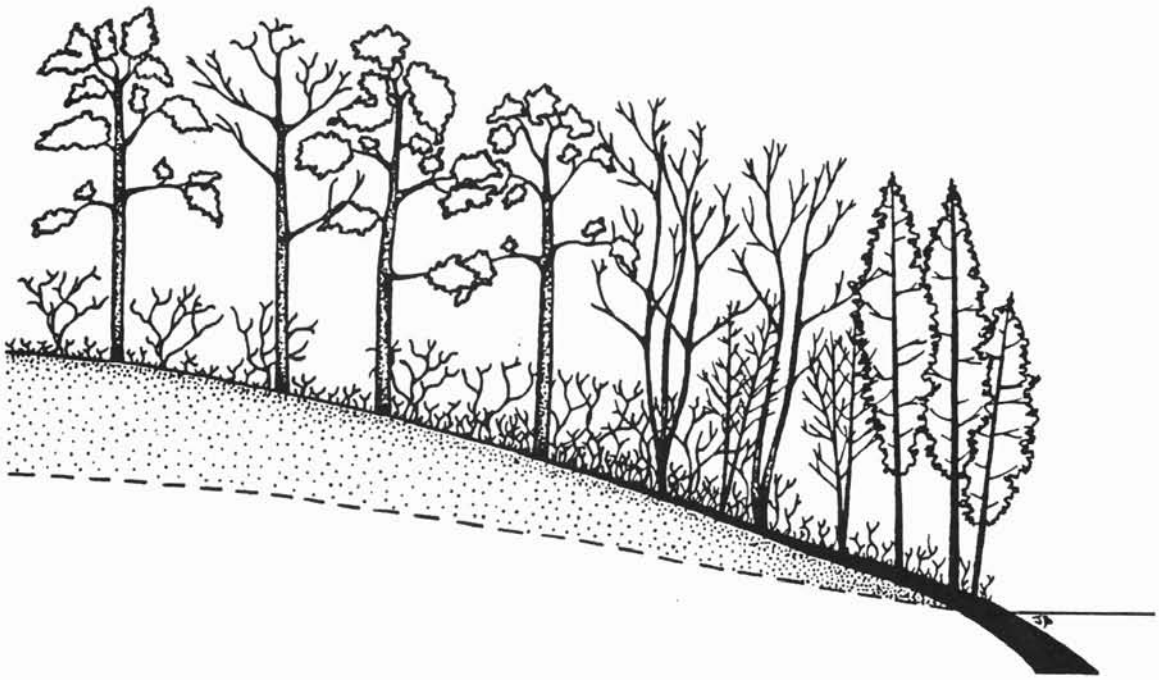
New Jersey Pinelands Commission Manual for Identifying and Delineating Pinelands Area Wetlands

A Pinelands Supplement to the Federal Manual



January 1991

New Jersey Pinelands Commission

NEW JERSEY PINELANDS COMMISSION MANUAL FOR IDENTIFYING AND DELINEATING PINELANDS AREA WETLANDS

A Pinelands Supplement to the Federal Manual

by

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PART I. INTRODUCTION

PURPOSE

The purpose of this manual is to describe the approach used by the New Jersey Pinelands Commission to identify and delineate freshwater wetlands in the nearly one million acre Pinelands Area (Figure 1). It is intended to serve as a Pinelands Commission supplement to the **Federal Manual for Identifying and Delineating Jurisdictional Wetlands** (Federal Interagency Committee for Wetland Delineation, 1989), hereafter referred to as the **Federal Manual.**

BACKGROUND

Subchapter 6 of the New Jersey Pinelands Comprehensive Management Plan (CMP, N.J.A.C. 7:50) establishes minimum standards deemed necessary to protect the long-term integrity of wetlands (see Appendix 1). All fifty-two Pinelands Area municipalities are required to adopt municipal master plans and land use ordinances that are consistent with these minimum standards which define wetlands, describe wetland soils and vegetation types, list prohibited and permitted uses and provide minimum performance standards.

Activities in areas under the jurisdiction of the Pinelands Commission are exempted from the requirements of the New Jersey Freshwater Wetlands Protection Act (N.J.S.A. 13:9B-1 et seq.), except that the discharge of dredged or fill material requires a permit issued under the provisions of Section 404 of the Federal Water Pollution Control Act Amendments of 1977 as amended by the Clean Water Act of 1977, or under an individual or general permit program administered by the State of New Jersey under the provisions of the federal act and applicable New Jersey state law. The state act allows the Pinelands Commission to provide for more stringent regulation of activities in and around freshwater wetlands in the Pinelands Area.

In 1989, the Pinelands Commission and the U.S. Army Corp of Engineers, Philadelphia district, entered into an agreement designating the Pinelands Commission as the lead agency with respect to the verification of waters and wetlands within the Pinelands Area. The Philadelphia district is responsible for the administration of Section 404 in the Pinelands Area. The agreement allows the two agencies to use their own methodology and regulations in determining wetland boundaries. Both agreed to use wetland delineation methodologies that examine vegetation, soils and hydrology to verify or establish wetland delineations.

The New Jersey Department of Environmental Protection, the agency responsible for administering the provisions of the state freshwater wetlands act, and the U.S. Army Corps of Engineers, as well

as the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service and the U.S. Soil Conservation Service use the **Federal Manual** to identify and delineate wetlands under their jurisdiction. The approach described in this Pinelands manual adapts the methods presented in the **Federal Manual** to the unique conditions found in the New Jersey Pinelands.

The format of this manual is somewhat similar to that of the **Federal Manual.** Criteria for wetland identification, field indicators and methods for identifying and delineating wetlands are presented, along with appropriate references and appendices. An attempt has been made not to duplicate information presented in the **Federal Manual** by referring extensively to that report. The Pinelands manual should, therefore, be used in conjunction with the **Federal Manual.**

