natural Heritage Program, Division of Fish and Wildlife, Department of Natural Resources and Environmental Control, Smyrna, DE. 136 pp.
- Berdine, M. A. 1998. Maryland vegetation classification. Maryland Department of Natural Resources, Annapolis, MD.
- Berdine, M. A., and A. M. A. Gould. 1999. Identification and protection of reference wetland natural communities in Maryland: Delmarva Bay Wetlands. The Biodiversity Program, Maryland Department of Natural Resources, Wildlife and Heritage Division. 87 pp.
- Bernard, J. M. 1963. Lowland forests of Cape May formation in southern New Jersey. *Bulletin of the New Jersey Academy of Science* 8:1-12.
- Bernard, J. M., and F. A. Bernard. 1971. Mature upland forests of Cape May County, New Jersey. *Bulletin of the Torrey Botanical Club* 98:167-171.
- Bertness, M. D. 1988. Peat accumulation and the success of marsh plants. *Ecology* 69:703-713.

- Bertness, M. D., L. Gough, and S. W. Shumway. 1992. Salt tolerances and the distribution of fugitive salt marsh plants. *Ecology* 73(5):1842-1851.
- Black, R. A., and R. N. Mack. 1976. *Tsuga canadensis* in Ohio: Synecological and phytogeographical relationships. *Vegetatio* 32(1):11-19.
- Blair, W. F. 1938. Ecological relationships of the mammals of the Bird Creek region, northeastern Oklahoma. *The American Midland Naturalist* 20:473-526.
- Borowitz, V. A., and A. G. Stephenson. 1985. Fruit composition and patterns of fruit dispersal of two *Cornus* spp. *Oecologia* 67:435-441.
- 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.
- Braun, E. L. 1950. Deciduous forests of eastern North America. Hafner Press, New York. 596 pp.
- Breden, T. F. 1988. A tidal swamp forest in New Jersey. *Bartonia* 54:146.
- 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.
- Brown, J. H. Jr., C. A. Castaneda, and R. J. Hindle. 1982a. Floristic relationships and dynamics of hemlock (*Tsuga canadensis*) communities in Rhode Island. *Bulletin of the Torrey Botanical Club* 109:385-391.
- Brumback, W. E., and L. J. Mehrhoff. 1996. Flora Conservanda: New England. The New England Plant Conservation Program (NEPCoP) list of plants in need of conservation. In collaboration with R. W. Enser, S. C. Gawler, R. G. Popp, P. Somers, and D. D. Sperduto, with assistance from W. D. Countryman and C. B. Hellquist.
- 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.
- Buckholz, K., and R. E. Good. 1982. Compendium of New Jersey Pine Barrens literature. Division of Pinelands Research, Center for Coastal and Environmental Studies. Rutgers, The State University, New Brunswick, NJ.
- Buhlmann, K. A., J. C. Mitchell, and L. R. Smith. 1999. Descriptive ecology of the Shenandoah Valley sinkhole pond system in Virginia. *Banisteria* 13:23-51.
- Burk, C. J. 1968. A floristic comparison of lower Cape Cod, Massachusetts and the North Carolina Outer Banks. *Rhodora* 70:215-227.
- Burns, R. M., and B. H. Honkala, technical coordinators. 1990a. *Silvics of North America: Volume 1. Conifers*. USDA Forest Service. Agriculture Handbook 654. Washington, DC. 675 pp.
- Burns, R. M., and B. H. Honkala, technical coordinators. 1990b. *Silvics of North America. Volume 2: Hardwoods*. Agriculture Handbook 654. USDA Forest Service, Washington, DC. 877 pp.
- CAP [Central Appalachian Forest Working Group]. 1998. *Central Appalachian Working group discussions*. The Nature Conservancy, Boston, MA.

- Cahoon, D. R., and J. C. Stevenson. 1986. Production, predation, and decomposition in a low-salinity Hibiscus marsh. *Ecology* 67:1341-1350.
- Cain, S. A. 1936. The composition and structure of an oak woods, Cold Spring Harbor, Long Island, with special attention to sampling methods. *The American Midland Naturalist* 17:725-740.
- Cain, S. A., and W. T. Penfound. 1938. *Aceretum rubri*: The red maple swamp forest of central Long Island. *The American Midland Naturalist* 19:390-416.
- Caldwell, F. A. 1990. A floristic and vegetation analysis of a freshwater-tidal marsh on the Merrimack River, West Newbury, Massachusetts. Master's thesis, University of New Hampshire. 96 pp.
- Calhoun, A. J. K., J. E. Cormier, R. B. Owen, Jr., A. F. O'Connell, Jr., C. T. Roman, and R. W. Tiner, Jr. 1994. The wetlands of Acadia National Park and vicinity. Maine Agricultural and Forest Experiment Station Miscellaneous Publication 721. 108 pp.
- Campbell, C. S., and L. M. Eastman. 1978. Contributions to the vascular flora of Oxford County, Maine. *Rhodora* 80:309-315.
- Campbell, J. 2001. Native vegetation types of Appalachian Kentucky. Unpublished report. The Nature Conservancy, Lexington, KY. 210 pp.
- Campbell, J. J. N., A. C. Risk, V. A. Andrews, B. Palmer-Ball, and J. R. MacGregor. 1990. Cooperative inventory of endangered, threatened, sensitive, and rare species, Daniel Boone National Forest, Stearns Ranger District. USDA Forest Service. 170 pp.
- Campbell, Julian J. N. Personal communication. Kentucky Field Office, The Nature Conservancy.
- 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.
- Chapman, V. J. 1937. A note on the salt marshes of Nova Scotia. *Rhodora* 39:53-57.
- Chrysler, M. A. 1930. The origin and development of the vegetation of Sandy Hook. *Bulletin of the Torrey Botanical Club* 57:163-176.
- 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. R., and J. Benforado. 1981. Introduction. Pages 1-9 in: J. R. Clark and J. Benforado, editors. *Wetlands of bottomland hardwood forests*. Elsevier Scientific Publications, New York.
- 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.
- Clovis, J. F. 1968. The vegetation of Smith Island, Virginia. *Castanea* 33:115-121.
- Collins, B. R., and K. H. Anderson. 1994. *Plant communities of New Jersey*. Rutgers University Press, New Brunswick, NJ. 287 pp.
- Comer, P. J., and D. A. Albert. 1997. Natural community crosswalk. Unpublished draft of February 20, 1997. Michigan Natural Features Inventory, Lansing, MI.

- 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.
- Comer, P., K. Goodin, G. Hammerson, S. Menard, M. Pyne, M. Reid, M. Robles, M. Russo, L. Sneddon, K. Snow, A. Tomaino, M. Tuffly. 2005. Biodiversity Values of Geographically Isolated Wetlands: An Analysis of 20 U.S. States. NatureServe, Arlington, VA.
- Conard, H. S. 1935. The plant associations of central Long Island. *The American Midland Naturalist* 16:433-516.
- Cooper, A. S. 1974. Salt marshes. In: H. T. Odum and B. J. Copeland, editors. *Coastal Ecological Systems of the United States. II. The Conservation Foundation, Washington, DC.*
- Cooper, A. W. 1963. A survey of the vegetation of the Toxaway River Gorge with some remarks about early botanical explorations and an annotated list of the vascular plants of the gorge area. *Journal of the Elisha Mitchell Scientific Society* 79:1-22.
- Cooper, A. W., and E. D. Waits. 1973. Vegetation types in an irregularly flooded salt marsh on the North Carolina Outer Banks. *Journal of the Elisha Mitchell Scientific Society* 89:78-91.
- Core, E. L. 1966. *Vegetation of West Virginia*. McClain Printing, Parsons, WV. 217 pp.
- 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., and T. J. Rawinski. 1999. Classification of vegetation and ecological land units of the Piney River and Mt. Pleasant area, Pedlar Ranger District, George Washington and Jefferson National Forests, Virginia. Natural Heritage Technical Report 99-03, 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. 2005. Prime Hook National Wildlife Refuge. Vegetation inventory. Unpublished report. Delaware Natural Heritage Program, Division of Fish and Wildlife, Smyrna.
- Curtis, J. T. 1959. *The vegetation of Wisconsin: An ordination of plant communities*. University of Wisconsin Press, Madison. 657 pp. [reprinted in 1987]
- DNHP [Delaware Natural Heritage Program]. 1998. A Natural Heritage survey of Cape Henlopen State Park, Sussex County, Delaware. Delaware Natural Heritage Program, Division of Fish and Wildlife, Department of Natural Resources and Environmental Control, Smyrna, DE. 136 p.
- 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.
- Damman, A. W. H. 1977. Geographical changes in the vegetation patterns of raised bogs in the Bay of Fundy region of Maine and New Brunswick. *Vegetatio* 35:137-151.
- Damman, A. W. H., and B. Kershner. 1977. Floristic composition and topographical distribution of the forest communities of the gneiss areas of western Connecticut. *Naturaliste Canadien* 104:23-45.

- Damman, A. W. H., and T. W. French. 1987. The ecology of peat bogs of the glaciated northeastern United States: A community profile. USDI Fish & Wildlife Service Biological Report 85(7.16). 100 pp.
- Davis, A. F., et al. 1992. A natural areas inventory of Delaware County, Pennsylvania. Pennsylvania Science Office of The Nature Conservancy. Middletown, PA. 110 pp.
- Dickson, J. G., and C. A. Segelquist. 1978. Winter bird populations in pine and pine-hardwood forest stands in east Texas. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 31:134-137.
- Dowhan, J. J., and R. Rozsa. 1989. Flora of Fire Island, Suffolk County, New York. Bulletin of the Torrey Botanical Club 116:265-282.
- Dunlop, D. A., and G. E. Crow. 1985. The vegetation and flora of the Seabrook Dunes with special reference to rare plants. Rhodora 87:471-486.
- EPA [Environmental Protection Agency]. 2004. Level III and IV Ecoregions of EPA Region 4. U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, Western Ecology Division, Corvallis, OR. Scale 1:2,000,000.
- Eastern Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe, Boston, MA.
- Ecological Society of America. 2005. VegBank. Vegetation plot database of the Ecological Society of America's Panel on Vegetation Classification. Information available at: <http://vegbank.org/vegbank/general/info.html>.
- 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.
- Egler, F. E. 1962. Ferns and flowering plants of Seashore State Park, Cape Henry, Virginia. New York State College of Forestry, Syracuse, NY. 60 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.
- Elias, T. B. 1980. The complete trees of North America, field guide and natural history. Book Division, Times Mirror Magazines, Inc. 948 pp.
- 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.
- Evans, M. 1991. Kentucky ecological communities. Draft report to the Kentucky Nature Preserves Commission. 19 pp.
- Eyre, F. H., editor. 1980. Forest cover types of the United States and Canada. Society of American Foresters, Washington, DC. 148 pp.
- FNAI [Florida Natural Areas Inventory]. 1990. Guide to the natural communities of Florida. Florida Natural Areas Inventory and Florida Department of Natural Resources, Tallahassee. 111 pp.
- FNAI [Florida Natural Areas Inventory]. 1992a. Natural communities. Unpublished document. The Nature Conservancy, Florida Natural Areas Inventory, Tallahassee. 6 pp.
- Faulkner, S. P., and W. H. Patrick, Jr. No date. Characterization of bottomland hardwood wetland transition zones in the lower Mississippi Valley. Unpublished document.