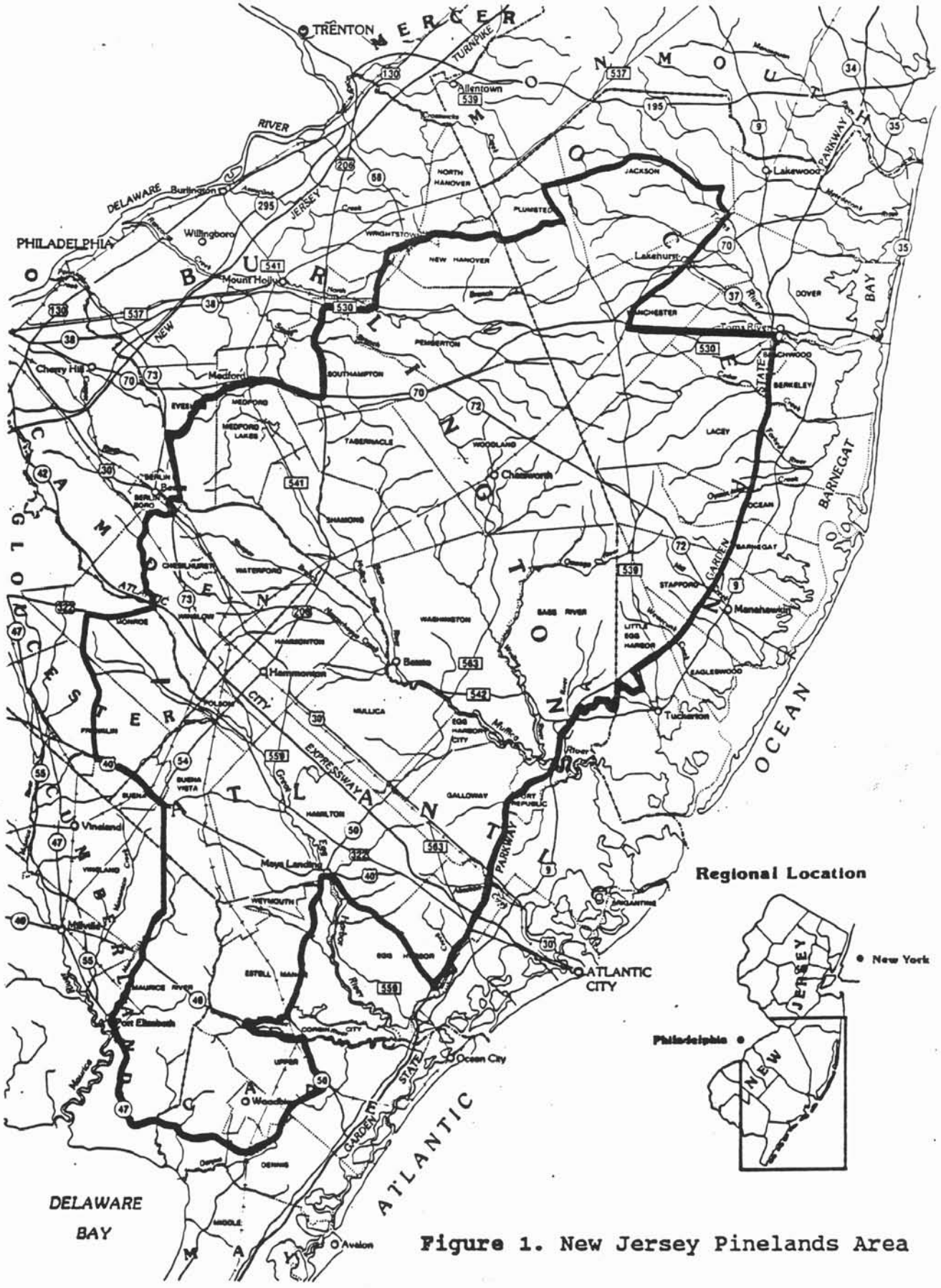


Figure 1. New Jersey Pinelands Area

PART II. TECHNICAL CRITERIA FOR WETLAND IDENTIFICATION

WETLAND DEFINITIONS

The four different wetland definitions formulated by the Corps of Engineers, Environmental Protection Agency, Soil Conservation Service and Fish and Wildlife Service are summarized in the **Federal Manual.** The definition given in the New Jersey Freshwater Wetlands Protection Act is nearly identical to that used by the Environmental Protection Agency and Corps of Engineers for administering the Section 404 permit program.

The mandatory technical criteria for wetland identification presented in the **Federal Manual** require that an area possess three basic attributes to be considered a wetland. These wetland attributes are: 1) hydrology; 2) soils; and 3) vegetation. The definition presented in the New Jersey Freshwater Wetlands Protection Act includes a provision which requires that the three parameter approach described in the **Federal Manual** be used.

The following definition (N.J.A.C. 7:50-6.3) is used by the Pinelands Commission in administering the provisions of the Pinelands Comprehensive Management Plan:

> "Wetlands are those lands which are inundated or saturated by water at a magnitude, duration and frequency sufficient to support the growth of hydrophytes. Wetlands include lands with poorly drained or very poorly drained soils as designated by the National Cooperative Soils Survey of the Soil Conservation Service of the United States Department of Agriculture. Wetlands include coastal wetlands and inland wetlands, including submerged lands."

Plant species lists are given for coastal wetlands and five inland wetland vegetation types. Inland wetlands include cedar swamps, hardwood swamps, pitch pine lowlands, bogs and inland marshes. Lakes, ponds, rivers and streams are also identified as inland wetlands. The definition of "wetland soils" (N.J.A.C. 7:50-3.1) includes a list of thirteen poorly drained and very poorly drained soils. A literal interpretation of the Pinelands Commission definition indicates that a site may be considered a wetland if **either** poorly drained or very poorly drained soil **or** wetland vegetation is present. In practice, the presence of wetland plant species (hydrophytes) has been used as the primary criterion in vegetated areas, and soils have been used to confirm the delineation of problem area wetlands.

The Pinelands Commission has reviewed each of the three mandatory federal technical criteria for wetland identification in relation to actual conditions in the Pinelands Area and to the Pinelands

wetland regulatory program. The interpretation and use of the mandatory federal technical criteria in the Pinelands Area are detailed in the following sections.

HYDROPHYTIC VEGETATION

Hydrophytic Vegetation Criterion

The Pinelands Commission defines a hydrophyte as "any plant growing in water or in substrate that is at least periodically deficient in oxygen as a result of excessive water content." This definition is similar to and consistent with the definition presented in the **Federal Manual** in which hydrophytic vegetation is defined as "macrophytic plant life growing in water, soil or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content."

The Fish and Wildlife Service's "National List of Plant Species That Occur in Wetlands" (Reed, 1988a) identifies the "wetland indicator status" of plant species associated with wetlands. "Wetland Plants of the State of New Jersey" (Reed, 1988b) is a subset of the national list and is used to determine the "wetland indicator status" of a plant in New Jersey. The list separates vascular plants into four groups based on the frequency (P) with which a plant species occurs in wetlands:

1) **obligate wetland plants** (OBL) almost always occur in wetlands (P >99%);
2) **facultative wetland plants** (FACW) usually occur in wetlands (P = 67-99%);
3) **facultative plants** (FAC) are equally likely to occur in wetlands or nonwetlands (P = 34-66%);
4) **facultative upland plants** (FACU) occasionally are found in wetlands (P = 1-33%) but usually occur in nonwetlands (P = 67-99%); and
5) **obligate upland plants** (UPL) almost always occur in uplands (P >99%).

A positive (+) or negative (-) symbol may be used to modify the indicator status of a facultative wetland species to more specifically define the frequency of occurrence in wetlands. A positive sign (e.g., FACW+) indicates a frequency toward the higher end of the category (more frequently found in wetlands). A negative sign (e.g., FAC-) indicates a frequency toward the lower end of the category (less frequently found in wetlands). The Fish and Wildlife Service assigns no indicator (NI) when there is insufficient information available to determine a wetland indicator status.

In the **Federal Manual** an area is considered to have hydrophytic vegetation if the following **hydrophytic vegetation criterion** is met:

"An area has hydrophytic vegetation when, under normal circumstances:

(1) more than 50 percent of the composition of the dominant species from all strata are obligate wetland (OBL), facultative wetland (FACW), and/or facultative (FAC) species, or

(2) a frequency analysis of all species within the community yields a prevalence index value of less than 3.0 (where OBL = 1.0, FACW = 2.0, FAC = 3.0, FACU = 4.0, and UPL = 5.0).

CAUTION: When a plant community has less than or equal to 50 percent of the dominant species from all strata represented by OBL, FACW, and/or FAC species, or a frequency analysis of all species within the community yields a prevalence index value of greater than or equal to 3.0, *and* hydric soils and wetland hydrology are present, the area also has hydrophytic vegetation. (*Note*: These areas are considered problem area wetlands.)

For each stratum (e.g., tree, shrub, and herb) in the plant community, dominant species are the most abundant plant species (when ranked in descending order of abundance and cumulatively totaled) that immediately exceed 50 percent of the total dominance measure (e.g., basal area or areal coverage) for the stratum, plus any additional species comprising 20 percent or more of the total dominance measure for the stratum. All dominants are treated equally in determining the presence of hydrophytic vegetation."

Pinelands Wetland Indicator Status

Common Pinelands species and their USFWS wetland indicator status are listed in Table 1. Reed (1988b), which is intended to describe general conditions throughout New Jersey, does not accurately reflect the distribution of several important plant species in the Pinelands. Revised classifications which better describe the local distribution of these species are given in Table 1. The term non-wetland is used in Table 1 to describe upland Pinelands species which do not occur in wetlands in other regions.

Table 1. Common Pinelands plants species and their wetland indicator status. The New Jersey indicator status assigned by Reed (1988b) is shown along with the revised Pinelands indicator status. A Pinelands status is given only where it differs from the New Jersey status. Species not occuring in wetlands in any region of the United States are not included on the New Jersey list. The species list was adapted from Ferren et al. (1979).

Scientific Name	Common Name	New Jersey Status	Pinelands Status
Trees			
Acer rubrum	red maple	FAC	
Acer rubrum	trident red maple(1)	FACW+	
Betula populifolia	gray birch	FAC	FACW
Chamaecyparis thyoides	Atlantic white cedar	OBL	
Ilex opaca	American holly	FACU+	FAC
Juniperus virginiana	eastern red cedar	FACU	
Liquidambar styraciflua	sweet gum	FAC	
Liriodendron tulipifera	tulip tree	FACU	
Magnolia virginiana	sweetbay magnolia	FACW+	
Nyssa sylvatica	black gum	FAC	FACW
Pinus echinata	shortleaf pine	---	NON-WETLAND
Pinus rigida	pitch pine	FACU	FAC
Quercus alba	white oak	FACU-	
Quercus coccinea	scarlet oak	---	NON-WETLAND
Quercus falcata	southern red oak	FACU-	
Quercus ilicifolia	scrub oak	---	FACU-
Quercus marilandica	blackjack oak	---	FACU-
Quercus palustris	pin oak	FACW	
Quercus phellos	willow oak	FAC+	
Quercus prinoides	dwarf chinkapin oak	NI	UPL
Quercus prinus	chestnut oak	---	NON-WETLAND
Quercus stellata	post oak	---	NON-WETLAND
Quercus velutina	black oak	---	NON-WETLAND
Sassafras albidum	sassafras	FACU-	
Shrubs			
Amelanchier canadensis	serviceberry	FAC	
Arctostaphylos uva-ursi	bearberry	NI	UPL
Aronia arbutifolia	red chokeberry	FACW	
Aronia melanocarpa	black chokeberry	FAC	
Ascyrum stans	St. Peterswort	FACU	
Cephalanthus occidentalis	common buttonbush	OBL	
Chamaedaphne calyculata	leatherleaf	OBL	
Chimaphila maculata	striped wintergreen	---	NON-WETLAND
Clethra alnifolia	coast pepperbush	FAC+	FACW-
Comptonia peregrina	sweet fern	---	NON-WETLAND
Decodon verticillatus	hairy swamp loosestrife	OBL	
Epigea repens	trailing arbutus	---	NON-WETLAND
Gaylussacia baccata	black huckleberry	FACU	FAC-
Gaylussacia dumosa	dwarf huckleberry	FAC	FACW+
Gaylussacia frondosa	dangleberry	FAC	FAC+
Gaultheria procumbens	teaberry	FACU	FAC
Hudsonia ericoides	golden heather	---	FACU
Ilex glabra	inkberry	FACW-	
Ilex laevigata	smooth holly	OBL	
Ilex verticillata	common winterberry	FACW+	
Itea virginica	virginia willow	OBL	
Kalmia angustifolia	sheep laurel	FAC	
Leiophyllum buxifolium	sand myrtle	FACU-	FAC-
Leucothoe racemosa	fetterbush	FACW	
Lyonia ligustrina	maleberry	FACW	

Table 1 continued.

Scientific Name	Common Name	New Jersey Status	Pinelands Status
Shrubs			
Lyonia mariana	staggerbush	FAC-	
Myrica heterophyllum	evergreen bayberry	FAC	
Myrica pensylvanica	northern bayberry	FAC	
Pyxidanthera barbulata	flowering pyxie moss	FACU-	
Rhododendron viscosum	swamp azalea	OBL	
Rubus hispidus	bristly blackberry	FACW	
Sambucus canadensis	American elder	FACW-	
Smilax glauca	cat greenbrier	FACU	
Smilax rotundifolia	common greenbrier	FAC	FACW-
Vaccinium atrococcum(2)	black highbush blueberry	FACW-	FACW+
Vaccinium corymbosum	highbush blueberry	FACW-	FACW+
Vaccinium macrocarpon	large cranberry	OBL	
Vaccinium vacillans	lowbush blueberry	---	FACU
Viburnum cassinoides	witherod	FACW	
Herbaceous Plants			
Andropogon glomeratus	bushy bluestem	FACW+	
Andropogon virginicus	broomsedge	FACU	
Arenaria caroliniana	sandwort	---	NON-WETLAND
Aster spectabilis	showy aster	---	FACU
Baptisia tinctoria	wild indigo	---	NON-WETLAND
Carex pensylvanica	Pennsylvania sedge	---	NON-WETLAND
Drosera spp.	sundews	OBL	
Eleocharis olivacea	bright green spikerush	OBL	
Eriocaulon septangulare	white buttons	OBL	
Eriophorum virginicum	tawny cotton grass	OBL	
Eupatorium album	white boneset	---	FACU
Glyceria obtusa	Atlantic manna grass	OBL	
Juncus militaris	bayonet rush	OBL	
Melampyrum lineare	American cow-wheat	FACU	
Orontium aquaticum	golden club	OBL	
Osmunda cinnamomea	cinnamon fern	FACW	
Osmunda regalis	royal fern	OBL	
Polygala lutea	orange milkwort	FACW+	
Pteridium aquilinum	bracken fern	FACU	
Rhexia mariana	Maryland meadow beauty	OBL	
Rhexia virginica	Virginia meadow beauty	OBL	
Sabatia difformis	lance-leaf rose gentian	OBL	
Sagittaria engelmanniana	Engelman arrowhead	OBL	
Sarracenia purpurea	northern pitcher plant	OBL	
Schizachyrium scoparium (3)	little bluestem	FACU-	
Scirpus subterminalis	subterminate bulrush	OBL	
Solidago odora	fragrant goldenrod	---	FACU
Tephrosia virginiana	goat's rue	---	NON-WETLAND
Utricularia fibrosa	fibrous bladderwort	OBL	
Woodwardia virginica	Virginia chainfern	OBL	
Xerophyllum asphodeloides	turkeybeard	---	FAC
Xyris caroliniana	Carolina yellow-eyed grass	FACW+	

(1) Trident red maple is listed in Reed (1988a).
(2) Vaccinium atrococcum is a synonym for Vaccinium corymbosum.
(3) Schizachyrium scoparium is a synonym for Andropogon scoparius.

There is a formal procedure to petition additions, deletions and changes in the national and regional lists. The Pinelands clasifications given in Table 1 are not recommended revisions to these lists. They reflect differences peculiar to the Pinelands and are only intended for use when identifying and classifying wetlands which fall under the jurisdiction of the Pinelands Commission. The **hydrophytic vegetation criterion** presented in the **Federal Manual** is appropriate for use in the Pinelands Area only if the revised Pinelands wetland indicator status classification is used.

Trident red maple (*Acer rubrum*), black gum (*Nyssa sylvatica*) and gray birch (*Betula populifolia*) dominate Pinelands deciduous swamps and do not usually occur in the uplands, especially in the central portions of the Pinelands. They are also important components of Atlantic white cedar swamps. Trident red maple is classified by Reed (1988a) as a facultative wetland plant (FACW+). This trilobed variety of red maple does not appear on the New Jersey list. Black gum and gray birch are classified as facultative (FAC) species by Reed (1988b). Although gray birch may occur in upland successional fields, especially along the Pinelands periphery, a Pinelands classification of FACW is more appropriate for both these tree species.

In the Pinelands, American holly (*Ilex opaca*) should be classified as a facultative (FAC) species rather than a facultative upland species (FACU+). Scrub oak (*Quercus ilicifolia*) and blackjack oak (*Quercus marilandica*), two tree species that are not listed by the Fish and Wildlife Service, are often found along the boundary between upland pine-oak forest and pitch pine lowlands. Both should be classified as facultative upland plants (FACU-) in the Pinelands.

Pitch pine (*Pinus rigida*) presents a special problem. In the Pinelands this species occurs on soils ranging from excessively drained to very poorly drained sands as well as hydric organic soils. Although it is the dominant species throughout extensive upland areas in the Pinelands, it also dominates the canopy of pitch pine lowlands. Pitch pine lowlands are transitional wetland communities which may represent the dominant wetland community in the Pinelands. Thus, pitch pine cannot be considered to occur only occasionally in wetlands, and its classification as a facultative upland plant is inappropriate in the Pinelands where it should be classified as a facultative plant (FAC).

Several common shrubs should also be reclassified in recognition of their greater association with wetlands in the Pinelands (Table 1). Sweet pepperbush (*Clethra alnifolia*), dwarf huckleberry (*Gaylussacia dumosa*), and highbush blueberry (*Vaccinium corymbosum*) may occur in uplands but they are more frequently encountered, taller and more abundant in Pinelands wetlands. All are facultative wetland species (FACW) in the Pinelands. Common

greenbrier (*Smilax rotundifolia*) is most abundant in the wetter portions of pitch pine lowlands, sometimes forming an impenetrable barrier. It too should be classified as FACW in the Pinelands.

A minor change (FAC to FAC+) has been made in the indicator status of dangleberry (*Gaylussacia frondosa*). Although this species is frequently encountered in Pinelands uplands, it is most abundant in the region's wetlands where it can reach a height of 4-6 ft or more. The increase in height and abundance along the transition from uplands to wetlands is often quite obvious and is useful in delineating wetland boundaries.