- Fender, F. S. 1937. The flora of Seven Mile Beach, New Jersey. *Bartonia* 19:23-41.
- Ferren, W. R., Jr., R. E. Good, R. Walker, and J. Arsenault. 1981. Vegetation and flora of Hog Island, a brackish wetland in the Mullica River, New Jersey. *Bartonia* 48:1-10.
- Ferren, W. R., Jr., and R. E. Good. 1977. Habitat, morphology and phenology of southern wild rice (*Zizania aquatica* L.) from the Wading River in New Jersey. *Bulletin of the Torrey Botanical Club* 104:392-399.
- 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.
- Flaccus, E. 1972. Vegetation natural areas of the hemlock - white pine - northern hardwood region of the eastern deciduous forest. USDI National Park Service. 541 pp.
- Fleming, G. P. 1985. A study of the dwarf pine forest and *Carex polymorpha* Muhl. on Panther Knob, West Virginia. Final report prepared for The Nature Conservancy, West Virginia Field Office. 149 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. 2001. 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. 2002a. Ecological communities of the Bull Run Mountains, Virginia: Baseline vegetation and floristic data for conservation planning and natural area stewardship. Natural Heritage Technical Report 02-12, Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond. Unpublished report prepared for Virginia Outdoors Foundation. 274 pp. plus appendices.
- Fleming, G. P. No date. Unpublished data. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA.
- 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, 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. 1998. Comparative wetlands ecology study of the Great Dismal Swamp, Northwest River, and North Landing River in Virginia. Natural Heritage Technical Report 98-9. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond. Unpublished report submitted to the U.S. Environmental Protection Agency. 181 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, Gary P. Personal communication. Ecologist, Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA.
- Forman, R. T. T. 1979. Pine Barrens: Ecosystems and landscape. Academy Press, New York. 601 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.
- Foti, Tom. Personal communication. Ecologist. Arkansas Natural Heritage Commission, Little Rock.
- Gaertner, F. 1955. Honeylocust (*Gleditsia triacanthos* L.) in field shelterbelts of western Oklahoma. Unpublished M.S. thesis, Oklahoma State University, Stillwater.
- Gawler, S. C. 2001. Natural landscapes of Maine: Natural community profiles. Open (non-forested) types. Final review draft, July 2001. Maine Natural Areas Program. Department of Conservation. Augusta, ME.
- 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]
- Gettman, R. W. 1974. A floristic survey of Sumter National Forest--The Andrew Pickens Division. M.S. thesis, Clemson University, Clemson, SC. 131 pp.
- Gibson, D. J., R. A. Zampella, and A. G. Windisch. 1999. New Jersey pine plains: The "true barrens" of the New Jersey Pine Barrens. Pages 52-66 in: R. C. Anderson, J. S. Fralish, and J. M. Baskin, editors. 1999. Savanna, barren, and rock outcrops plant communities of North America. Cambridge University Press, Cambridge.
- Glitzenstein, J. S., and D. R. Streng. 2004. Evaluating the NatureServe preliminary plant community classification for Francis Marion National Forest. Tall Timbers Research Station, Tallahassee, FL. Plus appendices and data.
- Godfrey, P. J., M. Benedict, and M. Soukup. 1978. A guide to the ecology of Cape Cod National Seashore (Mary 1978 draft). National Park Service Cooperative Research Unit, Institute for Man and Environment, University of Massachusetts, Amherst, MA.
- Golet, F. C. 1973. Wildlife wetland evaluations mode. In: J. S. Larson, editor. A guide to important characteristics and values of freshwater wetlands in the Northeast. Publication 31. Water Resources Research Center, University of Massachusetts, Amherst. 91 pp.
- 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.
- Good, R. E., and N. F. Good. 1975b. Vegetation and production of the Woodbury Creek and Hessian Run freshwater tidal marshes. *Bartonia* 43:38-45.
- Gordon, R. B. 1937a. The botanical survey of the Allegheny State Park. *New York State Museum Handbook* 17:23-88. State University of New York, Albany.
- Gordon, R. B. 1937b. A botanical survey of the southwestern section of the Allegheny State Park. *New York State Museum Handbook* 17:199-247. State University of New York, Albany.
- Gosner, K. L. 1979. A field guide to the Atlantic seashore: Invertebrates and seaweeds of the Atlantic coast from the Bay of Fundy to Cape Hatteras. Houghton Mifflin, Boston, MA.
- Grace, J. B., and R. G. Wetzel. 1981. Habitat partitioning and competitive displacement in cattail (*Typha*): Experimental field studies. *The American Midland Naturalist* 118:463-474.
- Greenall, J. A. 1996. Manitoba's terrestrial plant communities. Manitoba Conservation Data Centre MS Report 96-02.
- Greller, A. M. 1977. A classification of mature forests on Long Island, New York. *Bulletin of the Torrey Botanical Club* 104:376-382.
- Greller, A. M., R. E. Calhoun, and J. M. Mansky. 1978. Grace Forest: A mixed mesophytic stand on Long Island, New York. *Botanical Gazette* 139:482-489.
- Grossman, D. H., K. Lemon Goodin, and C. L. Reuss, editors. 1994. Rare plant communities of the conterminous United States: An initial survey. The Nature Conservancy, Arlington, VA. 620 pp.
- Grossman, D.H., D. Faber-Langendoen, A.S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. International Classification of Ecological Communities: Terrestrial Vegetation of the United States. Vol. I and II. The Nature Conservancy, Arlington, VA.
- Hack, J. T., and J. C. Goodlett. 1960. Geomorphology and forest ecology of a mountain region in the central Appalachians. USDI Geologic Survey. Professional Paper 347.
- Haines, A. 2001. *Eriocaulon parkeri* (Parker's Pipewort) conservation and research plan. New England Plant Conservation Program, Framingham, MA. [<http://www.newfs.org>]
- 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. 2001. Herbaceous tidal wetland communities of Maryland's eastern shore: Identification, assessment and monitoring. Report submitted to the U.S. EPA (Clean Water Act 1998 State Wetlands Protection Development Grant Program). Biodiversity Program, Maryland Department of Natural Resources, Wildlife and Heritage Division. 30 June 2001. [U.S. EPA Reference Wetland Natural communities of Maryland's Herbaceous Tidal Wetlands Grant #CD993724].
- Harrison, J. W. Personal communication. State Community Ecologist, Maryland Wildlife and Heritage Division, Department of Natural Resources, Tawes State Office Building, E-1, Annapolis, MD 21401.
- 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, 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.
- Harshberger, J. W. 1900. An ecological study of the New Jersey strand flora. *Proceedings of the Academy of Natural Science Philadelphia* 52:623-671.
- Harshberger, J. W. 1916. *The vegetation of the New Jersey Pine Barrens*. Reprinted 1970. Dover Publications, Inc., New York. 329 pp.
- Hart T. [1990]. Hudson River significant tidal habitats: A guide to the functions, values and protection of the river's natural resources. New York State Department of State, Division of Coastal Resources and waterfront revitalization Albany, NY. 184 pp.
- Harvill, A. M., Jr. 1965. The vegetation of Parramore Island, Virginia. *Castanea* 30:226-228.
- Harvill, A. M., Jr. 1967. The vegetation of Assateague Island, Virginia. *Castanea* 32:105-108.
- Heckscher, C. M., W. A. McAvoy, and K. Clancy. 1995. Biological assessment of the Milford Neck Preserve. Division of Fish and Wildlife, Department of Natural Resources and Environmental Control, Delaware Natural Heritage Program, Smyrna, DE. 29 pp.
- 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, A. F. 1923. The vegetation of the Penobscot Bay region, Maine. *Proceedings of the Portland Society of Natural History* 3:307-438.
- 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. 1997. Preliminary plant community classification for Oklahoma. Unpublished draft document, version 35629. University of Oklahoma, Oklahoma Natural Heritage Inventory, Norman. 47 pp.
- Homoya, Michael. Personal communication. Indiana Natural Heritage Data Center. Division of Nature Preserves, Department of Natural Resources, 402 West Washington Street, Room W267, Indianapolis, IN 46204. 317/232-4052. Personal communication with S. L. Neid, MRO, March/April, 1997.
- Hough, A. F. 1943. Soil factors and stand history in a virgin forest valley on the northern Allegheny Plateau. *Soil Science* 56:19-28.
- Hough, A. F., and R. D. Forbes. 1943. The ecology and silvics of forests in the high Plateaus of Pennsylvania. *Ecological Monographs* 13:300-320.
- Hunt, D. 1997a. Long Island oak forest project: Classification justification. Unpublished materials. New York Natural Heritage Program, Latham, NY.
- Hunt, D. 1997b. Classification of brackish interdunal swales. 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.
- Hunt, D. M. 1999. Natural community descriptions and specifications: Communities known or suspected from Adirondack Nature Conservancy. Unpublished report. New York Natural Heritage Program, Albany, NY. 272 pp.
- Hunt, D. M. 2000. Element global ranking form: Brackish Meadow. New York Natural Heritage Program, February 25, 2000.
- Hupp, C. R. 1982. Stream-grade variation and riparian forest ecology along Passage Creek, Virginia. *Bulletin of the Torrey Botanical Club* 109:488-499.
- Hupp, C. R. 1983. Vegetation pattern on channel features in the Passage Creek Gorge, Virginia. *Castanea* 48:62-72.
- Hupp, C. R. 1986. Upstream variation in bottomland vegetation patterns, northwestern Virginia. *Bulletin of the Torrey Botanical Club* 4:421-430.
- INAI [Iowa Natural Areas Inventory]. No date. Vegetation classification of Iowa. Iowa Natural Areas Inventory, Iowa Department of Natural Resources, Des Moines.
- Jenkins, D. 1974. Natural areas of the Chesapeake Bay region: Ecological priorities. Smithsonian Institute, Ecology Program, Center for Natural Areas Ecology.
- Johnson, A. F. 1981b. Plant communities of the Napeague Dunes. *Bulletin of the Torrey Botanical Club* 108:76-84.
- Johnson, A. F. 1985b. A guide to the plant communities of the Napeague Dunes, Long Island, New York. Mad Printers, Mattituck, NY. 58 pp. plus plates.
- Jones, S. B., Jr., and N. C. Coile. 1988. The distribution of the vascular flora of Georgia. Department of Botany, University of Georgia, Athens.
- 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.
- Jordan, M. J., W. A. Patterson, III, and A. G. Windisch. 2003. Conceptual ecological models for the Long Island pine barrens. *Forest Ecology and Management*. [in press]
- Karlin, E. 1988. Report on New Jersey conifer swamp study. Unpublished report to the New Jersey Natural Heritage Program.
- Karlin, E. F., and L. M. Lynn. 1988. Dwarf-shrub bogs of the southern Catskill Mountain region of New York State: Geographic changes in the flora of peatlands in northern New Jersey and southern New York. *Bulletin of the Torrey Botanical Club* 115:209-217.
- Kartesz, J. T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. First edition. In: J. T. Kartesz and C. A. Meacham. *Synthesis of the North American Flora, Version 1.0*. North Carolina Botanical Garden, Chapel Hill, NC.
- Kearsley, J. 1999a. Non-forested acidic peatlands of Massachusetts. Massachusetts Natural Heritage & Endangered Species Program, Massachusetts Division of Fisheries & Wildlife, Wetborough. June 1999. Unpublished report.
- Kern, M. J. 1985. T15R9 Aroostook County. A natural resources inventory. Bureau of Public Lands, Department of Conservation. State Planning Office, Augusta, Me. 169 pp.
- 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.

- Klimas, C. V. 1988b. Forest vegetation of the leveed floodplain of the lower Mississippi River. U.S. Army Corps of Engineers, Waterways Experimental Station, Lower Mississippi River Environmental Program. Report No. 11. Vicksburg, MS. 281 pp.
- Klimas, C. V., C. O. Martin, and J. W. Teaford. 1981. Impacts of flooding regime modification on wildlife habitats of bottomland hardwood forests in the lower Mississippi. U.S. Army Corps of Engineers, Waterways Experimental Station and Environmental Lab. Technical Report EL-81-13. Vicksburg, MS. 137 pp. plus appendix.
- Klotz, L. H. 1986. The vascular flora of Wallops Island and Wallops Mainland, Virginia. *Castanea* 51:306-326.
- Kuchler, A. W. 1956. Notes on the vegetation of southeastern Mount Desert Island, Maine. *University of Kansas Science Bulletin* 38:335-392.
- Kuchler, A. W. 1964. Potential natural vegetation of the conterminous United States. *American Geographic Society Special Publication* 36. New York, NY. 116 pp.
- Kunsman, J. 1994. A survey of the aquatic vascular plants of the upper Delaware River. Unpublished report to the National Park Service. Pennsylvania Science Office of The Nature Conservancy, Middletown, PA. 322 pp.
- Laderman, A. D. 1989. The ecology of the Atlantic white cedar wetlands: A community profile. USDI Fish and Wildlife Service. *Biological Report* 85(7.21). 114 pp.
- 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. 2002b. Vegetation classification of Assateague Island National Seashore, Addendum (version 2) - March 1, 2002. Unpublished draft. National Park Service. 31 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.
- Leahy, Mike. Personal communication. Missouri Natural Heritage Database, Missouri Department of Conservation, Jefferson City.
- Lee, H., W. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Uhlig, and S. McMurray. 1998. Ecological land classification for southern Ontario: First approximation and its application. Ontario Ministry of Natural Resources, Southcentral Science Section, Science Development and Transfer Branch. SCSS Field Guide FG-02.
- Little, S. 1974. Effects of fire on temperate forests: Northeastern United States. Chapter 1 in: T. T. Kozlowski and C. E. Ahlgren, editors. *Fire and Ecosystems*. Academic Press, New York.
- Lundgren, J. 1999a. Lower New England - Northern Piedmont Ecoregion Forest Classification. December 1999 Draft. 63 pp.
- Lundgren, J. 2000. Lower New England - Northern Piedmont Ecoregion Forest Classification. The Nature Conservancy, Conservation Science, Boston, MA. 72 pp.
- Lundgren, J. A. 1998. Natural communities of coastal Massachusetts: Inventory and assessment. Massachusetts Department of Fisheries and Wildlife Natural Heritage and Endangered Species Program, Boston, MA.
- Lundgren, J., B. Hammond, J. Stone, and L. Sneddon. 2000. Vegetation classification and mapping of Nantucket Island, Massachusetts. Final Draft. The Nature Conservancy, March 2000. 59 pp.

- Lundgren, J., editor. 2001. Plant communities of the High Allegheny Plateau Ecoregion. Draft revisions to the National Vegetation Classification, March 2000 subset. Natural Heritage Central Databases. The Association for Biodiversity Information, Arlington, VA, and The Nature Conservancy, Eastern Regional Office, Boston, MA. 71 pp. plus tables.
- Lutz, H. J. 1930. The vegetation of Heart's Content, a virgin forest in northwestern Pennsylvania. *Ecology* 11:1-29.
- Lynn, L. M., and E. F. Karlin. 1985. The vegetation of the low-shrub bogs of northern New Jersey and adjacent New York: Ecosystems at their southern limit. *Bulletin of the Torrey Botanical Club* 112:436-444.
- MENHP [Maine Natural Heritage Program]. 1991. Natural landscapes of Maine: A classification of ecosystems and natural communities. Unpublished document. Office of Comprehensive Planning, Maine Natural Heritage Program, Augusta. 77 pp.
- MNNHP [Minnesota Natural Heritage Program]. 1993. Minnesota's native vegetation: A key to natural communities. Version 1.5. Minnesota Department of Natural Resources, Natural Heritage Program, St. Paul, MN. 110 pp.
- Major, C. S., C. Bailey, J. Donaldson, R. McCoy, C. Nordman, M. Williams, and D. Withers. 1999. An ecological inventory of selected sites in the Cherokee National Forest. Tennessee Department of Environment and Conservation, Tennessee Division of Natural Heritage. Cost Share Agreement #99-CCS-0804-001. Nashville, TN.
- Malter, J. L. 1977. The flora of Citico Creek Wilderness Study Area, Cherokee National Forest, Monroe County, Tennessee. M.S. thesis, University of Tennessee, Knoxville. 116 pp.
- Martin, W. E. 1959b. The vegetation of Island Beach State Park, New Jersey. *Ecological Monographs* 29:1-46.
- Martin, W. H. 1975. The Lilley Cornett Woods: A stable mixed mesophytic forest in Kentucky. *Botanical Gazette* 136:171-183.
- Marye, W. B. 1920. The old Indian road. *Maryland Historical Magazine* 15:107-124, 208-229, 345-395.
- Marye, W. B. 1955a. The great Maryland barrens. *Maryland Historical Magazine* 50:11-23.
- Marye, W. B. 1955b. The great Maryland barrens. *Maryland Historical Magazine* 50:124-142.
- Marye, W. B. 1955c. The great Maryland barrens. *Maryland Historical Magazine* 50:234-253.
- Mayberry, Kathleen P., editor. 1999. *Seeing the Forest and the Trees: Ecological Classification for Conservation*. The Nature Conservancy, Arlington, Virginia.
- McAvoy, W., and K. Clancy. 1994. Community classification and mapping criteria for Category I interdunal swales and coastal plain pond wetlands in Delaware. Final Report submitted to the Division of Water Resources in the Department of Natural Resources and Environmental Control. 47 pp.
- McAvoy, William. Personal communication. Botanist, Delaware Natural Heritage Program, Delaware Division of Fish & Wildlife, Department of Natural Resources and Environmental Control, Smyrna, DE.
- 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.
- McCormick, J., R. R. Grant, Jr., and R. Patrick. 1970. Two studies of Tinicum Marsh. In: R. McCormick. *The natural features of Tinicum Marsh, with particular emphasis on vegetation*. The Conservation Foundation. 104 pp.
- McCormick, J., and T. Ashbaugh. 1972. Vegetation of a section of Oldmans Creek Tidal Marsh and related areas in Salem and Gloucester counties, New Jersey. *Bulletin of the New Jersey Academy of Science* 17:31-37.

- McCoy, D. A. 1958. Vascular plants of Pontotoc County, Oklahoma. *American Midland Naturalist* 59:371-396.
- McCoy, K. M., and G. P. Fleming. 2000. Ecological communities of U.S. Army Garrison, Fort Belvoir, Fort Belvoir, Virginia. Natural Heritage Technical Report 00-08, Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond. Unpublished report submitted to the U.S. Army. 156 pp. plus appendices.
- McDonald, A. 1938. Erosion and its control in Oklahoma Territory. Miscellaneous Publication 301, U.S. Department of Agriculture, Washington, DC.
- McDonnell, M. J. 1979. The flora of Plum Island, Essex County, Massachusetts. University of New Hampshire, Agricultural Experiment Station. Station Bulletin No. 513. Durham, NH. 110 pp.
- McIntosh, R. P. 1972. Forests of the Catskill Mountains, New York. *Ecological Monographs* 42:143-161.
- McWilliams, W. H., and J. F. Rosson, Jr. 1990. Composition and vulnerability of bottomland hardwood forests of the Coastal Plain province in the south central United States. *Forest Ecology and Management* 33/34:485-501.
- 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.
- 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.
- Metzler, K. J., and N. Barrett. 1982. National wetlands inventory. Unpublished report submitted to USDI Fish & Wildlife Service. 32 pp.
- Metzler, K., and J. Barrett. 1996. Vegetation classification for Connecticut organized into the modified UNESCO hierarchy. Unpublished review draft. Connecticut Natural Diversity Database. Hartford, CT. 48 pp.
- Metzler, K., and R. Rosza. 1982. Vegetation of fresh and brackish tidal marshes in Connecticut. *Newsletter of the Connecticut Botanical Society* 10(1):1-3.
- Midwestern Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe, Minneapolis, MN.
- Miller, W. R., and F. E. Egler. 1950. Vegetation of the Wequetequock-Pawcatuck tidal-marshes, Connecticut. *Ecological Monographs* 20:143-172.
- Moore, B., and N. Taylor. 1927. An ecological study of the vegetation of Mount Desert Island, Maine. *Brooklyn Botanical Garden Memoirs* 3:1-151.
- Moore, K. A., D. J. Wilcox, and R. J. Orth. 2000. Analysis of the abundance of submersed aquatic vegetation communities in the Chesapeake Bay. *Estuaries* 23:115-127.
- Motzkin, G. 1991. Atlantic white cedar wetlands of Massachusetts. Massachusetts Agricultural Experiment Station, University of Massachusetts. Research Bulletin 731. 53 pp.
- Motzkin, G. 1994. Calcareous fens of western New England and adjacent New York State. *Rhodora* 96(885):44-68.

- Motzkin, G., and D. R. Foster. 2002. Grasslands, heathlands and shrublands in coastal New England: Historical interpretations and approaches to conservation. *Journal of Biogeography* 29:1569-1590.
- Moul, E. T. 1969. Flora of Monomoy Island, Massachusetts. *Rhodora* 71:18-28.
- Moul, E. T. 1973. Marine flora and fauna of the northeastern United States: Higher plants of the marine fringe. USDC National Oceanographic and Atmospheric Administration. Technical Report NMFS CIRC-384. Seattle, WA. 61 pp.
- Mulholland, P. J., and D. R. Lenat. 1992. Streams of the southeastern Piedmont, Atlantic drainage. Pages 193-231 in: C. T. Hackney, S. M. Adams, and W. H. Martin, editors. *Biodiversity of the southeastern United States: Aquatic communities*. John Wiley and Sons, New York.
- NAP [Northern Appalachian-Boreal Forest Working Group]. 1998. Northern Appalachian-Boreal Working group discussions. The Nature Conservancy, Boston, MA.
- NDNHI [North Dakota Natural Heritage Inventory]. No date. Vegetation classification of North Dakota. North Dakota Natural Heritage Inventory, North Dakota Parks & Recreation Department, Bismarck.
- NJNHP [New Jersey Natural Heritage Program]. No date. Unpublished data. New Jersey Natural Heritage Program, Office of Lands Management, Trenton, NJ.
- Natureserve. 2004. Central Ecology Data Standards: High-Priority and Other Reported Fields. Arlington, VA.
- NatureServe Ecology - Southeastern United States. No date. Unpublished data. NatureServe, Durham, NC.
- NatureServe Ecology - Southeastern United States. No date. Unpublished data. NatureServe, Durham, NC.
- Nelson, B. W., and L. K. Fink. 1980. Geological and botanical features of sand beach in Maine. Bulletin No. 14. Maine Sea Grant Publications. 163 pp.
- Nelson, D. J., and D. C. Scott. 1962. Role of detritus in the productivity of a rock outcrop community in a Piedmont stream. *Limnology and Oceanography* 7:396-413.
- 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.
- Newbold, A. 1993. Report of wetlands vegetation study, 1993, Valley Forge National Historical Park. Unpublished report. 19 pp.
- Newbold, A. 1996. Report on the Mount Misery and Mount Joy vegetation study, 1996, Valley Forge National Historical Park. Unpublished report. 14 pp.
- Nichols, G. E. 1920. The vegetation of Connecticut: III. The associations of depositing areas along the seacoast. *Bulletin of the Torrey Botanical Club* 47:511-548.
- 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.
- Niering, W. A. 1953. The past and present vegetation of High Point State Park, New Jersey. *Ecological Monographs* 23:127-148.
- Niering, W. A., and F. E. Egler. 1966. The natural area of the Audubon Center of Greenwich. *The Vegetation of Connecticut Natural Areas No. 2*, State Geological and Natural History Survey of Connecticut. Hartford, CT. 20 pp.
- Niering, W. A., and R. S. Warren. 1977. Our dynamic tidal marshes: Vegetation changes as revealed by peat analysis. *The Connecticut Arboretum Bulletin* 22.

- Niering, W. A., and R. S. Warren. 1980. Vegetation patterns and processes in New England salt marshes. *Bioscience* 30:301-307.
- Nixon, S. W. 1982. The ecology of New England high salt marshes: A community profile. USDI Fish & Wildlife Service. FWS/OBS-81/55. 70 pp.
- Northern Appalachian Ecology Working Group. 2000. Northern Appalachian / Boreal Ecoregion community classification (Review Draft). The Nature Conservancy, Eastern Conservation Science Center, Boston, MA. 117 pp. plus appendices.
- OHNHD [Ohio Natural Heritage Database]. No date. Vegetation classification of Ohio. Ohio Natural Heritage Database, Division of Natural Areas and Preserves, Ohio Department of Natural Resources, Columbus.
- Oberholster, C. 1993. Preliminary list of natural communities of Alabama. Unpublished document. Alabama Department Conservation and Natural Resources, Natural Heritage Section, Montgomery, AL. 6 pp.
- Odum, W. E. 1988. Comparative ecology of tidal freshwater and salt marshes. *Annual Review of Ecological Systems* 19:147-176.
- Odum, W. E., T. J. Smith, III, J. K. Hoover, and C. C. McIvor. 1984. The ecology of tidal freshwater marshes of the United States east coast: A community profile. USDI Fish & Wildlife Service. FWS/OBS-83/17. 176 pp.
- Odum, W. E., and T. J. Smith. 1981. Ecology of tidal, low salinity ecosystems. Pages 36-44 in: R. C. Carey, P. S. Markovits, and J. B. Kirkwood, editors. Proceedings of the workshop on coastal ecosystems of the southeastern United States. USDI Fish & Wildlife Service, Office of Biological Services. Report No. FWS/OBS-80/59. Washington, DC.
- Ohmann, L. F., and M. F. Buell. 1968. Forest vegetation of the New Jersey highlands. *Bulletin of the Torrey Botanical Club* 95:287-298.
- Ohmann, L. F., and P. R. Ream. 1971. Wilderness ecology: Virgin plant communities of the Boundary Waters Canoe Area. USDA Forest Service, North Central Forest Experiment Station. Research Paper NC-63. St. Paul, MN. 35 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.
- Orth, R. J., and K. A. Moore. 1988. Distribution of *Zostera marina* L. and *Ruppia maritima* L. *sensu lato* along depth gradients in the lower Chesapeake Bay, USA. *Aquatic Botany* 32:291-305.
- Palmer-Ball, B., Jr., J. J. N. Campbell, M. E. Medley, D. T. Towles, J. R. MacGregor, and R. R. Cicerello. 1988. Cooperative inventory of endangered, threatened, sensitive and rare species, Daniel Boone National Forest, Somerset Ranger District. USDA Forest Service, Daniel Boone National Forest, Berea, KY. 244 pp.
- 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.
- Patterson, W. B., and H. R. DeSelm. 1989. Classification of forest vegetation of the bottomlands of west Tennessee. University of Tennessee, Department of Biological Sciences, Knoxville, and Tennessee Department of Conservation, Ecological Services Division. Report for Contract No. 89-3347. Nashville. 151 pp.

- 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.
- Penfound, W. T. 1952. Southern swamps and marshes. *Botanical Review* 7:413-446.
- Penfound, W. T. 1953. Plant communities of Oklahoma lakes. *Ecology* 34:561-583.
- Perles, S. J., G. S. Podniesinski, W. A. Millinor, and L. A. Sneddon. 2005c. Vegetation classification and mapping at Gettysburg National Military Park and Eisenhower National Historic Park. Draft Technical Report NPS/NER/NRTR--XXXX/XXX. 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.
- Perles, Stephanie. Personal communication. Ecologist, Pennsylvania Natural Heritage Program (PNHP-East), Harrisburg.
- 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. S., S. J. Perles, W. A. Millinor, and L. A. Sneddon. 2006. Vegetation classification and mapping at Delaware Water Gap National Recreation Area. Technical Report NPS/NER/NRTR--XXXX/XXX. National Park Service. Philadelphia, PA.
- Podniesinski, G., A. Leimanis, and J. Ebert. 1999. Unpublished data. Serpentine Plant Community Classification. Western Pennsylvania Conservancy, Pittsburgh, PA. 14 pp.
- Podniesinski, G., and G. Wagner. 2002. Classification, assessment, and protection of forested floodplain wetlands of the Susquehanna drainage. Report submitted to U.S. Environmental Protection Agency and the Pennsylvania Department of Conservation and Natural Resources by the Western Pennsylvania Conservancy, Pittsburgh, PA, and The Nature Conservancy, Middletown, PA. 159 pp.
- Podniesinski, Greg. Personal communication. Community Ecologist, Pennsylvania Natural Heritage Program (PNHP-East), Harrisburg.
- Poiani, K. A., B.D. Richter, M.G. Anderson, and H.E. Richter. 2000. Biodiversity conservation at multiple scales: Functional sites, landscapes and networks. *Bioscience* 50: 133-146.
- Putnam, J. A. 1951. Management of bottomland hardwoods. USDA Forest Service, Southern Forest Experiment Station. Occasional Paper No. 116. New Orleans, LA.
- Putnam, J. A., G. M. Furnival, and J. S. McKnight. 1960. Management and inventory of southern hardwoods. USDA Forest Service. Handbook 181. Washington, DC. 102 pp.
- Pyne, M. 1994. Tennessee natural communities. Unpublished document. Tennessee Department of Conservation, Ecology Service Division, Nashville. 7 pp.
- RINHP [Rhode Island Natural Heritage Program]. No date. Natural communities of Rhode Island. Rhode Island Natural Heritage Program, Department of Environmental Management, Providence.
- Racine, C. H. 1966. Pine communities and their site characteristics in the Blue Ridge escarpment. *Journal of the Elisha Mitchell Scientific Society* 82:172-181.
- Radis, R. 1986. Rare and endangered plant species within the New Jersey portion of the Delaware Water Gap National Recreation Area. Technical Report. National Park Service. Philadelphia, PA.
- 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. 1988. Ecology forum: Notes on riverside vegetation. *The Nature Conservancy News* 38:24-25.
- Rawinski, T. J. 1992. A classification of Virginia's indigenous biotic communities: Vegetated terrestrial, palustrine, and estuarine community classes. Unpublished document. Virginia Department of Conservation and Recreation, Division of Natural Heritage. Natural Heritage Technical Report No. 92-21. Richmond, VA. 25 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.
- Redfield, A. C. 1972. Development of a New England salt marsh. *Ecological Monographs* 42(2):201-237.
- 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.
- Rheinhardt, R. 1992. A multivariate analysis of vegetation patterns in tidal freshwater swamps of lower Chesapeake Bay, USA. *Bulletin of the Torrey Botanical Club* 119:192-207.
- Rheinhardt, R. D. 1991. Vegetation ecology of tidal freshwater swamps of the lower Chesapeake Bay, USA.
- Robichaud, B., and M. F. Buell. 1973. Vegetation of New Jersey. Rutgers University Press, New Brunswick, NJ. 340 pp.
- Rozsa, R., and K. Metzler. No date. Plant communities of Mashomak. Pages 101-161 in: Mashomak Preserve Master Plan. The Nature Conservancy unpublished report.
- Russell, E. W. B., and A. E. Schuyler. 1988. Vegetation and flora of Hopewell Furnace National Historic Site, eastern Pennsylvania. *Bartonia* 54:124-143.
- Saltonstall, K. 2002. Cryptic invasion by a non-native genotype of the common reed, *Phragmites australis*, into North America. *Proceedings of the National Academy of Science* 99:2445-2449.
- Schafale, M. 1998a. Fourth approximation guide. Mountain wetlands. February 1998 draft. North Carolina Natural Heritage Program, Raleigh.
- Schafale, M. 1998b. Fourth approximation guide. High mountain communities. March 1998 draft. North Carolina Natural Heritage Program, Raleigh.
- Schafale, M. 2000. Fourth approximation guide. Coastal Plain. January 2000 draft. North Carolina Natural Heritage Program, Raleigh.
- Schafale, M. 2002. Fourth approximation guide. Mountain communities. November 2002 draft. North Carolina Natural Heritage Program, Raleigh.
- Schafale, M. 2003b. Fourth approximation guide. Coastal Plain communities. March 2003 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.
- Schafale, Mike P. Personal communication. Ecologist, North Carolina Department of Environment, Health, and Natural Resources, Division of Parks and Recreation, Natural Heritage Program, Raleigh.
- Schall, D., and D. Murley. 1984. Survey of the pond flora of Cape Cod, Massachusetts. *Cape Naturalist* 12:58-61.
- 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, E. 1910. The ecological plant geography of Maryland; coastal zone; eastern shore district. Maryland Weather Service, Special Publication 3:101-148.
- 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.
- Simko, A. L. 1987. Coastal forests of southern New England. *Wildflower Notes* 2:21-26.
- 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.
- Sirkin, L. A. 1972. Origin and history of Maple Bog in the Sunken Forest, Fire Island, New York. *Bulletin of the Torrey Botanical Club* 99:131-135.
- Smith, D. W., and N. E. Linnartz. 1980. The southern hardwood region. Pages 145-230 in: J. W. Barrett, editor. *Regional silviculture of the United States*. Second edition. John Wiley and Sons, New York.
- Smith, E. B. 1988b. An atlas and annotated list of the vascular plants of Arkansas, 2nd edition. University of Arkansas, Fayetteville.
- Smith, L. M., compiler. 1996a. Natural plant communities in Louisiana currently recognized by the Louisiana Natural Heritage Program. Unpublished document. Louisiana Department of Wildlife and Fisheries, Natural Heritage Program, Baton Rouge. 2 pp.
- Smith, T. L. 1983. Natural ecological communities of Pennsylvania. Draft, revised 1991. Pennsylvania Natural Diversity Inventory, Middletown, PA.
- Smith, T. L. No date (a). Natural ecological communities of Pennsylvania. Pennsylvania Natural Diversity Inventory, East, Harrisburg, PA. 97 pp.
- Sneddon, L. A. 1994. Descriptions of coastal plain pondshore proposed community elements. Unpublished. The Nature Conservancy, Boston, MA.
- 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. A., M. Anderson, and J. Lundgren 1999. Classification of coastal plain pondshore communities of the Cape Cod National Seashore using the U.S. National Vegetation Classification. Unpublished report to the Cape Cod National Seashore. The Nature Conservancy, Boston, MA.

- 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., M. Anderson, and K. Metzler. 1994. A classification and description of terrestrial community alliances in The Nature Conservancy's Eastern Region: First approximation. Unpublished report to USDI Fish & Wildlife Service, Gap Analysis Program. The Nature Conservancy, Eastern Heritage Task Force, Boston, MA. 116 pp.
- 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.
- 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.
- Society for Ecological Restoration International Science & Policy Working Group. 2004. *The SER International Primer on Ecological Restoration*. Society for Ecological Restoration International. www.ser.org & Tucson, AZ
- Southeastern Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe, Durham, NC.
- Sperduto, D. 1994. A classification of the natural communities of New Hampshire. April 1994 approximation. Unpublished document. New Hampshire Natural Heritage Inventory, Department of Resources and Economic Development, Concord, NH. 45 pp. plus appendices.
- Sperduto, D. A., and K. F. Crowley. 2002b. Atlantic white cedar in New England: Analysis and proposed classification. New Hampshire Natural Heritage Inventory. DRED Division of Forests & Lands and The Nature Conservancy, Concord, NH.
- Sperduto, D. D. 1996. A guide to the natural communities of New Hampshire. Review draft. New Hampshire Natural Heritage Program, Division of Forests and Lands, Department of Resources and Economic Development. Concord, NH. 75 pp.
- Sperduto, D. D. 1997a. The natural communities of New Hampshire: A guide and classification. The New Hampshire Natural Heritage Inventory, Concord, NH. 126 pp.
- Sperduto, D. D. 1997b. A preliminary classification of natural communities in the New Hampshire Coastal Lowlands Ecoregion. NH Natural Heritage Inventory / The Nature Conservancy, Division of Forests and Lands, Department 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., W. F. Nichols, K. F. Crowley, and D. A. Bechtel. 2000b. Black gum (*Nyssa sylvatica* Marsh) in New Hampshire. New Hampshire Natural Heritage Inventory, Concord, NH. 51 pp. plus appendices.
- 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, NH.

- Stalter, R. 1979. The major plant communities of the Fire Island National Seashore. Pages 177-181 in: R. M. Linn, editor. Proceedings of the first conference on Scientific Research in the National Parks. USDI National Park Service, Washington, DC.
- 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.
- Steury, B. W. 1999. Annotated list of vascular plants from a nontidal barrier wetland along the Chesapeake Bay in Calvert County, Maryland. *Castanea* 64(2):187-200.
- Stone, W. 1911. The plants of southern New Jersey with special reference to the flora of the pine barrens. Annual Report for 1910. New Jersey State Museum, Trenton, NJ. 828 pp.
- Svenson, H. K. 1970. A linden (*Tilia*) forest on Cape Cod (with extended notes on *Tilia neglecta*, *Bromus pubescens*, and *Ribes hirtellum*). *Rhodora* 72:339-350.
- 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.
- 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
- 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 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.
- Teal, J. M. 1986. The ecology of regularly flooded salt marshes of New England: A community profile. Department of Interior, U.S. Fish and Wildlife Service, Washington, DC. Biological Report 85(7.4). 61 pp.
- Thayer, G. W., W. J. Kenworthy, and M. S. Fonseca. 1984. The ecology of eelgrass meadows of the Atlantic Coast: A community profile. USDI Fish & Wildlife Service, Office of Biological Service. FWS/OBS-84/02. 147 pp.
- Thomas, R. D., and C. M. Allen. 1993. Atlas of the vascular flora of Louisiana. Volume I: Ferns & fern allies, conifers, & monocotyledons. Louisiana Department of Wildlife and Fisheries, Natural Heritage Program and The Nature Conservancy, Louisiana Field Office, Baton Rouge. 218 pp.
- 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.
- Thompson, E., and J. Jenkins. 1992. Summary of field data from Minuteman National Park plant communities study. A report prepared under a contract with the Massachusetts Natural Heritage and Endangered Species Program for the National Park Service. 39 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, MD. 119 pp.
- Tiner, R. W. 1995. Wetlands of Maryland. USDI Fish & Wildlife Service. Maryland Department of Natural Resources, Hadley, MA. 193 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.
- Travis, R. W., and P. J. Godfrey. 1976. Interactions of plant communities and oceanic overwash on the manipulated barrier islands of Cape Hatteras National Seashore, North Carolina. Pages 777-780 in: Proceedings of the First Conference on Scientific Research in the National Parks, Volume II.
- Trudeau, P., P. J. Godfrey, and B. S. Timson. 1977. Beach vegetation and oceanic processes study of Popham State Park Beach, Reid State Park Beach, and Small Point Beach. USDA/SCS. Maine Department of Conservation. 144 pp.
- Tyndall, R. W. 1989. Aerial photo analysis of woody plant succession in eight Delmarva bays. Unpublished report for The Nature Conservancy. MD. 10 pp.
- Tyndall, R. W. 1992a. Historical considerations of conifer expansion in Maryland serpentine "barrens." *Castanea* 57:123-131.
- Tyndall, R. W. 1992b. Herbaceous layer vegetation on Maryland serpentine. *Castanea* 57:264-272.
- Tyndall, R. W., K. A. McCarthy, J. C. Ludwig, and A. Rome. 1990. Vegetation of six Carolina bays in Maryland. *Castanea* 55:1-21.
- Tyndall, R. W., and P. M. Farr. 1989. Vegetation structure and flora of a serpentine pine-cedar savanna in Maryland. *Castanea* 54:191-199.
- Tyndall, R. W., and P. M. Farr. 1990. Vegetation and flora of the Pilot serpentine area Maryland. *Castanea* 55:123-131.
- Ulrey, C. J. 1999. Classification of the vegetation of the Southern Appalachians. Final report. USDA Forest Service, Southeastern Research Station, Bent Creek Experimental Forest, Asheville, NC. 90 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.
- Van Auken, O. W., and J. K. Bush. 1988. Dynamics of establishment, growth, and development of black willow and cottonwood in the San Antonio River forest. *Texas Journal of Science* 40:269-277.