In the Pinelands, both sand myrtle (*Leiophyllum buxifolium*) and teaberry (*Gaultheria procumbens*) are facultative (FAC) rather than facultative upland species. Sand myrtle generally occurs within the transition from pine uplands to pitch pine lowlands and is most common along sand trails and open or recently disturbed wooded areas. Teaberry is common in uplands, pitch pine lowlands and swamps. Although available information does not warrant a reclassification of pyxie moss (*Pyxidanthera barbulata*) from FACU to FAC, wetland delineators should be aware that it is not uncommon to encounter this species in Pinelands wetlands.

Black huckleberry (*Gaylussacia baccata*) is usually the dominant shrub species in upland pine and oak forests in the region. It is also abundant in pitch pine lowlands, especially in areas with a recent or severe fire history. Like pitch pine, black huckleberry occurs on soils ranging from excessively drained to very poorly drained sands as well as hydric organic soils, and is found more than occasionally in wetlands. To accurately reflect its distribution in the Pinelands and to be consistent when applying the Fish and Wildlife Service wetland indictor status criteria, this species should be classified as a facultative species (FAC-) rather than as a facultative upland plant (FACU). Field persons should consider the ubiquitous nature of this species as well as that of pitch pine when delineating wetland boundaries.

HYDRIC SOILS

Hydric Soil Definition

The Pinelands Commission defines wetland soils as "those soils designated as very poorly drained or poorly drained by the Soil Conservation Service of the United States Department of Agriculture, including but not limited to Atsion, Bayboro, Berryland, Colemantown, Elkton, Keansburg, Leon, Muck, Othello, Pocomoke, St. Johns and Freshwater Marsh and Tidal Marsh soil types" (N.J.A.C. 7:50-2.11).

The definition of hydric soils and the **hydric soil criterion** presented in the **Federal Manual** were developed by the National Technical Committee for Hydric Soils (U.S.D.A. Soil Conservation Service (1987). Hydric soils are defined as "soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part." An area has hydric soils when the National Technical Committee for Hydric Soils (NTCHS) criteria for hydric soils are met. The NTCHS criteria were revised in September, 1990 (U.S.D.A. Soil Conservation Service, 1990). The revised NTCHS criteria are as follows:

1. All Histosols except Folists; or

2. Soils in Aquic suborder, Aquic subgroups, Albolls suborder, Salorthids great group, or Pell great groups of Vertisols, Pachic subgroups, or Cumulic subgroups that are:
   a. somewhat poorly drained and have a frequently occurring water table at less than 0.5 feet from the surface for a significant period (usually more than 2 weeks) during the growing season, or
   b. poorly drained or very poorly drained and have either:
      (1) a frequently occurring water table at less than 0.5 feet from the surface for a significant period (usually more than 2 weeks) during the growing season if textures are coarse sand, sand, or fine sand in all layers with 20 inches, or for other soils

      (2) a frequently occurring water table at less than 1.0 feet from the surface for a significant period (usually more than 2 weeks) during the growing season if permeability is equal to or greater than 6.0 inches/hour in all layers within 20 inches, or

(3) a frequently occurring water table at less than 1.5 feet from the surface for a significant period (usually more than 2 weeks) during the growing season if permeability is less than 6.0 inches/hour in any layer within 20 inches; or

3. Soils that are frequently ponded for long duration or very long duration during the growing season; or

4. Soils that are frequently flooded for long duration or very long duration during the growing season.

"Long duration" is defined as inundation for a single event that ranges from seven days to one month, and "very long duration" is inundation for a single event that is greater than one month. "Frequently flooded or ponded" is defined as flooding or ponding likely to occur often under usual weather conditions (more than 50 percent chance of flooding in any year or more than 50 times in 100 years).

Pinelands soils identified by the Soil Conservation Service (U.S.D.A. Soil Conservation Service, 1990) as meeting the hydric soil criteria established by the NTCHS are listed in Table 2. All soil series included in the Pinelands Commission's definition of wetland soils are found on this list. Four soil series not specifically listed as wetland soils in the Pinelands Comprehensive Management Plan but which are either poorly drained or very poorly drained and, therefore, meet the Comprehensive Management Plan's wetland soil criteria are included on the Soil Conservation Service list of hydric soils. These are Fallsington, Manahawkin, Mullica and Pasquotank.

As indicated in the **Federal Manual**, some map units may be hydric soils areas but are not on the hydric soils list because they were not assigned a series name when mapped. Freshwater Marsh, Muck, Tidal Marsh, Humaquepts, Sulfaquents and Sulfihemists are included in this category. All meet the hydric soil criteria. These soils nearly always display hydric conditions, and with the exception of Humaquepts which range from somewhat poorly drained to poorly drained soils, all are poorly drained or very poorly drained.

Somewhat poorly drained soils are defined by the Soil Conservation Service as soils which are wet for significant periods of time but not all the time. In the Pinelands this drainage class includes the Hammonton, Klej, Lakehurst and Woodstown series. None of these soils is included on the Soil Conservation Service hydric soil list (U.S.D.A. Soil Conservation Service, 1990). However, hydric soil inclusions are often found within areas mapped as somewhat poorly drained non-hydric soils. County hydric

Table 2. Hydric soils of the New Jersey Pinelands and associated non-hydric soils. The hydric soils list is based on U.S.D.A. Soil Conservation Service (1990). Freshwater Marsh, Muck, Sulfaquents, Sulfihemists and Tidal Marsh are not included on the New Jersey list because these mapping units were not assigned a soil series name. Soil drainage classes are moderately well drained (MW), somewhat poorly drained (SP), poorly drained (P) and very poorly drained (VP). The hydric criteria numbers correspond to the revised NTCHS criteria for hydric soils rather than those given in the Federal Manual. St. Johns and Leon have been correlated to Berryland and Atsion, respectively.

Soil Series, Subgroup or Land Type	Taxonomy	Temp	Drainage Class	High Water-Table		Permeab. within		Flooding		Hydric Criteria
				Depth (ft)	Months	20 in	Frequency	Duration	Months	Number
Atsion	Aeric Haplaquods	mesic	P	0-1.0	Nov-Jun	<6.0	none-rare	-	-	2B3
Atsion, tide flooded	Aeric Haplaquods	mesic	P	0-1.0	Jan-Dec	<6.0	frequent	v.brief	Jan-Dec	2B3
Bayboro	Umbric Paleaquults	thermic	VP	0-1.0	Nov-May	<6.0	none	-	-	2B3
Berryland	Typic Haplaquods	mesic	VP	0-0.5	Oct-Jun	<6.0	rare-freq	brief-long	Mar-Jun	2B3,4
Colemantown	Typic Ochraquults	mesic	P	0-1.0	Oct-Jun	<6.0	occasional	v.brief	Sep-Apr	2B3
Elkton	Typic Ochraquults	mesic	P	1-1.0	Nov-May	<6.0	none	-	-	2B3,3
Fallsington	Typic Ochraquults	mesic	P	0-1.0	Dec-May	<6.0	none	-	-	2B3
Freshwater Marsh	N/A	N/A	-	-	-	-	-	-	-	-
Hammonton (non-hydric)	Aquic Haplaudults	mesic	MW-SP	>=1.5	-	-	-	-	-	-
Keansburg	Typic Unbraquults	mesic	VP	0-0.5	Oct-Jun	<6.0	none-occasional	-	-	2B3
Klej (non-hydric)	Aquic Quartzipsamments	mesic	MW-SP	>=1.5	-	-	-	-	-	-
Lakehurst (non-hydric)	Haplaquodic Quartzipsamments	mesic	MW-SP	>=1.5	-	-	-	-	-	-
Leon	Aeric Haplaquods	thermic	P	0-1.0	Jun-Feb	<6.0	none-rare	-	-	2B3
Leon, Flooded	Aeric Haplaquods	thermic	P	0-1.0	Jun-Feb	<6.0	rare-common	brief-long	Mar-Sep	2B3,4
Manahawkin	Terric Medisaprists	mesic	VP	1.0-0	Oct-Jul	>=6.0	frequent	long	Jan-Mar	1,3,4
Muck	N/A	N/A	VP	-	-	-	-	-	-	-
Mullica	Typic Humaquepts	mesic	VP	0-0.5	Dec-May	<6.0	none-rare	-	-	2B3
Othello	Typic Ochraquults	mesic	P	0-1.0	Jan-May	<6.0	none	-	-	2B3
Pasquotank	Typic Haplaquepts	thermic	P	1.0-2.0	Dec-Mar	<6.0	none	-	-	2B3
Pocomoke, Drained	Typic Umbraquults	thermic	VP	0-1.5	Dec-May	<6.0	none	-	-	2B3
Pocomoke, Ponded	Typic Umbraquults	thermic	VP	1.0-0	Nov-Jun	<6.0	none	-	-	2B3
St. Johns	Typic Haplaquods	hyper-thermic	P	0-0.5	Jun-Oct	>=6.0	none	-	-	2B1
Sulfaquents	N/A	N/A	P, VP	-	-	-	-	-	-	-
Sulfihemists	N/A	N/A	P, VP	-	-	-	-	-	-	-
Tidal Marsh	N/A	N/A	-	-	-	-	-	-	-	-
Woodstown (non-hydric)	Aquic Hapludults	mesic	MW	>=1.5	-	-	-	-	-	-

soil lists prepared by the Soil Conservation Service identify non-hydric soil mapping units which include hydric soil components such as Pocomoke and Atsion.