- Vegetation Classification Panel, The Ecological Society of America. 2002. Standards for associations and alliances of the U.S. National Vegetation Classification. The Ecological Society of America. [available online: www.esa.org/vegstds_v1.htm].
- Vogelmann, H. W. 1976. An unusual black gum swamp in Maine. *Rhodora* 78:326-327.
- WINHIP [Wisconsin Natural Heritage Inventory Program]. No date. Vegetation classification of Wisconsin. Wisconsin Natural Heritage Program, Wisconsin Department of Natural Resources, Madison.
- 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.
- Walton, D. P. Personal communication. Ecologist, Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA.
- Walton, D., N. Putnam, and P. Trianosky. 1997. A classification of the terrestrial plant communities of West Virginia. Second draft. West Virginia Natural Heritage Program. Elkins, WV.
- Ware, D. M. E., and S. Ware. 1992. An *Acer barbatum*-rich ravine forest community in the Virginia coastal plain. *Castanea* 57:110-122.
- Webber, E. E. 1967. Bluegreen algae from a Massachusetts salt marsh. *Bulletin of the Torrey Botanical Club* 94:99-106.
- Wharton, C. H. 1978. The natural environments of Georgia. Georgia Department of Natural Resources, Atlanta. 227 pp.
- Wharton, C. H., W. M. Kitchens, E. C. Pendleton, and T. W. Sipe. 1982. The ecology of bottomland hardwood swamps of the Southeast: A community profile. U.S. Fish and Wildlife Service, Office of Biological Services. FWS/OBS-81/37. Washington, DC.
- White, J., and M. Madany. 1978. Classification of natural communities in Illinois. Pages 311-405 in: Natural Areas Inventory technical report: Volume I, survey methods and results. Illinois Natural Areas Inventory, Urbana, IL.
- Whitlatch, R. B. 1982. The ecology of New England tidal flats: A community profile. USDI, U.S. Fish and Wildlife Service, Biological Services Program, Washington, DC. FWS/OBS-81/01. 125 pp.
- Whittaker, R. H. 1956. Vegetation of the Great Smoky Mountains. *Ecological Monographs* 26:1-80.
- Wieland, R. G. 1994b. Mississippi Natural Heritage Program: Ecological communities. Unpublished document. Mississippi Department of Wildlife, Fisheries, and Parks, Museum of Natural Science, Natural Heritage Program, Jackson, MS. 7 pp.
- Wieland, R. G. 2000b. Ecological communities of Mississippi: Mississippi Natural Heritage Program. Unpublished document. Mississippi Department of Wildlife, Fisheries, and Parks, Museum of Natural Science, Natural Heritage Program, Jackson, MS. 8 pp.
- Windisch, A. G. 1995a. Natural community inventory of Willow Grove Lake Site, Salem, Cumberland and Gloucester counties, New Jersey. The Nature Conservancy draft report. New Jersey Natural Heritage Program, Trenton, NJ.
- 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.
- Windisch, A. G. 1995c. Natural community inventory of Mashipacong Bogs site, New Jersey. New Jersey Natural Heritage Program, Office of Natural Lands Management, Division of Parks and Forestry. Trenton, NJ.

- Windisch, A. G. Personal communication. Ecologist, New Jersey Natural Heritage Program, Office of Lands Management, Trenton, NJ.
- Woods, K. D. 1987. Northern hardwood forests in New England. *Wildflower Notes* 2:2-10.
- Zanoni, T. A., P. G. Risser, and I. H. Butler. 1979. Natural areas for Oklahoma. Oklahoma Natural Heritage Program, Norman. 72 pp.
- Zaremba, R. E., and S. P. Leatherman. 1984. Overwash processes and foredune ecology, Nauset Spit, Massachusetts. Miscellaneous Paper EL-84-8. Prepared by Massachusetts Audubon Society and University of Massachusetts under cooperative agreement between USDI National Park Service, North Atlantic Region, Boston, MA, and the U.S. Army Corps of Engineering Research Center. Published by U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 232 pp.
- Zebryk, T. 1990. Vegetation and site characteristics of a *Nyssa*-dominated wetland in central Massachusetts. Unpublished report. Draft 3.
- Zollner, Douglas. Personal communication. Ecologist, The Nature Conservancy, Arkansas Field Office, Little Rock.

Appendix A: NatureServe Ecological Classifications Glossary of Terms

- 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/sparingly 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.

Appendix B: Similar National Vegetation Classification Associations Table

Introduction

This Appendix identifies similar associations (i.e. community types) identified in the Delaware Estuary Watershed. It does not include all of the similar associations in the National Vegetation Classification System outside of the study area. The list was limited to just those NVC associations identified as occurring within the Delaware Estuary watershed. If an association is not listed, then it does not have any similar associations identified within the watershed.

Definitions of Fields

NVC Common Name: This is the primary common or colloquial name of the association. This name contrasts from the translated name for the association, which is the word-for-word translation of the latin scientific name for the association. The NVC common name is used as the primary name of the community type in the Guide. The names in this table match the names in the Guide.

Similar Associations: This field is used to "cross-reference" other, closely related or apparently similar associations that also occur in the Delaware Estuary watershed. This includes any similar association(s) which may be mistaken for a particular Association. They may be in the same or different formation or alliance of the National Vegetation Classification hierarchy. Community types whose classification is not at issue (e.g., two types have similar sounding names but are differentiated by the degree of canopy closure and lower frequency of associated light-requiring species) are listed. Any comments regarding the relationship of each particular Similar Association to the Element is included in the Similar Association Note field.

Similar Associations Comments: General comments that pertain to any similar Associations listed in the Similar Associations table. This field is used to describe the differentiating features of similar Associations whose classification is not at issue.

NVC Common Name	Similar Association NVC Common Name	Similar Association Notes
Dogwood - Willow Swamp	Skunk-cabbage Seepage Meadow	
Skunk-cabbage Seepage Meadow	Dogwood - Willow Swamp	may have a similar composition.
Water-lily Aquatic Wetland	Pond-lily Tidal Marsh	
Virginia Pine Successional Forest	Appalachian Low-Elevation Mixed Pine / Hillside Blueberry Forest	can have a very similar canopy in the Piedmont and Blue Ridge ecoregions, but Appalachian Low Elevation Mixed Pine Forest is generally created and maintained by fire and/or logging but not heavy plowing and/or erosion. Virginia Pine Successional Forest generally has signs of heavy agricultural use such as sparse herbaceous or shrub layers, large percentage of invasive exotics such as <i>Lonicera japonica</i> in the herbaceous layer, old plowlines, human debris, and extremely even aged canopy, whereas Appalachian Low Elevation Mixed Pine Forest generally has a more intact herbaceous/shrub layer (especially <i>Vaccinium pallidum</i>) and less signs of severe human disturbance.
Atlantic Coast Interdune Swale	Interdune Switchgrass Brackish Depression	
Birch - Willow Riverbank Shrubland	River Birch Low Floodplain Forest	
Mid-Atlantic Maritime Salt Shrub	Brackish Meadow	
Central Coast Beach Heather Dune Shrubland	Beachgrass - Panicgrass Dune Grassland	
Piedmont Cliff (Acidic Type)	Kittatinny Ridge Sparsely Vegetated Sandstone Cliff	
Beachgrass - Panicgrass Dune Grassland	Central Coast Beach Heather Dune Shrubland	
Beachgrass - Panicgrass Dune Grassland	Northern Beachgrass Dune	
Overwash Dune Grassland	Northeastern Atlantic Brackish Interdunal Swale	
Interdune Switchgrass Brackish Depression	Atlantic Coast Interdune Swale	
Interdune Switchgrass Brackish Depression	Brackish Meadow	
Eastern Reed Marsh	Reed-grass Tidal Marsh	
Reed-grass Tidal Marsh	Eastern Reed Marsh	
Atlantic Coast Brackish Tidal Marsh	Transitional Tidal Marsh	
North Atlantic Low Salt Marsh	Brackish Tidal Low Marsh	
Brackish Tidal Low Marsh	North Atlantic Low Salt Marsh	
Brackish Tidal Low Marsh	Alkali Bulrush Brackish Marsh	
Brackish Tidal Low Marsh	Central Atlantic Brackish Marsh	
Brackish Tidal Low Marsh	Mesohaline Seepage Marsh	
Mid-Atlantic High Salt Marsh	North Atlantic High Salt Marsh	
Pond-lily Tidal Marsh	Water-lily Aquatic Wetland	
Pond-lily Tidal Marsh	Pickerelweed Tidal Marsh	
North Atlantic Coast Intertidal Mud Flat	Estuary Quillwort Tidal Flat	occurs in freshwater tidal conditions.
North Atlantic Coast Intertidal Mud Flat	Estuary Pipewort Freshwater Intertidal Flat	occurs on sandy substrates, not mud flats.
Pickerelweed Tidal Marsh	Pond-lily Tidal Marsh	
Pickerelweed Tidal Marsh	Northeastern Leafy Forb Marsh	
Pickerelweed Tidal Marsh	Freshwater Tidal Mixed Forbs High Marsh	
Bluejoint Wet Meadow	Reed Canarygrass Eastern Marsh	
Bluejoint Wet Meadow	Seasonally Flooded Mixed Graminoid Meadow	
North Atlantic High Salt Marsh	Mid-Atlantic High Salt Marsh	
Red Maple - Blackgum Basin Swamp	Central Appalachian Forested Acid Seep	
Red Maple - Blackgum Basin Swamp	Lower New England Red Maple - Blackgum Swamp	
Red Maple - Blackgum Basin Swamp	Southern Red Maple - Black Gum Swamp Forest	
Central Appalachian White Pine - Eastern Hemlock Forest	White Pine - Hemlock Dry-Mesic Coniferous Forest	

Appendix B. Similar NVC Associations in the Delaware Estuary Watershed

NVC Common Name	Similar Association NVC Common Name	Similar Association Notes
Central Atlantic Freshwater Subtidal River Bed	Northern Atlantic Coast Beaked Ditch-grass Bed	
Central Atlantic Freshwater Subtidal River Bed	Salt Panne Pool	
Reed Canarygrass Eastern Marsh	Bluejoint Wet Meadow	
New Jersey Pitch Pine / Scrub Oak Barren	Mid-Successional Pine - Oak Woodland	
Estuary Quillwort Tidal Flat	North Atlantic Coast Intertidal Mud Flat	is another mudflat community.
Estuary Quillwort Tidal Flat	Estuary Pipewort Freshwater Intertidal Flat	
Mid-Atlantic Mesic Mixed Hardwood Forest	Northeastern Atlantic Coastal Oak - Beech Forest	
Water-hemp Tidal Marsh	Freshwater Tidal Mixed Forbs High Marsh	
Water-hemp Tidal Marsh	Central Atlantic Brackish Marsh	
Hemlock - Beech - Oak Forest	Red Oak - Northern Hardwood Forest	
Hemlock - Beech - Oak Forest	White Pine - Oak Forest	
Southern New Jersey Mesic Pine Barrens	Appalachian Low-Elevation Mixed Pine / Hillside Blueberry Forest	
Red Maple - Tussock Sedge Wooded Marsh	Lower New England Red Maple - Blackgum Swamp	
High Allegheny Rich Red Oak - Sugar Maple Forest	Northeastern Atlantic Coastal Oak - Beech Forest	
High Allegheny Rich Red Oak - Sugar Maple Forest	Hemlock / White Pine - Red Oak - Mixed Hardwood Forest	
Central Appalachian Forested Acid Seep	Red Maple - Blackgum Basin Swamp	
Coastal Loblolly Pine Wetland Forest	Southern Red Maple - Black Gum Swamp Forest	
Successional Maritime Forest	Chesapeake Bay Tall Maritime Shrubland	
Brackish Meadow	Mid-Atlantic Maritime Salt Shrub	
Brackish Meadow	Interdune Switchgrass Brackish Depression	
Lower New England Red Maple - Blackgum Swamp	Red Maple - Blackgum Basin Swamp	
Lower New England Red Maple - Blackgum Swamp	Red Maple - Tussock Sedge Wooded Marsh	
Lower New England Red Maple - Blackgum Swamp	Southern New England Red Maple Seepage Swamp	
Freshwater Tidal Woodland	Ash - Swamp Blackgum Freshwater Tidal Swamp	is the southern analog of this association.
Freshwater Tidal Woodland	North Atlantic Fresh Tidal Shrub Swamp	
Northern Atlantic Coast Beaked Ditch-grass Bed	Central Atlantic Freshwater Subtidal River Bed	
Northern Atlantic Coast Beaked Ditch-grass Bed	Salt Panne Pool	
Red Oak - Northern Hardwood Forest	Hemlock - Beech - Oak Forest	
Red Oak - Northern Hardwood Forest	Northern Hardwood Forest	
Red Oak - Northern Hardwood Forest	White Pine - Oak Forest	
Oligohaline Mixed Forbs Tidal Marsh	Freshwater Tidal Mixed Forbs High Marsh	
River Birch Low Floodplain Forest	Birch - Willow Riverbank Shrubland	on more exposed, heavily scoured shores that support stunted <i>Betula nigra</i> and <i>Platanus occidentalis</i> .
River Birch Low Floodplain Forest	Coastal Plain Streamside Forest	
Highbush Blueberry Bog Thicket	Blueberry Wetland Thicket	
Northeastern Leafy Forb Marsh	Pickereelweed Tidal Marsh	
Southern Red Maple - Black Gum Swamp Forest	Red Maple - Blackgum Basin Swamp	
Southern Red Maple - Black Gum Swamp Forest	Coastal Loblolly Pine Wetland Forest	

NVC Common Name	Similar Association NVC Common Name	Similar Association Notes
Northern Hardwood Forest	Red Oak - Northern Hardwood Forest	
Virginia Pine Serpentine Forest	Serpentine Emergent Wetland	
Virginia Pine Serpentine Forest	Serpentine Red Maple - Oak - Catbrier Serpentine Forest	
Virginia Pine Serpentine Forest	Serpentine Red Maple - Pine Forest	
Virginia Pine Serpentine Forest	Serpentine Red-cedar - Virginia Pine - Catbrier Serpentine Forest	
Virginia Pine Serpentine Forest	Serpentine Indiangrass - Little Bluestem Grassland	
Virginia Pine Serpentine Forest	Serpentine Little Bluestem - Prairie Dropseed Grassland	
Virginia Pine Serpentine Forest	Appalachian Low-Elevation Mixed Pine / Hillside Blueberry Forest	
Northern Beachgrass Dune	Beachgrass - Panicgrass Dune Grassland	
Ash - Swamp Blackgum Freshwater Tidal Swamp	Freshwater Tidal Woodland	is the northern analog of this association.
Ash - Swamp Blackgum Freshwater Tidal Swamp	Red Maple / Seaside Alder Woodland	
White Pine - Oak Forest	Hemlock - Beech - Oak Forest	
White Pine - Oak Forest	Red Oak - Northern Hardwood Forest	
White Pine - Oak Forest	Northeastern Dry Oak-Hickory Forest	has less pine, more hickory, and little or no beech, but can intergrade to this type.
Atlantic White-cedar / Seaside Alder Swamp	Red Maple / Seaside Alder Woodland	
Serpentine Emergent Wetland	Virginia Pine Serpentine Forest	
Serpentine Emergent Wetland	Serpentine Red Maple - Oak - Catbrier Serpentine Forest	
Serpentine Emergent Wetland	Serpentine Red Maple - Pine Forest	
Serpentine Emergent Wetland	Serpentine Red-cedar - Virginia Pine - Catbrier Serpentine Forest	
Serpentine Emergent Wetland	Serpentine Indiangrass - Little Bluestem Grassland	
Serpentine Emergent Wetland	Serpentine Little Bluestem - Prairie Dropseed Grassland	
Red Maple / Seaside Alder Woodland	Ash - Swamp Blackgum Freshwater Tidal Swamp	This community has many other canopy dominants; however, Acer rubrum (red maple) is included. The two communities share very similar environments along tidal rivers (or former tidal rivers). This community is potentially related to the successional predecessor
Red Maple / Seaside Alder Woodland	Atlantic White-cedar / Seaside Alder Swamp	These communities occupy similar streamside basin swamps, they have been influenced by similar anthropogenic disturbances, and they share many of the same species; however, the difference between the associations is the dominant canopy species, Atlantic white cedar.
Chesapeake Bay Tall Maritime Shrubland	Successional Maritime Forest	
Freshwater Tidal Mixed Forbs High Marsh	Pickerelweed Tidal Marsh	
Freshwater Tidal Mixed Forbs High Marsh	Water-hemp Tidal Marsh	
Freshwater Tidal Mixed Forbs High Marsh	Oligohaline Mixed Forbs Tidal Marsh	
White Pine - Hemlock Dry-Mesic Coniferous Forest	Central Appalachian White Pine - Eastern Hemlock Forest	
Northeastern Dry Oak-Hickory Forest	White Pine - Oak Forest	can intergrade with this type in New England but is characterized by Fagus grandifolia (beech) (more or less absent in Northeastern Dry-Oak hickory forest), a greater amount of Pinus strobus (white pine) in the canopy (usually >20%), and little or no Carya (hickory).
Northeastern Dry Oak-Hickory Forest	Northeastern Coastal Oak - Heath Forest	lacks Viburnum acerifolium (maple leaf viburnum) and Cornus florida (flowering dogwood) and in general is less diverse and occurring on relatively more nutrient-poor soils.
North Atlantic Fresh Tidal Shrub	Freshwater Tidal Woodland	

Appendix B. Similar NVC Associations in the Delaware Estuary Watershed

NVC Common Name	Similar Association NVC Common Name	Similar Association Notes
Swamp		
North Atlantic Fresh Tidal Shrub Swamp	Alluvial Alder Swamp	
Northeastern Atlantic Brackish Interdunal Swale	Overwash Dune Grassland	
Woolgrass Marsh	Seasonally Flooded Mixed Graminoid Meadow	
Estuary Pipewort Freshwater Intertidal Flat	North Atlantic Coast Intertidal Mud Flat	
Estuary Pipewort Freshwater Intertidal Flat	Estuary Quillwort Tidal Flat	
Inland Dune Ridge Forest	Appalachian Low-Elevation Mixed Pine / Hillside Blueberry Forest	
Salt Panne Pool	Central Atlantic Freshwater Subtidal River Bed	
Salt Panne Pool	Northern Atlantic Coast Beaked Ditch-grass Bed	
Blueberry Wetland Thicket	Highbush Blueberry Bog Thicket	
Coastal Oak / Laurel Forest	Coastal Plain Chestnut Oak - Beech Forest	
Northeastern Coastal Oak - Heath Forest	Northeastern Dry Oak-Hickory Forest	
Northeastern Atlantic Coastal Oak - Beech Forest	Mid-Atlantic Mesic Mixed Hardwood Forest	
Northeastern Atlantic Coastal Oak - Beech Forest	High Allegheny Rich Red Oak - Sugar Maple Forest	
Mid-Successional Pine - Oak Woodland	New Jersey Pitch Pine / Scrub Oak Barren	
Southern New England Red Maple Seepage Swamp	Lower New England Red Maple - Blackgum Swamp	
Eastern Tussock Sedge Meadow	Seasonally Flooded Mixed Graminoid Meadow	
Alluvial Alder Swamp	North Atlantic Fresh Tidal Shrub Swamp	
Alkali Bulrush Brackish Marsh	Brackish Tidal Low Marsh	
Alkali Bulrush Brackish Marsh	Central Atlantic Brackish Marsh	
Central Atlantic Brackish Marsh	Brackish Tidal Low Marsh	
Central Atlantic Brackish Marsh	Water-hemp Tidal Marsh	
Central Atlantic Brackish Marsh	Alkali Bulrush Brackish Marsh	
Central Atlantic Brackish Marsh	Mesohaline Seepage Marsh	
Mesohaline Seepage Marsh	Brackish Tidal Low Marsh	
Mesohaline Seepage Marsh	Central Atlantic Brackish Marsh	
Serpentine Red Maple - Oak - Catbrier Serpentine Forest	Virginia Pine Serpentine Forest	
Serpentine Red Maple - Oak - Catbrier Serpentine Forest	Serpentine Emergent Wetland	
Serpentine Red Maple - Oak - Catbrier Serpentine Forest	Serpentine Red Maple - Pine Forest	
Serpentine Red Maple - Oak - Catbrier Serpentine Forest	Serpentine Red-cedar - Virginia Pine - Catbrier Serpentine Forest	
Serpentine Red Maple - Oak - Catbrier Serpentine Forest	Serpentine Indiangrass - Little Bluestem Grassland	
Serpentine Red Maple - Oak - Catbrier Serpentine Forest	Serpentine Little Bluestem - Prairie Dropseed Grassland	
Serpentine Red Maple - Pine Forest	Virginia Pine Serpentine Forest	
Serpentine Red Maple - Pine Forest	Serpentine Emergent Wetland	
Serpentine Red Maple - Pine Forest	Serpentine Red Maple - Oak - Catbrier Serpentine Forest	
Serpentine Red Maple - Pine Forest	Serpentine Red-cedar - Virginia Pine - Catbrier Serpentine Forest	
Serpentine Red Maple - Pine Forest	Serpentine Indiangrass - Little Bluestem Grassland	
Serpentine Red Maple - Pine Forest	Serpentine Little Bluestem - Prairie	

NVC Common Name	Similar Association NVC Common Name	Similar Association Notes
	Dropseed Grassland	
Serpentine Red-cedar - Virginia Pine - Catbrier Serpentine Forest	Virginia Pine Serpentine Forest	
Serpentine Red-cedar - Virginia Pine - Catbrier Serpentine Forest	Serpentine Emergent Wetland	
Serpentine Red-cedar - Virginia Pine - Catbrier Serpentine Forest	Serpentine Red Maple - Oak - Catbrier Serpentine Forest	
Serpentine Red-cedar - Virginia Pine - Catbrier Serpentine Forest	Serpentine Red Maple - Pine Forest	
Serpentine Red-cedar - Virginia Pine - Catbrier Serpentine Forest	Serpentine Indiangrass - Little Bluestem Grassland	
Serpentine Red-cedar - Virginia Pine - Catbrier Serpentine Forest	Serpentine Little Bluestem - Prairie Dropseed Grassland	
Serpentine Indiangrass - Little Bluestem Grassland	Virginia Pine Serpentine Forest	
Serpentine Indiangrass - Little Bluestem Grassland	Serpentine Emergent Wetland	
Serpentine Indiangrass - Little Bluestem Grassland	Serpentine Red Maple - Oak - Catbrier Serpentine Forest	
Serpentine Indiangrass - Little Bluestem Grassland	Serpentine Red Maple - Pine Forest	
Serpentine Indiangrass - Little Bluestem Grassland	Serpentine Red-cedar - Virginia Pine - Catbrier Serpentine Forest	
Serpentine Indiangrass - Little Bluestem Grassland	Serpentine Little Bluestem - Prairie Dropseed Grassland	
Serpentine Little Bluestem - Prairie Dropseed Grassland	Virginia Pine Serpentine Forest	
Serpentine Little Bluestem - Prairie Dropseed Grassland	Serpentine Emergent Wetland	
Serpentine Little Bluestem - Prairie Dropseed Grassland	Serpentine Red Maple - Oak - Catbrier Serpentine Forest	
Serpentine Little Bluestem - Prairie Dropseed Grassland	Serpentine Red Maple - Pine Forest	
Serpentine Little Bluestem - Prairie Dropseed Grassland	Serpentine Red-cedar - Virginia Pine - Catbrier Serpentine Forest	
Serpentine Little Bluestem - Prairie Dropseed Grassland	Serpentine Indiangrass - Little Bluestem Grassland	
Kittatinny Ridge Sparsely Vegetated Sandstone Cliff	Piedmont Cliff (Acidic Type)	occurs primarily in the Southeast, within topographically low settings such as river bluffs that are not subject to flood scouring.
Seasonally Flooded Mixed Graminoid Meadow	Bluejoint Wet Meadow	
Seasonally Flooded Mixed Graminoid Meadow	Woolgrass Marsh	
Seasonally Flooded Mixed Graminoid Meadow	Eastern Tussock Sedge Meadow	
Hemlock / White Pine - Red Oak - Mixed Hardwood Forest	High Allegheny Rich Red Oak - Sugar Maple Forest	
Northeastern Modified Successional Forest	Black Locust Successional Forest	
Coastal Plain Streamside Forest	River Birch Low Floodplain Forest	
Transitional Tidal Marsh	Atlantic Coast Brackish Tidal Marsh	
Pine Barrens Floodplain Forest	Small River Red Maple - Elm Floodplain Forest	
Coastal Plain Chestnut Oak - Beech Forest	Coastal Oak / Laurel Forest	
Small River Red Maple - Elm Floodplain Forest	Pine Barrens Floodplain Forest	
Appalachian Low-Elevation Mixed Pine / Hillside Blueberry Forest	Virginia Pine Successional Forest	is distinguished from this community by differences in land-use history; Virginia Pine Successional Forest exists in flat to moderately sloping land that was heavily plowed in the recent past (10-60 years), whereas this community is generally a product of less disturbed soils and more historic disturbance by fire or logging without plowing.

Appendix B. Similar NVC Associations in the Delaware Estuary Watershed

NVC Common Name	Similar Association NVC Common Name	Similar Association Notes
Appalachian Low-Elevation Mixed Pine / Hillside Blueberry Forest	Southern New Jersey Mesic Pine Barrens	
Appalachian Low-Elevation Mixed Pine / Hillside Blueberry Forest	Virginia Pine Serpentine Forest	
Appalachian Low-Elevation Mixed Pine / Hillside Blueberry Forest	Inland Dune Ridge Forest	
Black Locust Successional Forest	Northeastern Modified Successional Forest	can have Robinia (black locust) as an important canopy component but is not dominated by it as is this type.

Appendix C. NVC and State Classification Crosswalk Table

Introduction

This Appendix identifies the crosswalk between the NVC association and state community type in the New Jersey, Delaware and Pennsylvania State Vegetation Classifications. In many cases, the state name of the community type is the same as the NVC name and the types are equivalent. However, in some cases, the NVC global name and state classification name are different, but the types are equivalent in concept. Another scenario occurs where the NVC global name and state classification name are different and the elements are not equivalent in concept. This table identifies the various relationships between NVC associations and state types. If an association from *The Guide* is not listed, it simply may not have a crosswalk to a state type because a suitable match does not yet exist, or the types may not be documented in classification documents.

Definitions of Fields

NVC Common Name: Primary common or colloquial name of the association. This name contrasts from the translated name for the association, which is the word-for-word translation of the latin scientific name (also called the Global Name) for the association. The common name is used as the primary name in the Guide.

State: US State where the association occurs.

NVC Global Scientific Name: This is the global name of the element in the National Vegetation Classification System. The names of dominant and diagnostic species are the foundation of Association global names. Species occurring in the same stratum are separated by a hyphen (-), and 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. Species less consistently found in all occurrences of the Association are placed in parentheses ().

State Classification Name ≠ NVC Global Name: The State Name listed is the state name referenced in the state natural community classification that has a different name from the NVC Global Name.

Relationship to Standard: The classifiers broader, finer, intersects, undetermined, and equivalent indicate whether the type designated in the State Classification is more or less, inclusive of the global element concept designated by the Global Scientific Name or NVC Common Name.

Values for Relationship:

Broader: the concept of the state community is broader than the global element concept

Finer: the concept of the state community is finer (more narrow) than the global element concept

Intersects: the concepts of the state community and the global element overlap (i.e. neither fully in includes the other) and are related in a way that is more complex than a simple "broader / finer" relationship.

Undetermined: the relationship of the state community to the global element has not been determined

Equivalent: concept designated in state community name is equivalent to the global element concept

Reference: This field identifies the reference to the Delaware, New Jersey, or Pennsylvania state natural community classifications that identify the state name of the community.

- Bowman, P. 2000. Draft classification for Delaware. Unpublished draft. Delaware Natural Heritage Program. Division of Fish and Wildlife, Delaware Division of Natural Resources and Environmental Control, Smyrna, DE.
- 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.
- 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.
- 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.

Not referenced in classification (unassigned): This classifier indicates that NatureServe and the state Natural Heritage Program consider the type to occur in the state, but the NVC type has not been assigned a crosswalk in the state classification. This could be due to the fact that there may not be a suitable match between a NVC type and a state type or because the type may not yet be documented in the state classification.

Appendix C: Delaware Estuary NVC Association Crosswalks to State Natural Community Classifications

NVC Association Common Name	State	NVC Global Scientific Name	State Classification Name # NVC Global Name	Relationship to NVC Standard	Reference
Alluvial Alder Swamp	DE	Cornus amomum - Alnus serrulata Shrubland	same as global	Equivalent	Bowman 2000
Appalachian Low-Elevation Mixed Pine / Hillside Blueberry Forest	PA	Pinus virginiana - Pinus (rigida, echinata) - (Quercus prinus) / Vaccinium pallidum Forest	Virginia pine - mixed hardwood forest	Broader	Fike 1999
Ash - Swamp Blackgum Freshwater Tidal Swamp	DE	Fraxinus (profunda, pennsylvanica) - (Nyssa biflora) / Polygonum arifolium Forest	Acer rubrum - Fraxinus (pennsylvanica, profunda) Tidal Forest	Equivalent	Clancy 1996
Atlantic Coast Brackish Tidal Marsh	NJ	Scirpus pungens Tidal Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Atlantic Coast Interdune Swale	DE	Morella cerifera / Spartina patens Shrubland	Morella cerifera - Baccharis halmifolia / Spartina patens Shrubland	Equivalent	Bowman 2000
Atlantic Coast Interdune Swale	NJ	Morella cerifera / Spartina patens Shrubland	Morella cerifera - Baccharis halmifolia / Spartina patens Shrubland	Equivalent	Breden et al. 2001
Atlantic Coast Wild Rice Tidal Marsh	NJ	Zizania aquatica Tidal Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Atlantic Coast Wild Rice Tidal Marsh	DE	Zizania aquatica Tidal Herbaceous Vegetation	same as global	Equivalent	Bowman 2000
Atlantic Giant Cordgrass Marsh	NJ	Spartina cynosuroides Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Atlantic Giant Cordgrass Marsh	DE	Spartina cynosuroides Herbaceous Vegetation	Spartina cynosuroides Tidal Herbaceous Vegetation	Equivalent	Clancy 1996
Atlantic White-cedar / Seaside Alder Swamp	DE	Chamaecyparis thyoides / Alnus maritima Woodland	same as global	Undetermined	Clancy 1996
Beachgrass - Panicgrass Dune Grassland	NJ	Ammophila breviligulata - Panicum amarum var. amarum Herbaceous Vegetation	Ammophila breviligulata - Panicum amarum Herbaceous Vegetation	Equivalent	Breden et al. 2001
Beachgrass - Panicgrass Dune Grassland	DE	Ammophila breviligulata - Panicum amarum var. amarum Herbaceous Vegetation	Ammophila breviligulata - Panicum amarum Herbaceous Vegetation	Equivalent	Clancy 1996
Birch - Willow Riverbank Shrubland	PA	Betula nigra - Platanus occidentalis - Salix (interior, caroliniana) Shrubland	River birch - sycamore floodplain scrub	Undetermined	Fike 1999
Black Locust Successional Forest	PA	Robinia pseudoacacia Forest	Black locust forest	Undetermined	Fike 1999
Blueberry Wetland Thicket	PA	Vaccinium corymbosum - Rhododendron viscosum - Clethra alnifolia Shrubland	Highbush blueberry - meadow-sweet wetland	Undetermined	Fike 1999
Blueberry Wetland Thicket	DE	Vaccinium corymbosum - Rhododendron viscosum - Clethra alnifolia Shrubland	same as global	Equivalent	Bowman 2000
Blueberry Wetland Thicket	NJ	Vaccinium corymbosum - Rhododendron viscosum - Clethra alnifolia Shrubland	same as global	Equivalent	Breden et al. 2001
Bluejoint Wet Meadow	PA	Calamagrostis canadensis - Phalaris arundinacea Herbaceous Vegetation	Bluejoint - reed canary grass marsh	Broader	Fike 1999
Brackish Meadow	DE	Panicum virgatum - Spartina patens Herbaceous Vegetation	Panicum virgatum Tidal Herbaceous Vegetation	Equivalent	Clancy 1996
Brackish Meadow	NJ	Panicum virgatum - Spartina patens Herbaceous Vegetation	Panicum virgatum - Carex silicea Herbaceous Vegetation	Equivalent	Breden et al. 2001
Brackish Tidal Low Marsh	DE	Spartina alterniflora - Lilaopsis chinensis Herbaceous Vegetation	same as global	Undetermined	Clancy 1996
Brackish Tidal Low Marsh	NJ	Spartina alterniflora - Lilaopsis chinensis Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Bulrush Deepwater Marsh	NJ	Schoenoplectus (tabernaemontani, acutus) Eastern Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Bulrush Deepwater Marsh	PA	Schoenoplectus (tabernaemontani, acutus) Eastern Herbaceous Vegetation	Bulrush marsh	Broader	Fike 1999
Buttonbush Coastal Plain Pond	DE	Cephalanthus occidentalis / Polygonum hydropiperoides - Panicum verrucosum Shrubland	Cephalanthus occidentalis / Panicum verrucosum - Dichantherium spretum - Rhexia virginica - Fimbristylis autumnalis Shrubland	Undetermined	Clancy 1996