Hydric Soil Criteria Number

Manahawkin, Muck and Sulfihemists are organic soils. Freshwater Marsh and Tidal Marsh may be organic or mineral soils. All meet at least one criterion for designation as a hydric soil, although Manahawkin is the only one included on the New Jersey list.

Although hydric organic soils are widely distributed throughout the region, the majority of hydric soils are mineral soils. With the exception of the St. Johns series which is described as a 2b1 soil, all mineral soils listed by the Soil Conservation Service (U.S.D.A. Soil Conservation Service, 1990) meet hydric criterion 2b3 (i.e., they are poorly drained or very poorly drained mineral soils with a permeability of less than 6.0 inches per hour and a water table at less than 1.5 feet from the surface for a significant period during the growing season). St. Johns is an outdated classification in the Pinelands and has been correlated to Berryland. Thus, St. Johns soils should also be listed as meeting criteria 2b3.

Water Table Level

The applicable hydric soil criteria for mineral soils consider soil drainage, soil texture and water table level. Permeability is also considered when evaluating poorly drained or very poorly drained soils.

Different water table levels are applied to poorly drained and very poorly drained soils with different soil permeabilities and textures because in low permeability, fine textured soils the depth to saturated soils will be nearer to the surface than suggested by the water level observed in a hole. This is due to a capillary fringe which is most pronounced in clay soils.

All poorly drained and very poorly drained Pinelands mineral soils included in the New Jersey hydric soils list are assigned a hydric criteria number of 2b3 (St. Johns exception previously noted) which indicates that a water table at less than 1.5 ft from the surface meets the **hydric soil criterion.**

Although it appears that the 1.5 ft test has general application in the Pinelands, in practice, use of the NTCHS criteria can lead to differences in field interpretations which may result in either the 0.5 ft or 1.0 ft test being applied. For example, water tables at less than 1.5 ft from the surface may be observed in soils with profiles similar to Hammonton soils (non-hydric, somewhat poorly drained). A field interpreter may classify such soils as belonging to either the Hammonton series or consider it

a hydric soil inclusion (e.g., Pocomoke). In the first case, the 0.5 ft water table test would be used while in the latter case the 1.5 ft water table test would be applied. This situation is further complicated because the Soil Conservation Service officially assigns a water table of no less than 1.5 ft to Hammonton soils, and soils with a water table that is greater than 1.0 ft from the surface would generally not be included in the Pocomoke series. A similar problem may be encountered in areas of Lakehurst (non-hydric, somewhat poorly drained) and Atsion (hydric, poorly drained) soils. In addition, different interpretations of the NTCHS criteria can result in a sandy soil such as Atsion being assigned either a 2b1, 2b2 or 2b3 hydric soil criteria number.

Certain interpretations of the NTCHS criteria can result in the net loss of plant communities that are generally recognized as Pinelands wetland communities. The region's sandy soils intensifies the contrast in moisture between uplands and wetlands, and compared to other areas in the United States, the distribution of Pinelands wetland plant communities more accurately reflects hydrologic conditions. The transition from Pinelands plant communities dominated by upland species to those dominated by wetland plants has been shown to coincide with a water table depth of approximately 1.5 ft (Roman et al., 1985).

In the Pinelands, the estimated depth to the water table based on soil morphology is a more important hydric soil criterion than one based on soil permeability, texture or drainage class. Thus, a soil need only have a frequently occurring water table at less than 1.5 ft from the surface for a significant period (usually more than 2 weeks) during the growing season to be classified as a hydric soil in the Pinelands, regardless of permeability, texture or drainage class. Although this may be a broader approach than that intended by the NTCHS, it is more straightfoward, better reflects conditions found in the Pinelands and affords a greater level of protection to the wetlands and water resources of this nationally significant region.

Growing Season

The hydric soil criteria require that water table levels be near the surface for "a significant period (usually more than 2 weeks) during the growing season." Growing season is defined in the **Federal Manual** as "the portion of the year when soil temperatures are above biological zero (41°F)." Growing seasons are assigned according to soil temperature regimes. Several soils found in the Pinelands are classified as thermic or hyper-thermic. Use of either regime is inappropriate because all soils in the Pinelands are actually mesic. The error resulted from assigning names of soils found in southern states (e.g., Pocomoke and Leon) to New Jersey soils. Growing season months for mesic soils are March through October (U.S.D.A. Soil Conservation Service, 1990).

WETLAND HYDROLOGY

Hydrology is the most important environmental factor controlling wetlands. As indicated in the **Federal Manual**, wetland hydrology is usually the most difficult of the three technical criteria to establish in the field due primarily to annual, seasonal and daily fluctuations. The **wetland hydrology criterion** given in the **Federal Manual** is similar to that given for soils. As with the **hydric soils criterion**, soil drainage, permeability and water table depth are considered when determining whether certain soils meet the **wetland hydrology criterion.**

"An area has wetland hydrology when saturated to the surface or inundated at some point in time during an average rainfall year, as defined below:

1. Saturation to the surface normally occurs when soils in the following natural drainage classes meet the following conditions:
   A. In somewhat poorly drained mineral soils, the water table is less than 0.5 feet from the surface for usually one week or more during the growing season; or
   B. In low permeability (<6.0 inches/hour), poorly drained or very poorly drained mineral soils, the water table is less than 1.5 feet from the surface for usually one week or more during the growing season; or
   C. In more permeable ($\geq$6.0 inches/hour), poorly drained or very poorly drained mineral soils, the water table is less than 1.0 feet from the surface for usually one week or more during the growing season; or
   D. In poorly drained or very poorly drained organic soils, the water table is usually at a depth where saturation to the surface occurs more than rarely (*Note*: Organic soils that are cropped are often drained, yet the water table is closely managed to minimize oxidation of organic matter; these soils often retain their hydric characteristics and if so, meet the wetland hydrology criterion).

2. An area is inundated at some time if ponded or frequently flooded with surface water for one week or more during the growing season."

This criterion is not entirely consistent with the revised NTCHS criteria which require that saturation to the surface occur frequently for a significant period (usually more than 2 weeks) during the growing season and that poorly drained or very poorly drained soils comprised of coarse sand, sand or fine sand in all

layers within 20 in have a frequently occurring water table at less than 0.5 ft from the surface. This inconsistency is being addressed by the national committee that is currently revising the **Federal Manual**.

For the reasons previously described in the discussion of the **hydric soil criterion**, areas of mineral soils in the Pinelands will be considered to display wetland hydrology if they have a frequently occurring water table at less than 1.5 ft from the surface for a significant period (usually more than 2 weeks) during the growing season regardless of soil permeability, texture or drainage class. The 1.5 ft water table level will also be used when considering whether a poorly drained or a very poorly drained organic soil is saturated to the surface.

PART III. FIELD INDICATORS AND OTHER AVAILABLE INFORMATION

Part III of the **Federal Manual** describes field indicators for each of the three technical criteria for wetland identification, and Part IV provides detailed procedures for distinguishing wetlands from non-wetlands in disturbed areas (Section 4.21) and problem area wetlands (Section 4.24). Historical and recent disturbances such as fire, cutting and impoundments have had a significant effect on Pinelands wetland vegetation patterns. Evergreen forested wetlands and spodosols, two specific problem area wetlands described in the **Federal Manual**, cover extensive areas within the region, while entisols (floodplain and sandy soils) are common, especially along the western periphery of the Pinelands. Thus, disturbed areas and problem area wetlands are often the rule rather than the exception in the Pinelands and are incorporated into the following discussion on field indicators.

HYDROPHYTIC VEGETATION

Pinelands wetland communities are generally dominated by a few common species, and differences among most wetland types are reflected in the relative abundance of these species. Although a knowledge of other, less common species may provide additional insight into the wetland status of a particular area, a field person can successfully make most wetland determinations armed only with the ability to identify the species listed in Table 1. A key to most of these common trees, shrubs and herbaceous plants (Ferren et al., 1979) is given in Appendix 2. A selected list of wetland field guides is given in Appendix 3. A more complete list is provided in Appendix A of the **FEDERAL MANUAL.**

Dominant Vegetation

The **Federal Manual** indicates that when identifying dominant vegetation within a plant community (1) dominance within each stratum should be considered and (2) all dominants should be treated equally in determining whether hydrophytic vegetation is present. Dominant species for a particular stratum are the most abundant plant species that immediately exceed 50 percent of the total dominance measure (e.g., total cover or basal area) for a given stratum, plus any additional species comprising 20 percent or more of the total dominance measure for that stratum. The total dominance measure is calculated by ranking dominant species in descending order of abundance and cumulatively totaling individual dominance measures.

The **FEDERAL MANUAL** suggests five vegetative strata for which dominants should be determined. Because of the effects of fire and cutting on Pinelands vegetation (e.g., many trees, including pitch pine and red maple, are multi-stemmed and slow growing), the diameters and heights assigned to these strata may not always be entirely consistent with the structure of the region's wet-

lands. In these cases, the following alternate system may be used. The strata may include: (1) tree layer (≥2.5 inches diameter at breast height, dbh); (2) shrub and woody vine layer, including multi-stemmed, bushy shrubs (usually 1 to 6 feet tall), small trees and saplings (≤2.5 inches diameter at breast height and usually 3 feet to 20 feet tall); and (3) herb layer (herbaceous plants including graminoids, forbs, ferns, fern allies, herbaceous vines, and tree seedlings). Bryophytes and lichens should also be sampled as part of the herb layer.

Field Indicators

Section 3.6 of the **Federal Manual** describes five different field indicators which demonstrate that hydrophytic vegetation is present. Hydrophytic vegetation is considered present if:

"1) OBL species comprise all dominants in the plant community (*Note*: In these cases, the area can be considered wetland without detailed examination of soils and hydrology, provided significant hydrologic modifications are not evident); or

2) OBL species do not dominate each stratum, but more than 50 percent of the dominants of all strata are OBL, FACW, or FAC species (including FACW+, FACW-, FAC+, and FAC-); or

3) A plant community has a visually estimated percent coverage of OBL and FACW species that exceeds the coverage of FACU and UPL species; or

4) A frequency analysis of all species within the community yields a prevalence index value of less than 3.0 (where OBL = 1.0, FACW = 2.0, FAC = 3.0, FACU = 4.0, and UPL = 5.0); or

5) A plant community has less than or equal to 50 percent of the dominant species from all strata represented by OBL, FACW, and/or FAC species, *or* a frequency analysis for all species within the community yields a prevalence index value greater than or equal to 3.0, *and* hydric soils and wetland hydrology are present. (*Note*: In other words, if the hydric soil and wetland hydrology criteria are met, then the vegetation is considered hydrophytic. For purposes of this manual, these situations are treated as disturbed or problem area wetlands because these plant communities are usually nonwetlands)."

It is noted in Section 3.6 of the **Federal Manual** that areas where obligate species comprise all dominants in the plant community can be considered wetlands without detailed examination of soils and hydrology, provided significant hydrologic modifications are not evident. This assumption concerning the presence of hydric soils is restated in Section 4.11 (Plant Community Assessment Procedure, Step 7), where the additional comment is made that hydric soils are assumed to be present and do not need to be ex-

amined where all dominant species have an indicator status of obligate (OBL) and facultative wet (FACW) and the wetland boundary is abrupt. All five field indicators given in **Section 3.6** as well as the notes concerning areas dominated by obligate and facultative wetland species are applicable in the Pinelands. A wetland boundary should be considered "abrupt" when the transition from upland to wetland vegetation is relatively well defined, that is, where non-wetland and FACU species are rare or absent and OBL and FACW species are dominant.

Pinelands Wetland Plant Communities

A knowledge of community classification is essential to accurately delineate wetlands in the field. Fortunately, Pinelands wetland plant communities have been extensively described. A bibliography of selected references is included in Appendix 3. Most of these have been reviewed by Tiner (1989).

The National Wetlands Inventory has delineated more than seventy inland wetland classes in the Pinelands, reflecting the compositional and structural diversity of the region's wetlands. McCormick (1979) presented a more concise description of Pinelands wetland vegetation which because of its simplicity is generally compatible with most other systems that have been developed. This system provided the primary basis for the list of wetland community types presented in the Pinelands Comprehensive Management Plan (N.J.A.C. 7:50-6.5, Appendix 1). Table 3 summarizes the results of several descriptive studies, including McCormick's (1979), in relation to the wetland types listed in the Comprehensive Management Plan. The following sections describe key field features of the most commonly encountered Pinelands wetland communities.

Atlantic White Cedar Swamps

Atlantic white cedar swamps and other wetlands in which cedar is a codominant species are among the easiest wetland types to delineate. These swamps are usually found adjacent to streams and are buffered from non-wetland areas by hardwood swamps or pitch pine lowland wetlands. It can almost always be assumed that cedar swamps meet the hydric soil and wetland hydrology criteria. The understory is dominated by obligate and facultative wetland plants which facilitates wetland delineation even in harvested areas. Although Atlantic white cedar swamps generally occur on organic soils, they may occasionally be found on mineral hydric soils such as Berryland or Atsion.

Instances where wetlands hydrology is not apparent within an area dominated by cedar are extremely rare. Because cedar germination and seedling survival require wetland conditions, these anomalies can be attributed to altered drainage following estab-

Table 3a. Summary of Pinelands wetland communties: Atlantic white cedar swamp

Species	Cedar Swamp Pinelands Commission (1980)	Southern White Cedar Swamp McCormick (1979)	Atlantic White Cedar Swamp Stoltzfus (1990)	C.thyoides entity Olsson (1979)
Trees				
Acer rubrum	X	X	D	X
Betula populifolia			X	
Chamaecyparis thyoides	D	D	D	D
Magnolia virginiana	X	X	X	
Nyssa sylvatica	X	X	X	X
Pinus rigida		X	X	
Sassafras albidum			X	
Shrubs				
Amelanchier canadensis			X	
Chamaedaphne calyculata			X	
Clethra alnifolia	X	X	D	D
Gaultheria procumbens			X	X
Gaylussacia baccata			X	
Gaylussacia frondosa	X	X	D	X
Gaylussacia dumosa			X	
Ilex glabra	X		X	
Ilex laevigata			X	
Kalmia latifolia			X	
Leucothoe racemosa	X	X	D	X
Myrica pensylvanica		X	X	
Parthenocissus quinquefolia			X	
Rhododendron viscosum	X	X	D	D
Rhus radicans			X	
Rubus hispidus			X	
Smilax rotundifolia			X	
Vaccinium corymbosum	X	X	D	D
Vaccinium macrocarpon			X	
Viburnum nudum			X	
Herbs				
Aralia nudicaulis			X	
Carex collinsii			X	
Carex spp.			X	X
Drosera spp.	X	X	X	
Dryopteris simulata			X	
Mitchella repens		X	X	
Osmunda cinnamomea	X			
Osmunda regalis	X			
Rhychospora alba				X
Sarracenia purpurea	X	X		
Trientalis borealis			X	
Woodwardia spp.		X	X	X
Utricularia spp.		X		
Bryophytes				
Sphagnum spp.	X	X	X	X
Leucobryum glaucum				X

D-dominant species; X-present
Bernard (1963): Forest stands located in Cape May peninsula excluded from summary.
Stoltzfus (1990): Species occurring in only one stand deleted from summary.