NVC Association Common Name	State	NVC Global Scientific Name	State Classification Name # NVC Global Name	Relationship to NVC Standard	Reference
Calcareous Shrub Fen	PA	Cornus amomum - Salix candida / Dasiphora fruticosa ssp. floribunda / Carex stricta Shrubland	Poison sumac - red-cedar - bayberry fen	Broader	Fike 1999
Cape May - Delmarva Depression Meadow	DE	Cladium mariscoides - Coelorachis rugosa Herbaceous Vegetation	Dichanthelium spretum - Cladium mariscoides Herbaceous Vegetation	Undetermined	Clancy 1996
Cape May - Delmarva Depression Meadow	NJ	Cladium mariscoides - Coelorachis rugosa Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Cape May Lowland Swamp	NJ	Acer rubrum - Nyssa sylvatica - Liquidambar styraciflua - Populus heterophylla Forest	same as global	Equivalent	Breden et al. 2001
Cattail Brackish Tidal Marsh	NJ	Typha angustifolia - Hibiscus moscheutos Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Cattail Brackish Tidal Marsh	DE	Typha angustifolia - Hibiscus moscheutos Herbaceous Vegetation	same as global	Equivalent	Bowman 2000
Central Appalachian / Northern Piedmont Low-Elevation Chestnut Oak Forest	PA	Quercus prinus - (Quercus coccinea, Quercus velutina) / Kalmia latifolia / Vaccinium pallidum Forest	Dry oak - heath forest	Intersects	Fike 1999
Central Appalachian Blueberry Shrubland	PA	Vaccinium (angustifolium, myrtilloides, pallidum) High Allegheny Plateau / Central Appalachian Dwarf-shrubland	Low heath shrubland	Undetermined	Fike 1999
Central Appalachian Forested Acid Seep	PA	Acer rubrum - Nyssa sylvatica High Allegheny Plateau, Central Appalachian Forest	Red maple - black-gum palustrine forest	Broader	Fike 1999
Central Appalachian Rich Cove Forest	PA	Acer saccharum - Fraxinus americana - Tilia americana - Liriodendron tulipifera / Actaea racemosa Forest	Sugar maple - basswood forest	Broader	Fike 1999
Central Appalachian White Pine - Eastern Hemlock Forest	PA	Pinus strobus - Tsuga canadensis / Acer pensylvanicum / Polystichum acrostichoides Forest	Hemlock (white pine) forest	Broader	Fike 1999
Central Atlantic Brackish Marsh	DE	Spartina alterniflora - Amaranthus cannabinus Herbaceous Vegetation	Spartina alterniflora - Amaranthus cannabinus Herbaceous Vegetation	Undetermined	Clancy 1996
Central Atlantic Freshwater Subtidal River Bed	NJ	Stuckenia pectinata - Potamogeton perfoliatus - (Zannichellia palustris) Tidal Herbaceous Vegetation	Stuckenia pectinata - Zannichellia palustris - (Ruppia maritima) Permanently Flooded-Tidal Herbaceous Vegetation	Equivalent	Breden et al. 2001
Central Atlantic Freshwater Subtidal River Bed	DE	Stuckenia pectinata - Potamogeton perfoliatus - (Zannichellia palustris) Tidal Herbaceous Vegetation	Zannichellia palustris Herbaceous Vegetation	Equivalent	Clancy 1996
Central Coast Beach Heather Dune Shrubland	DE	Hudsonia tomentosa / Panicum amarum var. amarulum Dwarf-shrubland	same as global	Equivalent	Bowman 2000
Chesapeake Bay Tall Maritime Shrubland	NJ	Prunus serotina / Morella cerifera / Smilax rotundifolia Forest	same as global	Equivalent	Breden et al. 2001
Chesapeake Bay Tall Maritime Shrubland	DE	Prunus serotina / Morella cerifera / Smilax rotundifolia Shrubland	same as global	Equivalent	Bowman 2000
Chesapeake Red Maple Swamp	NJ	Acer rubrum - Fraxinus pennsylvanica / Saururus cernuus Forest	same as global	Equivalent	Breden et al. 2001
Chestnut Oak - Black Birch Wooded Talus Slope	PA	Quercus prinus - Betula lenta / Parthenocissus quinquefolia Talus Woodland	Birch (black-gum) rocky slope woodland	Broader	Fike 1999
Coastal Freshwater Marsh	NJ	Schoenoplectus pungens var. pungens - Juncus canadensis Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Coastal Loblolly Pine Wetland Forest	DE	Pinus taeda / Morella cerifera / Osmunda regalis var. spectabilis Forest	Pinus taeda Forested Wetland Series	Undetermined	Clancy 1996
Coastal Loblolly Pine Wetland Forest	NJ	Pinus taeda / Morella cerifera / Osmunda regalis var. spectabilis Forest	same as global	Equivalent	Breden et al. 2001
Coastal Oak / Laurel Forest	NJ	Quercus velutina - Quercus coccinea - Quercus prinus / Kalmia latifolia Forest	same as global	Equivalent	Breden et al. 2001

Appendix C: Delaware Estuary NVC Association Crosswalks to State Natural Community Classifications

NVC Association Common Name	State	NVC Global Scientific Name	State Classification Name # NVC Global Name	Relationship to NVC Standard	Reference
Coastal Pitch Pine / Scrub Oak Barren	NJ	<i>Pinus rigida</i> / <i>Quercus ilicifolia</i> / <i>Morella pensylvanica</i> Woodland	same as global	Equivalent	Breden et al. 2001
Coastal Plain Atlantic White-cedar Swamp	DE	<i>Chamaecyparis thyoides</i> / <i>Ilex glabra</i> - <i>Rhododendron viscosum</i> Forest	<i>Chamaecyparis thyoides</i> / <i>Ilex glabra</i> / Mixed Herbaceous Forest	Undetermined	Clancy 1996
Coastal Plain Atlantic White-cedar Swamp	NJ	<i>Chamaecyparis thyoides</i> / <i>Ilex glabra</i> - <i>Rhododendron viscosum</i> Forest	<i>Chamaecyparis thyoides</i> / <i>Ilex glabra</i> Forest	Equivalent	Breden et al. 2001
Coastal Plain Mesic Pine Barrens	NJ	<i>Pinus rigida</i> / <i>Quercus ilicifolia</i> - <i>Kalmia angustifolia</i> / <i>Pyxidanthera barbulata</i> Woodland	same as global	Equivalent	Breden et al. 2001
Coastal Plain Muck Pondshore	NJ	<i>Rhexia virginica</i> - <i>Panicum verrucosum</i> Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Coastal Plain Muck Pondshore	DE	<i>Rhexia virginica</i> - <i>Panicum verrucosum</i> Herbaceous Vegetation	<i>Panicum</i> spp. - <i>Eleocharis</i> spp. - <i>Scleria reticularis</i> Herbaceous Vegetation	Undetermined	Clancy 1996
Coastal Plain Pond	DE	<i>Nymphaea odorata</i> - <i>Eleocharis robbinsii</i> Herbaceous Vegetation	<i>Nymphaea odorata</i> - <i>Eleocharis robbinsii</i> Herbaceous Vegetation	Undetermined	Clancy 1996
Coastal Plain Pond	NJ	<i>Nymphaea odorata</i> - <i>Eleocharis robbinsii</i> Herbaceous Vegetation		Equivalent	Breden et al. 2001
Coastal Plain Pondshore	DE	<i>Dulichium arundinaceum</i> - <i>Juncus canadensis</i> - <i>Juncus pelocarpus</i> Herbaceous Vegetation	<i>Dulichium arundinaceum</i> - <i>Juncus canadensis</i> Herbaceous Vegetation	Undetermined	Clancy 1996
Deep Muck Coastal Plain Pond	DE	<i>Eleocharis flavescens</i> - <i>Xyris difformis</i> Herbaceous Vegetation	<i>Xyris difformis</i> var. <i>difformis</i> Herbaceous Vegetation	Undetermined	Clancy 1996
East-central Hemlock Hardwood Forest	PA	<i>Tsuga canadensis</i> - <i>Fagus grandifolia</i> - <i>Acer saccharum</i> / (<i>Hamamelis virginiana</i> , <i>Kalmia latifolia</i>) Forest	Hemlock - tuliptree - birch forest	Broader	Fike 1999
Eastern Cattail Marsh	PA	<i>Typha</i> (<i>angustifolia</i> , <i>latifolia</i>) - (<i>Schoenoplectus</i> spp.) Eastern Herbaceous Vegetation	Cattail Marsh	Undetermined	Fike 1999
Eastern Cattail Marsh	DE	<i>Typha</i> (<i>angustifolia</i> , <i>latifolia</i>) - (<i>Schoenoplectus</i> spp.) Eastern Herbaceous Vegetation	<i>Typha</i> (<i>angustifolia</i> , <i>latifolia</i>) - (<i>Scirpus</i> spp.) Herbaceous Vegetation	Equivalent	Clancy 1996
Eastern Cattail Marsh	NJ	<i>Typha</i> (<i>angustifolia</i> , <i>latifolia</i>) - (<i>Schoenoplectus</i> spp.) Eastern Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Eastern Hemlock - Great Laurel Swamp	PA	<i>Tsuga canadensis</i> / <i>Rhododendron maximum</i> / <i>Sphagnum</i> spp. Forest	Hemlock-mixed hardwood palustrine forest	Intersects	Fike 1999
Eastern Reed Marsh	DE	<i>Phragmites australis</i> Eastern North America Temperate Semi-natural Herbaceous Vegetation	<i>Phragmites australis</i> Semipermanently Flooded Ruderal Herbaceous Vegetation	Equivalent	Bowman 2000
Eastern Tussock Sedge Meadow	PA	<i>Carex stricta</i> - <i>Carex vesicaria</i> Herbaceous Vegetation	Tussock sedge marsh	Undetermined	Fike 1999
Estuary Pipewort Freshwater Intertidal Flat	NJ	<i>Eriocaulon parkeri</i> - <i>Polygonum punctatum</i> Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Estuary Quillwort Tidal Flat	NJ	<i>Isoetes riparia</i> Tidal Sparse Vegetation	same as global	Equivalent	Breden et al. 2001
Fall-line Riverwash Bedrock Prairie	PA	<i>Andropogon gerardii</i> - <i>Panicum virgatum</i> - <i>Baptisia australis</i> Herbaceous Vegetation	Big bluestem - Indian grass river grassland	Broader	Fike 1999
Floodplain Pool	NJ	<i>Peltandra virginica</i> - <i>Saururus cernuus</i> - <i>Carex crinita</i> / <i>Climacium americanum</i> Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Freshwater Tidal Mixed Forbs High Marsh	DE	<i>Impatiens capensis</i> - <i>Peltandra virginica</i> - <i>Sagittaria latifolia</i> - (<i>Typha angustifolia</i>) Tidal Herbaceous Vegetation	<i>Impatiens capensis</i> - <i>Sagittaria latifolia</i> - <i>Peltandra virginica</i> Tidal Herbaceous Vegetation	Equivalent	Clancy 1996
Freshwater Tidal Woodland	NJ	<i>Acer rubrum</i> - <i>Fraxinus pensylvanica</i> / <i>Polygonum</i> spp. Forest	<i>Acer rubrum</i> - <i>Fraxinus pensylvanica</i> / <i>Polygonum</i> spp. Woodland	Equivalent	Breden et al. 2001
Golden-saxifrage Forested Seep	PA	<i>Chrysosplenium americanum</i> Herbaceous Vegetation	Skunk cabbage - golden saxifrage forest seep	Finer	Fike 1999

NVC Association Common Name	State	NVC Global Scientific Name	State Classification Name # NVC Global Name	Relationship to NVC Standard	Reference
Golden-saxifrage Forested Seep	DE	Chrysosplenium americanum Herbaceous Vegetation	Symplocarpus foetidus / Brachythecium rivulare - Hygroamblystegium tenax Herbaceous Vegetation	Finer	Clancy 1996
Green Ash - Mixed Hardwood Floodplain Forest	NJ	Fraxinus pennsylvanica - (Juglans nigra, Platanus occidentalis) Forest	same as global	Equivalent	Breden et al. 2001
Green Ash - Mixed Hardwood Floodplain Forest	PA	Fraxinus pennsylvanica - (Juglans nigra, Platanus occidentalis) Forest	Green Ash - Mixed Hardwood Floodplain Forest	Equivalent	Fike 1999
Hemlock - Beech - Oak Forest	PA	Tsuga canadensis - Fagus grandifolia - Quercus rubra Forest	Hemlock - (white pine) - northern hardwood forest	Broader	Fike 1999
Hemlock / White Pine - Red Oak - Mixed Hardwood Forest	PA	Quercus rubra - Tsuga canadensis - Liriodendron tulipifera / Hamamelis virginiana Forest	Hemlock - tuliptree - birch forest	Broader	Fike 1999
High Allegheny Rich Red Oak - Sugar Maple Forest	PA	Quercus rubra - Acer saccharum - Liriodendron tulipifera Forest	Red oak - mixed hardwood forest	Broader	Fike 1999
Highbush Blueberry Bog Thicket	NJ	Vaccinium corymbosum / Sphagnum spp. Shrubland	same as global	Equivalent	Breden et al. 2001
Highbush Blueberry Bog Thicket	PA	Vaccinium corymbosum / Sphagnum spp. Shrubland	Highbush blueberry - sphagnum wetland	Equivalent	Fike 1999
Inland Dune Ridge Forest	DE	Pinus virginiana - Quercus falcata - Carya pallida Forest	Pinus virginiana - Quercus spp. - Carya pallida Forest	Undetermin ed	Clancy 1996
Inland Dune Ridge Forest	NJ	Pinus virginiana - Quercus falcata - Carya pallida Forest	same as global	Equivalent	Breden et al. 2001
Interdune Switchgrass Brackish Depression	DE	(Morella cerifera) - Panicum virgatum - Spartina patens Herbaceous Vegetation	Panicum virgatum - Spartina patens Herbaceous Vegetation	Equivalent	Bowman 2000
Little Bluestem - Poverty Grass Low- to Mid-Elevation Outcrop Opening	PA	Schizachyrium scoparium - Danthonia spicata - Carex pennsylvanica / Cladonia spp. Herbaceous Vegetation	Little bluestem - Pennsylvania sedge opening	Undetermin ed	Fike 1999
Loblolly Pine Dune Woodland	DE	Pinus taeda / Hudsonia tomentosa Woodland	Loblolly Pine Dune Woodland	Equivalent	Clancy 1996
Lower New England Red Maple - Black Gum Swamp	NJ	Acer rubrum / Rhododendron viscosum - Clethra alnifolia Forest	same as global	Equivalent	Breden et al. 2001
Maritime Holly Forest	NJ	Ilex opaca / Morella pensylvanica Forest	same as global	Equivalent	Breden et al. 2001
Maritime Red-cedar Woodland	DE	Juniperus virginiana var. virginiana / Morella pensylvanica Woodland	Maritime Red-cedar Woodland	Equivalent	Clancy 1996
Maritime Red-cedar Woodland	NJ	Juniperus virginiana var. virginiana / Morella pensylvanica Woodland	same as global	Equivalent	Breden et al. 2001
Mesic Coastal Plain Oak Forest	DE	Quercus falcata - Quercus phellos / Ilex opaca Forest	same as global	Undetermin ed	Clancy 1996
Mesic Coastal Plain Oak Forest	NJ	Quercus falcata - Quercus phellos / Ilex opaca Forest	same as global	Equivalent	Breden et al. 2001
Mesohaline Seepage Marsh	DE	Spartina alterniflora - Ptilimnium capillaceum - Polygonum punctatum Herbaceous Vegetation	same as global	Undetermin ed	Clancy 1996
Mid-Atlantic High Salt Marsh	DE	Spartina patens - Distichlis spicata - Juncus roemerianus Herbaceous Vegetation	Spartina patens - Distichlis spicata Herbaceous Vegetation	Equivalent	Clancy 1996
Mid-Atlantic Maritime Salt Shrub	NJ	Baccharis halimifolia - Iva frutescens / Spartina patens Shrubland	same as global	Equivalent	Breden et al. 2001
Mid-Atlantic Maritime Salt Shrub	DE	Baccharis halimifolia - Iva frutescens / Spartina patens Shrubland	Baccharis halimifolia - Iva frutescens Shrubland	Equivalent	Clancy 1996
Mid-Atlantic Mesic Mixed Hardwood Forest	NJ	Fagus grandifolia - Quercus (alba, rubra) - Liriodendron tulipifera / Polystichum acrostichoides Forest	Fagus grandifolia - Quercus alba - Liriodendron tulipifera - Carya spp. Forest	Equivalent	Breden et al. 2001
Mid-Atlantic Mesic Mixed Hardwood Forest	DE	Fagus grandifolia - Quercus (alba, rubra) - Liriodendron tulipifera / Polystichum acrostichoides Forest	Fagus grandifolia - Quercus alba - Liriodendron tulipifera - Liquidambar styraciflua Forest	Equivalent	Clancy 1996
Mid-Atlantic Terrace Hardwood Floodplain Forest	NJ	Liriodendron tulipifera - Fraxinus spp. / Liriodendron benzoin - Viburnum prunifolium / Podophyllum peltatum Forest	same as global	Equivalent	Breden et al. 2001
Mid-Successional Pine - Oak Woodland	NJ	Pinus rigida - (Pinus echinata) / Quercus (marilandica, ilicifolia) / Vaccinium pallidum Woodland	same as global	Equivalent	Breden et al. 2001

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NVC Association Common Name	State	NVC Global Scientific Name	State Classification Name # NVC Global Name	Relationship to NVC Standard	Reference
Montane Cliff (Calcareous Type)	PA	Asplenium ruta-muraria - Pellaea atropurpurea Sparse Vegetation	Calcareous opening/cliff	Undetermined	Fike 1999
New Jersey Pitch Pine / Scrub Oak Barren	NJ	Pinus rigida / Quercus (marilandica, ilicifolia) / Pyxidantha barbulata Woodland	same as global	Equivalent	Breden et al. 2001
North Atlantic Coast Intertidal Mud Flat	NJ	Sagittaria subulata - Limosella australis Tidal Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
North Atlantic Coastal Oak - Holly Forest	NJ	Quercus velutina / Ilex opaca Forest	Quercus velutina - Fagus grandifolia - Sassafras albidum / Ilex opaca Forest	Equivalent	Breden et al. 2001
North Atlantic Coastal Plain Vine Dune	DE	Smilax glauca - Toxicodendron radicans Vine-Shrubland	same as global	Equivalent	Bowman 2000
North Atlantic Fresh Tidal Shrub Swamp	NJ	Alnus (incana ssp. rugosa, serrulata) - Cornus amomum Shrubland	same as global	Equivalent	Breden et al. 2001
North Atlantic Fresh Tidal Shrub Swamp	DE	Alnus (incana ssp. rugosa, serrulata) - Cornus amomum Shrubland	Alnus serrulata - Cornus amomum Shrubland	Equivalent	Clancy 1996
North Atlantic High Salt Marsh	NJ	Spartina patens - Distichlis spicata - (Juncus gerardii) Herbaceous Vegetation	Spartina patens - Distichlis spicata - Plantago maritima Herbaceous Vegetation	Equivalent	Breden et al. 2001
North Atlantic High Salt Marsh	DE	Spartina patens - Distichlis spicata - (Juncus gerardii) Herbaceous Vegetation	Spartina patens - Distichlis spicata Herbaceous Vegetation	Equivalent	Bowman 2000
North Atlantic Low Salt Marsh	DE	Spartina alterniflora / (Ascophyllum nodosum) Acadian/Virginian Zone Herbaceous Vegetation	Spartina alterniflora Herbaceous Vegetation	Equivalent	Clancy 1996
North Atlantic Low Salt Marsh	NJ	Spartina alterniflora / (Ascophyllum nodosum) Acadian/Virginian Zone Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
North Atlantic Upper Ocean Beach	NJ	Cakile edentula ssp. edentula - Chamaesyce polygonifolia Sparse Vegetation	same as global	Equivalent	Breden et al. 2001
North Atlantic Upper Ocean Beach	DE	Cakile edentula ssp. edentula - Chamaesyce polygonifolia Sparse Vegetation	Cakile edentula ssp. edentula Sparse Vegetation	Undetermined	Clancy 1996
Northeastern Atlantic Brackish Interdunal Swale	NJ	Spartina patens - Eleocharis parvula Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Northeastern Atlantic Coastal Oak - Beech Forest	NJ	Fagus grandifolia - Quercus alba - Quercus rubra Forest	Fagus grandifolia - Quercus alba - Quercus rubra - Liriodendron tulipifera Forest	Equivalent	Breden et al. 2001
Northeastern Buttonbush Shrub Swamp	NJ	Cephalanthus occidentalis - Decodon verticillatus Shrubland	same as global	Equivalent	Breden et al. 2001
Northeastern Buttonbush Shrub Swamp	PA	Cephalanthus occidentalis - Decodon verticillatus Shrubland	Buttonbush wetland	Undetermined	Fike 1999
Northeastern Buttonbush Shrub Swamp	DE	Cephalanthus occidentalis - Decodon verticillatus Shrubland	Cephalanthus occidentalis Semi-permanently Flooded Shrubland	Undetermined	Clancy 1996
Northeastern Coastal Oak - Heath Forest	NJ	Quercus coccinea - Quercus velutina / Sassafras albidum / Vaccinium pallidum Forest	same as global	Equivalent	Breden et al. 2001
Northeastern Dry Oak-Hickory Forest	NJ	Quercus (alba, rubra, velutina) / Cornus florida / Viburnum acerifolium Forest	same as global	Equivalent	Breden et al. 2001
Northeastern Dry Oak-Hickory Forest	PA	Quercus (alba, rubra, velutina) / Cornus florida / Viburnum acerifolium Forest	Dry oak - mixed hardwood forest	Intersects	Fike 1999
Northeastern Dry Oak-Hickory Forest	DE	Quercus (alba, rubra, velutina) / Cornus florida / Viburnum acerifolium Forest	Piedmont Oak-Beech-Mountain Laurel Forest	Equivalent	Clancy 1996
Northeastern Leafy Forb Marsh	PA	Pontederia cordata - Peltandra virginica - Sagittaria latifolia Herbaceous Vegetation	Pickerel-weed - arrow-arum - arrowhead wetland	Equivalent	Fike 1999
Northeastern Leafy Forb Marsh	NJ	Pontederia cordata - Peltandra virginica - Sagittaria latifolia Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001

NVC Association Common Name	State	NVC Global Scientific Name	State Classification Name ≠ NVC Global Name	Relationship to NVC Standard	Reference
Northeastern Modified Successional Forest	PA	<i>Prunus serotina</i> - <i>Liriodendron tulipifera</i> - <i>Acer rubrum</i> - <i>Fraxinus americana</i> Forest	Red maple (terrestrial) forest	Equivalent	Fike 1999
Northeastern Pin Oak - Swamp White Oak Forest	NJ	<i>Quercus palustris</i> - (<i>Quercus bicolor</i>) - <i>Acer rubrum</i> / <i>Osmunda cinnamomea</i> Forest	<i>Quercus</i> (palustris, bicolor) - <i>Acer rubrum</i> / <i>Osmunda cinnamomea</i> Forest	Equivalent	Breden et al. 2001
Northeastern Pin Oak - Swamp White Oak Forest	PA	<i>Quercus palustris</i> - (<i>Quercus bicolor</i>) - <i>Acer rubrum</i> / <i>Osmunda cinnamomea</i> Forest	Bottomland oak - hardwood palustrine forest	Broader	Fike 1999
Northern Atlantic Coast Beaked Ditch-grass Bed	NJ	<i>Ruppia maritima</i> Acadian/Virginian Zone Temperate Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Northern Atlantic Coast Beaked Ditch-grass Bed	DE	<i>Ruppia maritima</i> Acadian/Virginian Zone Temperate Herbaceous Vegetation	<i>Ruppia maritima</i> Herbaceous Vegetation	Equivalent	Bowman 2000
Northern Bayberry Dune Shrubland	DE	<i>Morella pensylvanica</i> - <i>Prunus maritima</i> Shrubland	same as global	Equivalent	Bowman 2000
Northern Bayberry Dune Shrubland	NJ	<i>Morella pensylvanica</i> - <i>Prunus maritima</i> Shrubland	<i>Morella pensylvanica</i> - <i>Rosa rugosa</i> Shrubland	Equivalent	Breden et al. 2001
Northern Beachgrass Dune	NJ	<i>Ammophila breviligulata</i> - <i>Lathyrus japonicus</i> Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest	DE	<i>Fagus grandifolia</i> - <i>Liriodendron tulipifera</i> - <i>Carya cordiformis</i> / <i>Lindera benzoin</i> / <i>Podophyllum peltatum</i> Forest	<i>Liriodendron tulipifera</i> - <i>Fagus grandifolia</i> - <i>Quercus</i> sp. (alba, rubra, velutina) / <i>Lindera benzoin</i> Forest	Equivalent	Bowman 2000
Northern Hardwood Forest	PA	<i>Acer saccharum</i> - <i>Betula alleghaniensis</i> - <i>Fagus grandifolia</i> / <i>Viburnum lantanoides</i> Forest	Northern Hardwood Forest	Broader	Fike 1999
Northern Peatland Sedge Coastal Plain Pond	DE	<i>Carex striata</i> var. <i>brevis</i> Herbaceous Vegetation	<i>Carex striata</i> - <i>Dichanthelium spretum</i> Herbaceous Vegetation	Undetermined	Clancy 1996
Northern Peatland Sedge Coastal Plain Pond	NJ	<i>Carex striata</i> var. <i>brevis</i> Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Northern Piedmont Rich Fen	PA	<i>Morella pensylvanica</i> - <i>Dasiphora fruticosa</i> ssp. <i>floribunda</i> / <i>Carex sterilis</i> - <i>Carex flava</i> Shrub Herbaceous Vegetation	Poison sumac - red-cedar - bayberry fen	Broader	Fike 1999
Open Water Marsh with Mixed Submergents/Emergents	NJ	<i>Vallisneria americana</i> - <i>Potamogeton perfoliatus</i> Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Open Water Marsh with Mixed Submergents/Emergents	DE	<i>Vallisneria americana</i> Herbaceous Vegetation	same as global	Equivalent	Bowman 2000
Overwash Dune Grassland	DE	<i>Spartina patens</i> - <i>Schoenoplectus pungens</i> - <i>Solidago sempervirens</i> Herbaceous Vegetation	same as global	Equivalent	Bowman 2000
Panicgrass Pondshore	NJ	<i>Panicum hemitomon</i> - <i>Panicum verrucosum</i> Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Pasture Fen	PA	<i>Juniperus virginiana</i> / <i>Dasiphora fruticosa</i> ssp. <i>floribunda</i> / <i>Carex flava</i> - <i>Carex tetanica</i> Shrub Herbaceous Vegetation	Poison sumac - red-cedar - bayberry fen	Broader	Fike 1999
Pickerelweed Tidal Marsh	DE	<i>Peltandra virginica</i> - <i>Pontederia cordata</i> Tidal Herbaceous Vegetation	<i>Peltandra virginica</i> - <i>Pontederia cordata</i> Tidal Herbaceous Vegetation	Undetermined	Clancy 1996
Pickerelweed Tidal Marsh	NJ	<i>Peltandra virginica</i> - <i>Pontederia cordata</i> Tidal Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Pine Barrens Bog	NJ	<i>Chamaedaphne calyculata</i> / <i>Carex striata</i> Dwarf-shrubland	same as global	Equivalent	Breden et al. 2001
Pine Barrens Hilltop Forest	NJ	<i>Quercus prinus</i> - <i>Quercus velutina</i> / <i>Gaylussacia frondosa</i> Forest	same as global	Equivalent	Breden et al. 2001
Pine Barrens Sandreed Savanna	NJ	<i>Gaylussacia dumosa</i> / <i>Calamoviifa brevipilis</i> Shrub Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Pitch Pine - Oak Forest	NJ	<i>Pinus rigida</i> - <i>Quercus coccinea</i> / <i>Vaccinium pallidum</i> - (<i>Morella pensylvanica</i>) Forest	same as global	Equivalent	Breden et al. 2001

Appendix C: Delaware Estuary NVC Association Crosswalks to State Natural Community Classifications

NVC Association Common Name	State	NVC Global Scientific Name	State Classification Name ≠ NVC Global Name	Relationship to NVC Standard	Reference
Pitch Pine - Reedgrass Savanna	NJ	<i>Pinus rigida</i> / <i>Gaylussacia dumosa</i> / <i>Calamovilfa brevifolia</i> Woodland	same as global	Equivalent	Breden et al. 2001
Pitch Pine - Scarlet Oak Low- to Mid-Elevation Ridgetop	PA	<i>Pinus rigida</i> - <i>Quercus coccinea</i> / <i>Vaccinium angustifolium</i> Woodland	Pitch pine - mixed hardwood woodland	Broader	Fike 1999
Pitch Pine / Pennsylvania Sedge Woodland	NJ	<i>Pinus rigida</i> / <i>Carex pensylvanica</i> Woodland	same as global	Equivalent	Breden et al. 2001
Pitch Pine Bog	NJ	<i>Pinus rigida</i> / <i>Chamaedaphne calyculata</i> / <i>Sphagnum</i> spp. Woodland	same as global	Equivalent	Breden et al. 2001
Pitch Pine Dune Woodland	DE	<i>Pinus rigida</i> / <i>Hudsonia tomentosa</i> Woodland	Pitch Pine Dune Woodland	Equivalent	Clancy 1996
Pitch Pine Lowland	NJ	<i>Pinus rigida</i> / <i>Vaccinium corymbosum</i> - <i>Leucothoe racemosa</i> / <i>Sphagnum</i> spp. Woodland	same as global	Equivalent	Breden et al. 2001
Pitch Pine Rocky Summit	PA	<i>Pinus rigida</i> / (<i>Quercus ilicifolia</i>) / <i>Photinia melanocarpa</i> / <i>Deschampsia flexuosa</i> Woodland	Pitch pine - scrub oak woodland	Intersects	Fike 1999
Pitch Pine Subhydric Lowland	NJ	<i>Pinus rigida</i> / <i>Gaylussacia baccata</i> - <i>Kalmia angustifolia</i> Woodland	same as global	Equivalent	Breden et al. 2001
Pond-lily Tidal Marsh	NJ	<i>Nuphar lutea</i> ssp. <i>advena</i> Tidal Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Pond-lily Tidal Marsh	DE	<i>Nuphar lutea</i> ssp. <i>advena</i> Tidal Herbaceous Vegetation	<i>Nuphar advena</i> Tidal Herbaceous Vegetation	Undetermined	Clancy 1996
Prairie Sedge - Tussock Sedge Fen	PA	<i>Carex prairea</i> - <i>Carex stricta</i> - <i>Pycnanthemum virginianum</i> Herbaceous Vegetation	Open sedge (<i>Carex stricta</i> , <i>C. prairea</i> , <i>C. lacustris</i>) fen	Undetermined	Fike 1999
Red Maple - Black Ash Swamp	PA	<i>Fraxinus nigra</i> - <i>Acer rubrum</i> / <i>Carex leptalea</i> Saturated Forest	Red maple - black ash palustrine forest	Broader	Fike 1999
Red Maple - Blackgum Basin Swamp	PA	<i>Acer rubrum</i> - <i>Nyssa sylvatica</i> - <i>Betula alleghaniensis</i> / <i>Sphagnum</i> spp. Forest	Red maple - black-gum palustrine forest	Broader	Fike 1999
Red Maple - Sweetgum Swamp	NJ	<i>Liquidambar styraciflua</i> - <i>Acer rubrum</i> - <i>Quercus phellos</i> / <i>Leucothoe racemosa</i> Forest	same as global	Equivalent	Breden et al. 2001
Red Maple - Sweetgum Swamp	DE	<i>Liquidambar styraciflua</i> - <i>Acer rubrum</i> - <i>Quercus phellos</i> / <i>Leucothoe racemosa</i> Forest	<i>Acer rubrum</i> - <i>Liquidambar styraciflua</i> - <i>Nyssa sylvatica</i> Swamp Forest	Broader	Clancy 1996
Red Maple - Tussock Sedge Wooded Marsh	PA	<i>Acer rubrum</i> / <i>Carex stricta</i> - <i>Onoclea sensibilis</i> Woodland	Red maple - sedge palustrine woodland	Equivalent	Fike 1999
Red Maple Upland Forest	PA	<i>Acer rubrum</i> / <i>Dennstaedtia punctilobula</i> Forest	Red maple (terrestrial) forest	Undetermined	Fike 1999
Red Oak - Northern Hardwood Forest	PA	<i>Quercus rubra</i> - <i>Acer saccharum</i> - <i>Fagus grandifolia</i> / <i>Viburnum acerifolium</i> Forest	Northern Hardwood Forest	Broader	Fike 1999
Reed Canarygrass Eastern Marsh	PA	<i>Phalaris arundinacea</i> Eastern Herbaceous Vegetation	Bluejoint - reed canary grass marsh	Broader	Fike 1999
Reed-grass Tidal Marsh	DE	<i>Phragmites australis</i> Tidal Herbaceous Vegetation	same as global	Equivalent	Bowman 2000
Ridgetop Scrub Oak Barrens	PA	<i>Quercus ilicifolia</i> - <i>Prunus pumila</i> Shrubland	Scrub oak shrubland	Broader	Fike 1999
River Birch Low Floodplain Forest	DE	<i>Betula nigra</i> - <i>Platanus occidentalis</i> / <i>Impatiens capensis</i> Forest	<i>Platanus occidentalis</i> - <i>Fraxinus pennsylvanica</i> / <i>Acer negundo</i> / <i>Lindera benzoin</i> Forest	Undetermined	Clancy 1996
River Birch Low Floodplain Forest	PA	<i>Betula nigra</i> - <i>Platanus occidentalis</i> / <i>Impatiens capensis</i> Forest	Sycamore floodplain forest	Intersects	Fike 1999
Rocky Bar and Shore (Riverweed Type)	DE	<i>Podostemum ceratophyllum</i> Herbaceous Vegetation	same as global	Equivalent	Bowman 2000
Salt Panne (Salicornia Type)	NJ	<i>Salicornia</i> (<i>virginica</i> , <i>bigelovii</i> , <i>maritima</i>) - <i>Spartina alterniflora</i> Herbaceous Vegetation	<i>Sarcocornia perennis</i> - <i>Salicornia</i> spp. - <i>Spartina alterniflora</i> Dwarf-shrubland	Equivalent	Breden et al. 2001
Salt Panne (Salicornia Type)	DE	<i>Salicornia</i> (<i>virginica</i> , <i>bigelovii</i> , <i>maritima</i>) - <i>Spartina alterniflora</i> Herbaceous Vegetation	Salt Panne	Equivalent	Clancy 1996
Serpentine Emergent Wetland	PA	<i>Deschampsia caespitosa</i> - <i>Vernonia noveboracensis</i> Herbaceous Vegetation	Serpentine seepage wetland	Broader	Fike 1999