Table 3b. Summary of Pinelands wetland communties: Hardwood swamp

Species	Hardwood Swamp Pinelands Commission (1980)	Broadleaf Swamp McCormick (1979)	*A.rubrum-N.sylvatica* entity Olsson (1979)	*A.rubrum* Type Bernard (1963)	*C.thyoides A.rubrum* Type Bernard (1963)	Mixed Forest Bernard (1963)	Hardwood Swamp Ehrenfeld and Gulick (1981)
Trees							
Acer rubrum	D	D	D	D	D	X	D
Betula populifolia	X	X					X
Chamaecyparis thyoides	X	X			D		
Ilex opaca				X	X	X	X
Liquidambar styraciflua	X			X	X	X	
Magnolia virginiana	D	CD		X	X	X	X
Nyssa sylvatica	D	CD	X	X	X	X	X
Pinus rigida	X	X					
Pinus taeda						X	X
Quercus alba						X	X
Quercus falcata						X	
Quercus ilicifolia			X				
Quercus nigra				X			
Quercus palustris						X	
Quercus phellos				X		X	
Sassafras albidum		X				X	X
Shrubs							
Alnus rugosa							X
Amelanchier intermedia							X
Chamaedaphne calyculata	X	X					
Clethra alnifolia	X	D	D	D	D	D	X
Gaultheria procumbens			X				
Gaylussacia baccata		X					
Gaylussacia frondosa	X	X	X				X
Ilex verticillata					X	X	
Kalmia angustifolia		X					
Kalmia latifolia					X		
Leucothoe racemosa	X	X	X	X		X	X
Lyonia ligustrina			X				
Rhododendron viscosum	X	X	X			X	X
Rhus radicans					X		
Smilax rotundifolia			X				X
Vaccinium atrococcum				X		X	
Vaccinium corymbosum	X	D	D	D	D	X	X
Herbs							
Osmunda cinnamomea	X						
Osmunda regalis					X		
Woodwardia spp.	X			X	X		
Juncus spp.	X						
Bryophytes							
Sphagnum spp.			X				
Leucobryum glaucum			X				
Polytrichum juniperinum			X				

D-dominant species; CD-codominant species; X-present

Pinelands Commission (1980): The Comprehensive Management Plan notes that hardwood swamps include other lowland forests dominated by Liquidambar styraciflua, Quercus palustris and/or Quercus phellos.

Bernard (1963): Forest stands located in the Cape May peninsula excluded from summary.

Ehrenfeld and Gulick (1981): Species composition and importance values varied greatly among sites primarily in response to hydrologic conditions.

Table 3c. Summary of Pinelands wetland communties: Pitch pine lowlands

Species	Pitch Pine Lowlands Pinelands Commission (1980)	Pitch Pine Lowland Forest McCormick (1979)	Pine Transition Forest McCormick (1979)	*P.rigida-L.racemosa* Entity Olsson (1979)	Dry Pitch Pine Lowland Zampella (1990)	Wet Pitch Pine Lowland Zampella (1990)	Pine-Maple Swamp Zampella (1990)
Trees							
Acer rubrum	X	X	X		X	X	D
Betula populifolia	X	X	X				
Nyssa sylvatica	X	X	X	X		X	X
Pinus rigida	D	D	D	X	D	D	X
Quercus ilicifolia			X				
Quercus marilandica				X			
Shrubs							
Amelanchier canadensis					X	X	X
Chamaedaphne calyculata	X	D					
Clethra alnifolia	X		X	X	X	X	X
Gaultheria procumbens	X	X	X	X	X	X	X
Gaylussacia baccata		D	X	X	D	D	
Gaylussacia frondosa	X	D	D	X	X	D	D
Gaylussacia dumosa			X			X	
Ilex glabra						X	
Ilex verticillata			X				
Kalmia angustifolia	X	D	D	X	X	X	
Leiophyllum buxifolium				X			
Leucothoe racemosa			X	X	X	X	X
Lyonia ligustrina			X				
Lyonia mariana			X		X	X	
Myrica pensylvanica			X				
Aronia arbutifolia						X	X
Rhododendron viscosum			X	X		X	X
Smilax glauca			X	X	X	X	X
Smilax rotundifolia			X	X		X	X
Vaccinium atrococcum						D	D
Vaccinium corymbosum	X		X	X	X	D	D
Vaccinium vacillans				X			
Herbs							
Osmunda cinnamomea			X				X
Pteridium aquilinum		X	X		X		
Woodwardia virginica							X
Xerophyllum asphodeloides		X	X		X		
Bryophytes and Lichens							
Cladonia spp.				X	X		
Sphagnum spp.		X	X		X	X	X
Polytrichum spp.			X	X			

D-dominant species; X-present
McCormick (1979): At least 20 species of shrubs and woody vines are noted as occurring in pitch pine lowland forests; only those specifically mentioned are listed here.
Zampella (1990): Only frequently encountered species are listed.

Table 3d. Summary of Pinelands wetland communties: Bogs (shrubby wetlands)

Species	Bogs Pinelands Commission (1980)	Shrubby Wetland McCormick (1979)	Thicket-Bog Vegetation Type Olsson (1979) Entity C1	Entity C3	Entity C4
Trees					
Acer rubrum		X	X	X	X
Chamaecyparis thyoides					X
Magnolia virginiana					
Nyssa sylvatica			X		
Pinus rigida		X	X		
Quercus ilicifolia			X		
Shrubs					
Aronia melanocarpa			X		
Chamaedaphne calyculata	X	D		D	X
Clethra alnifolia	X		X	X	
Gaylussacia baccata			X		
Gaylussacia frondosa	X		X		
Hudsonia ericoides			X		
Kalmia angustifolia	X	X	X	D	
Leiophyllum buxifolium			X		
Leucothoe racemosa			X		
Lyonia ligustrina			X		
Lyonia mariana	X	X			
Rhododendron viscosum	X		X		
Rhus copallina			X		
Smilax glauca			X		
Vaccinium corymbosum	X	D	D	X	X
Vaccinium macrocarpon	X		X	X	D
Viburnum nudum			D		
Herbs					
Carex bullata				X	D
Carex spp.	X		X		
Drosera spp.	X		X		X
Dulichium arundinaceum					X
Glyceria obtusa					D
Lachnanthes tinctoria					X
Panicum virgatum			X		X
Sarracenia purpurea	X				
Woodwardia virginica				X	X
Bryophytes and Lichens					
Cladonia spp.			X		
Sphagnum spp.	X	X	X	X	X
Polytrichum spp.			X		
Leucobryum glaucum			X		

D-dominant species; X-present
Olsson (1979): Enitity C1-Shrub thicket (species are noted for three separate vegetation types: a. possum haw stands; b. blueberry stands; and c. abandoned cranberry bogs); Entity C3-Chamadaephne calyculata; and Entity C4-Vaccinium macrocarpon-Carex bullata-Glyceria obtusa (species are noted for three separate vegetation types: a. cranberry stands; b. sedge stands; and c. blunt mannagrass).

Table 3e. Summary of Pinelands wetland communities: Inland marsh

Species	In. Marsh Pinelands Commission (1980)	Herbaceous Wetland McCormick (1979) Ponds and Streams	Savannahs	Marsh-Sod Veg. Type Olsson (1979)	Stream-Pond Veg. Type Olsson (1979)
Trees					
Acer rubrum				X	
Chamaecyparis thyoides				X	X
Pinus rigida				X	
Shrubs					
Chamaedaphne calyculata				X	X
Clethra alnifolia				X	
Gaultheria procumbens				X	
Gaylussacia baccata				X	
Kalmia angustifolia				X	
Leiophyllum buxifolium				X	
Leucothoe racemosa				X	
Lyonia ligustrina				X	
Smilax glauca				X	
Vaccinium corymbosum				X	
Vaccinium macrocarpon				X	
Herbs					
Ambrosia artemisiifolia				X	
Andropogon glomeratus			X	X	
Aster spectabilis				X	
Carex bullata			X		X
Carex spp.	X	X		X	
Drosera spp.				X	X
Dulichium arundinaceum				X	
Eriocaulon spp.		X			
Platanthera blephariglottis				X	
Hypericum canadense				X	
Juncus spp.	X	X		X	
Lachnanthes tinctoria				X	
Nuphar variegatum		X			
Nymphaea odorata		X		X	X
Panicum virgatum				X	
Peltandra virginica	X				
Polygala lutea				X	
Pontederia cordata	X				
Rhexia virginica				X	
Rhynchospora alba				X	X
Scirpus subterminalis					X
Solidago odora				X	
Typhus spp.	X				
Woodwardia spp.		X			
Utricularia spp.		X			
Bryophytes and Lichens					
Cladonia spp.				X	
Sphagnum spp.		X		X	
Polytrichum spp.				X	

D-dominant species; X-present
Pinelands Commission (1980): Hydrophytic grasses are also included.
Olsson (1979): Marsh-Sod vegetation type inlcudes species occurring in four separate entities (a.Rhynchospora alba-Spagnum spp.; b. Lachnathes tinctoria-Rhexia virginica-Dulichium arundianceum; c. Polygala lutea-Habenaria blephariglottis (Platanthera blephariglottis); and d. haul road.

lishment of the stand. Such areas should be considered wetlands unless understory composition and soil morphology clearly indicate upland conditions.