NVC Association Common Name	State	NVC Global Scientific Name	State Classification Name # NVC Global Name	Relationship to NVC Standard	Reference
Serpentine Indiangrass - Little Bluestem Grassland	PA	Sorghastrum nutans - Schizachyrium scoparium Serpentine Herbaceous Vegetation	Serpentine Virginia pine - oak forest	Broader	Fike 1999
Serpentine Little Bluestem - Prairie Dropseed Grassland	PA	Schizachyrium scoparium - Sporobolus heterolepis Serpentine Herbaceous Vegetation	Serpentine Virginia pine - oak forest	Broader	Fike 1999
Serpentine Red Maple - Oak - Catbrier Serpentine Forest	PA	Acer rubrum - Quercus spp. / Smilax spp. Serpentine Forest	Serpentine pitch pine - oak forest	Intersects	Fike 1999
Serpentine Red Maple - Pine Forest	PA	Acer rubrum - Pinus virginiana - Pinus rigida / Microstegium vimineum - Smilax spp. Serpentine Forest	Serpentine Virginia pine - oak forest	Intersects	Fike 1999
Serpentine Red-cedar - Virginia Pine - Catbrier Serpentine Forest	PA	Juniperus virginiana - Pinus virginiana / Smilax rotundifolia Serpentine Forest	Serpentine Virginia pine - oak forest	Broader	Fike 1999
Silver Maple - Elm Forest	PA	Acer saccharinum - Ulmus americana Forest	Silver Maple Floodplain Forest	Broader	Fike 1999
Skunk-cabbage Seepage Meadow	PA	Symplocarpus foetidus Herbaceous Vegetation	Skunk cabbage - golden saxifrage forest seep	Finer	Fike 1999
Small River Red Maple - Elm Floodplain Forest	PA	Acer (rubrum, saccharinum) - Ulmus americana Forest	Red maple-elm-willow floodplain swamp	Broader	Fike 1999
Southern New England Red Maple Seepage Swamp	NJ	Acer rubrum - Fraxinus (pennsylvanica, americana) / Lindera benzoin / Symplocarpus foetidus Forest	same as global	Equivalent	Breden et al. 2001
Southern New Jersey Mesic Pine Barrens	NJ	Pinus (rigida, echinata) - Quercus coccinea / Ilex opaca Woodland	Pinus (rigida, echinata) - Quercus coccinea / Ilex opaca Forest	Equivalent	Breden et al. 2001
Southern Red Maple - Black Gum Swamp Forest	NJ	Acer rubrum - Nyssa sylvatica - Magnolia virginiana / Viburnum nudum var. nudum / Osmunda cinnamomea - Woodwardia areolata Forest	Acer rubrum - Nyssa sylvatica - Magnolia virginiana Forest	Equivalent	Breden et al. 2001
Southern Red Maple - Black Gum Swamp Forest	DE	Acer rubrum - Nyssa sylvatica - Magnolia virginiana / Viburnum nudum var. nudum / Osmunda cinnamomea - Woodwardia areolata Forest	Acer rubrum - Liquidambar styraciflua - Nyssa sylvatica Swamp Forest	Broader	Clancy 1996
Southern Red Maple - Black Gum Swamp Forest	PA	Acer rubrum - Nyssa sylvatica - Magnolia virginiana / Viburnum nudum var. nudum / Osmunda cinnamomea - Woodwardia areolata Forest	Red maple - magnolia Coastal Plain palustrine forest	Undetermined	Fike 1999
Southern Red Oak / Heath Forest	DE	Quercus alba - Quercus falcata - (Pinus taeda) / Gaylussacia frondosa Forest	Quercus falcata - Pinus taeda / Gaylussacia frondosa Forest	Undetermined	Clancy 1996
Southern Red Oak / Heath Forest	NJ	Quercus alba - Quercus falcata - (Pinus taeda) / Gaylussacia frondosa Forest	Quercus (falcata, alba, velutina) / Gaylussacia baccata - Vaccinium pallidum Forest	Equivalent	Breden et al. 2001
Speckled Alder Swamp	PA	Alnus incana Swamp Shrubland	Alder - ninebark wetland	Broader	Fike 1999
Successional Aspen - Gray Birch Forest	PA	Populus tremuloides - Betula populifolia Forest	Aspen/gray (paper) birch forest	Undetermined	Fike 1999
Successional Maritime Forest	NJ	Prunus serotina - Sassafras albidum - Amelanchier canadensis - Quercus velutina / Smilax rotundifolia Forest	Prunus serotina - Sassafras albidum - Amelanchier canadensis / Smilax rotundifolia Shrubland	Equivalent	Breden et al. 2001
Successional Maritime Forest	DE	Prunus serotina - Sassafras albidum - Amelanchier canadensis - Quercus velutina / Smilax rotundifolia Forest	Prunus serotina - Sassafras albidum - Amelanchier canadensis - Quercus velutina / Smilax rotundifolia Shrubland	Equivalent	Bowman 2000
Transitional Tidal Marsh	DE	Schoenoplectus americanus - Spartina patens Herbaceous Vegetation	Schoenoplectus americanus Tidal Herbaceous Vegetation	Undetermined	Clancy 1996
Tuliptree - Beech - Maple Forest	PA	Fagus grandifolia - Betula lenta - Liriodendron tulipifera - Acer saccharum Forest	Tuliptree - beech - maple forest	Equivalent	Fike 1999
Upper South Switchgrass Wet Prairie	NJ	Panicum virgatum Seasonally Flooded Herbaceous Vegetation	same as global	Equivalent / Similar type	Breden et al. 2001

Appendix C: Delaware Estuary NVC Association Crosswalks to State Natural Community Classifications

NVC Association Common Name	State	NVC Global Scientific Name	State Classification Name # NVC Global Name	Relationship to NVC Standard	Reference
Virginia Pine Serpentine Forest	PA	<i>Pinus virginiana</i> / <i>Quercus marilandica</i> Serpentine Forest	Serpentine Virginia pine - oak forest	Undetermined	Fike 1999
Virginia Pine Successional Forest	PA	<i>Pinus virginiana</i> Successional Forest	Virginia pine - mixed hardwood forest	Broader	Fike 1999
Water-hemp Tidal Marsh	DE	<i>Amaranthus cannabinus</i> Tidal Herbaceous Vegetation	<i>Amaranthus cannabinus</i> Tidal Herbaceous Vegetation	Undetermined	Clancy 1996
Water-hemp Tidal Marsh	NJ	<i>Amaranthus cannabinus</i> Tidal Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Water-lily Aquatic Wetland	NJ	<i>Nuphar lutea</i> ssp. <i>advena</i> - <i>Nymphaea odorata</i> Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Water-lily Aquatic Wetland	PA	<i>Nuphar lutea</i> ssp. <i>advena</i> - <i>Nymphaea odorata</i> Herbaceous Vegetation	Spatterdock - Water lily wetland	Equivalent	Fike 1999
Water-willow Rocky Bar and Shore	PA	<i>Justicia americana</i> Herbaceous Vegetation	Water-willow (<i>Justicia americana</i>) - smartweed riverbed community	Undetermined	Fike 1999
Water-willow Shrub Swamp	DE	<i>Decodon verticillatus</i> Semipermanently Flooded Shrubland	<i>Decodon verticillatus</i> Shrubland	Undetermined	Clancy 1996
Water-willow Shrub Swamp	NJ	<i>Decodon verticillatus</i> Semipermanently Flooded Shrubland	same as global	Equivalent	Breden et al. 2001
White Pine - Hemlock Dry-Mesic Coniferous Forest	PA	<i>Pinus strobus</i> - <i>Tsuga canadensis</i> Lower New England / Northern Piedmont Forest	Hemlock (white pine) forest	Broader	Fike 1999
White Pine - Oak Forest	PA	<i>Pinus strobus</i> - <i>Quercus (rubra, velutina)</i> - <i>Fagus grandifolia</i> Forest	Dry white pine (hemlock) - oak forest	Broader	Fike 1999
Willow River-Bar Shrubland	PA	<i>Salix nigra</i> / <i>Carex torta</i> Temporarily Flooded Shrubland	Black willow shrub/scrub wetland	Equivalent	Fike 1999
Woolgrass Marsh	NJ	<i>Scirpus cyperinus</i> Seasonally Flooded Herbaceous Vegetation	same as global	Equivalent	Breden et al. 2001
Woolgrass Marsh	PA	<i>Scirpus cyperinus</i> Seasonally Flooded Herbaceous Vegetation	Bulrush marsh	Undetermined	Fike 1999

Appendix D. Heritage Methodology and Plot Sampling Form

Natural Heritage Methodology

Natural heritage methodology provides a rigorous set of standard procedures for identifying, inventorying, and mapping species and ecosystems of conservation concern. Because biodiversity encompasses the variety of life at all levels, not just species, natural heritage methodology is designed to deal with both species and ecological communities. At the core of the methodology is the concept of the element occurrence, the spatial representation of a species or ecological community at a specific location. An element occurrence generally delineates a species population or ecological community stand, and represents the geo-referenced biological feature that is of conservation or management interest.

In the broadest sense, natural heritage methodology answers three key questions:

- 1) What species and ecosystems exist in a region (the elements of biodiversity)?
- 2) How are they doing (their condition and status), and which are priorities for conservation?
- 3) Where precisely are they found (documenting and mapping element occurrences)?

To answer these questions, natural heritage programs carry out a series of repeated steps. Each time the steps are repeated, the data are refined to give a better picture of biodiversity and of problems and progress in its conservation.

Basic Steps of Heritage Methodology

1. **Develop a list of the elements of biodiversity in a given jurisdiction, focusing on better-known species groups (e.g., vertebrate animals, vascular plants), and on the ecological communities present.**
2. **Assess the relative risk of extirpation or extinction of the elements to determine conservation status and set initial priorities for detailed inventory and protection.**
3. **Gather information from all available sources for priority elements, focusing on known locations, possible locations, and ecological and management requirements.**
4. **Conduct field inventories for these elements and collect data about their location, condition, and conservation needs.**
5. **Process and manage all the data collected, using standard procedures that will allow compilation and comparison of data across jurisdictional boundaries.**
6. **Analyze the data with a view toward refining previous conclusions about element rarity and risk, location, management needs, and other issues.**
7. **Provide access to data and information products to interested parties so that it can be used to guide conservation, management planning, and other natural resource decision-making.**

The following form is an example of the standard plot sampling field form used by NatureServe and the Natural Heritage Programs. The Natural Heritage Methodology described above is applied and the data is recorded in the field on one of these forms. Field forms may be adjusted slightly to capture specific project related data.

NATURESERVE PLOT FORM	
Plot Code _____	Polygon Code _____ Airphoto # _____
Park sublocation (Surveysite) _____	
Quad Name _____	Quad Code _____
Survey Date: _____	Surveyors: _____ Sourcecode: _____
Provisional Community Name	
Classified Community Name _____	GELCODE: CEGL00 _____
Ecological System type	
Directions to Plot:	
Plot length _____	width _____ shape _____ Permanent (y/n) _____ Plot Photos (y/n) _____ Roll# _____ Frame# _____
Plot representativeness	
Field UTM X _____ m E	Field UTM Y _____ m N
Error +/- _____ m	
Corrected UTM Y _____ m	UTMZone _____

Appendix D. Heritage Methodology and Plot Sampling Form

ENVIRONMENTAL DESCRIPTION

			Aspect (use true, not magnetic, value):				
Slope	Deg	%	Topographic Position	Landform		Geology: Bedrock	Geology: Surficial
Flat	1	0%	Crest/Summit/Ridge		Kame		
Gentle	0	1-9%	Upper/Shoulder Slope			Igneous	Bedrock
Modt.	1-5	10-25%	High Plateau		/pond	Granitic	Talus
Som. Steep	6-	26-49%	Middle Slope	bank		Dioritic	Glacial till
Steep	14	50-100%	Slope step (terracette)	hel	ine	Gabbroic	Moraine
V. Steep	15-	101-	Lower Slope		tain	Metamorphic	Esker/outwash
Abrupt	26	275%	Toe Slope		ash plain		Glacial delta
Overhang	27-	276-	Low level/terrace		w	Slate/phyllite	Lacustrine/ fluvial
	45	300%	Channel wall			Schist	
Record	46-	>300%	Channel bed	lin	Plateau	Gneiss	Marine
more	69		Depression		ie	Marble	Aeolian
exact	70-			oment		Serpentine	
measures	95			y		Sedimentary	Other
if taken:	>10			plain	ce	Shale	
	0					Limestone	
						/Dolomite	
					Valley		
					Other_____	Other	

Cowardin System	Hydrologic regime	Salinity
___ Riverine	___ Permanently Flooded	Coastal salt (>30 ppt)
___ Palustrine	___ Semipermanently Flooded	Coastal brackish (5-30 ppt)
___ Lacustrine	___ Seasonally Flooded	Fresh tidal (< 5 ppt)
___ Estuarine	___ Saturated (& may be seas. flooded)	Inland salt
	___ Temporarily Flooded	Inland brackish
	___ Intermittently Flooded	
	___ Tidally Flooded	

Soil Taxon/Description:			Soil Profile notes Depth examined: _____ Horizons, colors, depth to obstruction, depth to water table, depth to mottling, etc.
Soil Texture	Soil Drainage	Unvegetated Surface: (please use cover scale below)	
___ silt loam	___ Rapidly drained	___ Bedrock	
___ silt	___ Well drained	___ Large rocks (cobbles, boulders > 10 cm)	
___ clay loam	___ Moderately well drained	___ Small rocks/gravel (0.2-10 cm)	
___ clay	___ Somewhat poorly drained	___ Sand (0.1-2 mm)	
___ peat	___ Poorly drained	___ Litter, duff	
___ muck	___ Very poorly drained	___ Wood (> 1 cm)	
Soil pH:	Soil Stoniness	___ Bare soil	
	___ v. little (< 1%)	___ Water	
	___ moderate (2-20%)	ther: _____	
	___ very stony (20-50%)		
	___ exceedingly stony (>50%)		

Additional environment notes:

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum) <u>Trees and Shrubs</u> % Evergreen: ____ % Deciduous: ____ <u>Herbs</u> ____ Annual ____ Perennial	Leaf Type (of dominant stratum) ____ Broad-leaved ____ Needle-leaved ____ Microphyllous ____ Graminoid ____ Forb ____ Pteridophyte ____ Non-vascular	Physiognomic class ____ Forest ____ Woodland ____ Shrubland ____ Dwarf Shrubland ____ Herbaceous ____ Nonvascular ____ Sparsely Vegetated	Cover Classes: Strata & Unveg. Surface 5% 10% 20% 30% 0% 0% 0% 0% 00%	Height Classes for Strata <0.5 m 0.5-1m 1-2 m 2-5 m 5-10 m 10-15 m 15-20 m 20-35 m 35-50 m >50 m
			Characteristic / diagnostic species <i>*please use height and cover classes from table above</i>	
T1 Emergent				
T2 Canopy				
T3 Sub-canopy				
S1 Tall Shrub				
S2 Short Shrub				
H Herbaceous				
N Non-vascular				
V Vine/liana				

Brief word picture of community:
Topographic sketch:
Adjacent vegetation type(s):
Known/inferred land-use history:
Animal use evidence
Natural disturbance evidence:
Invasive species notes:
Other anthropogenic disturbance comments
Other Comments

ADDITIONAL NOTES (*continue as needed on reverse*)

See the companion document:

Key to the Delaware Estuary Ecological Systems and Natural Communities

Sneddon, L., S. Gawler and E. Largay. 2006. Key to the Delaware Estuary Ecological Systems and Natural Communities. Version 1. NatureServe. Arlington, Virginia.