Hardwood Swamps

Most hardwood swamps in the Pinelands are dominated by red maple. Associated species in red maple swamps include Atlantic white cedar, black gum, pitch pine and gray birch. Although sweet gum is most often a component of red maple swamps along the periphery of the Pinelands, it is sometimes found in the interior. The hydrology of red maple swamps is variable and ranges from saturated to seasonally flooded. Like Atlantic white cedar swamps, areas dominated by red maple are almost always wetlands, and it can usually be assumed that the hydric soil and wetland hydrology criteria are met. This is especially true in the central Pinelands where most red maple swamps are found adjacent to cedar swamps or stream corridors. Exceptions are most common in areas where somewhat poorly drained loamy soils are extensive, such as in Cape May County, or where forest has succeeded farmed land. In these areas, the composition of the understory can provide important information, and a greater reliance must be placed on soil morphology.

Sweet gum forests are common along the western periphery of the Pinelands. Because many of these areas were previously farmed, understory composition and structure is variable. Associated species may include plants typically found in red maple swamps as well as peripheral species such as willow oak (*Quercus phellos*), spice bush (*Lindera benzoin*), southern arrowwood (*Viburnum dentatum*), black cherry (*Prunus serotina*), sensitive fern (*Onoclea sensibilis*), false nettle (*Boehmeria cylindrica*), bedstraw (*Galium* spp.), poison ivy (*Rhus radicans*) and Virginia creeper (*Parthenocissus quinquefolia*).

Forests dominated by sweet gum are most extensive in the northwestern Pinelands portion of Burlington County where they occur on hydric soils such as Pocomoke and Pasquotank as well as on non-hydric Nixonton soils. White oak, black oak and sassafras are commonly found in sweet gum stands occurring on non-hydric soils. Only those sweet gum stands occurring on soils displaying hydric characteristics should be considered Pinelands wetlands where non-wetland tree species are an important component of the canopy or where the understory is not dominated by obligate and facultative wetland plant species.

Pitch Pine Lowlands

Pitch pine lowlands are comprised of a complex of Pinelands vegetation types which occupy a transitional landscape position, linking upland forests to swamps. These lowland forests also occur in topographical depressions and broad areas of low

relief. Although at least 24 shrub species occur in the pitch pine lowland vegetation complex, the understory of the different communities is dominated by only three to six common species. Most species occurring in pitch pine lowlands are found across the upland to wetland vegetational gradient. Pitch pine dominates the canopy in all but the wettest end of the gradient where red maple and black gum increase in importance.

Although the occurrence of several uncommon species may be limited to the upland or wetland end of the vegetational gradient, differences among pitch pine lowland vegetation types are, to a large degree, reflected in differences in relative abundance of the common shrub species. Due to the subtle vegetational, soil and hydrologic gradients occurring within pitch pine lowlands, these wetlands are among the most difficult to delineate accurately both in the field or from aerial photography. Understanding these problem wetlands is critical because they cover large areas in the Pinelands and are frequently encountered during wetland delineations due to their landscape position.

A wetlands delineator must recognize that there is a wet end and a dry end to the pitch pine lowland vegetational gradient along which water table levels may vary from flooded conditions to 2 ft below the surface. Pine-scrub oak forests usually occur along the upland boundary of pitch pine lowland. The understory of the pine-scrub oak forest is dominated by shrub-form scrub oak, black huckleberry, lowbush blueberry and dangleberry. The boundary between the pine-scrub oak forest and pitch pine lowland is usually characterized by an obvious decrease in scrub oak (as well as other oaks, if present) and lowbush blueberry. Looking upgradient, the upland boundary often appears as a patchy line of scrub oak. If necessary, soil observations should begin immediately downgradient from this boundary. Other plant indicators of wetland conditions are an increase in shrub height, an increase in the abundance of dangleberry, fetterbush, staggerbush, sheep laurel and greenbrier and the occasional occurrence of highbush blueberry. Obvious wetland plant indicators such as dense dangleberry and highbush blueberry cover and the frequent occurrence of red maple, sweetbay, swamp azalea, cinnamon fern and *Sphagnum* are usually found well within the wetland and far beyond the upland/wetland boundary.

Wildfires, prescribed burns and cutting have all had a profound effect on the composition and structure of pitch pine lowlands. Severe fires that kill the canopy are responsible for the short-form pitch pine lowlands found throughout the region. Pitch pine in these stands are less than 20 ft tall and are generally of sprout origin. Differences in vegetation and hydrology create a fire damage gradient which is most severe in

the middle of the gradient and less severe at the upland and swamp ends. Tree height and crown diameter can, therefore, sometimes provide important indicators when delineating pitch pine lowland wetlands, especially when interpreting aerial photography.

Fire also tends to shift the understory species composition of a pitch pine lowland towards the drier end of the upland to wetland gradient. Species such as turkeybeard, sheep laurel and black huckleberry which are characteristic of the dry end of the lowland gradient are most abundant following a fire. The vegetation may reflect the effects of a severe wildfire for decades.

Pitch pine lowlands are usually associated with mineral soils. Although they may be found on Pocomoke, Hammonton and Klej soils, they occur primarily on the somewhat poorly to very poorly drained soils of the Lakewood catena. Compared to other Pinelands wetland types, greater reliance should be placed on soils when delineating pitch pine lowland wetlands. The soils of pitch pine lowlands and problems encountered when delineating them will be discussed in detail in the section on hydric Pinelands soils.

Bogs (Shrubby Wetlands)

The term bog is used to describe a variety of shrub dominated Pinelands wetlands. These wetlands occur in topographic depressions, along streams, in areas where killing wildfires or timber harvesting has occurred and in abandoned cranberry bogs. The most common bog shrub species are leatherleaf, highbush blueberry and sheep laurel. Although some shrubby wetlands may represent temporary, successional features of the landscape, many, such as leatherleaf bogs, are relatively stable communities.

It can generally be assumed that shrubby wetlands dominated by leatherleaf or highbush blueberry are wetlands. Although topographic depressions supporting these species are sometimes found within upland areas, most are components of pitch pine lowland wetlands. Sheep laurel presents a special problem. Both sheep laurel and black huckleberry may dominate mineral soil wetlands in recently burned areas and in areas severely disturbed by past wildfires. Sheep laurel may also be prominent in burned upland areas. As with pitch pine lowland communities, the role of soil morphology becomes more important in these problem wetlands areas.

HYDRIC SOILS

Hydric Soil Field Indicators

There are several excellent sources of information on hydric Pinelands soils. Modal or typical soil descriptions are given in the U.S.D.A. Soil Conservation Service soil surveys covering the seven Pinelands counties. These surveys are listed in Appendix 3 along with other selected references on Pinelands soils. Hydric Pinelands soil descriptions obtained from these surveys are summarized in Appendix 4.

Because of the low topographic relief and sandy soils that characterize the New Jersey Pinelands Area, the transition between upland and wetland mineral soils is often subtle and problem area wetlands are frequently encountered. As previously noted, spodosols and entisols are problem area soils which predominate in the Pinelands. The purpose of this section is to briefly describe key features that can be used in the field to distinguish common hydric Pinelands soils from associated non-hydric soils, emphasizing common problem area wetland soils.

Soil classification provides a useful framework for the field investigation of hydric soils. Although many soils do not neatly conform to any known soil series, comparison of field characteristics to modal descriptions can provide valuable insight into a soil's development and hydric nature. However, in the final assessment it is a soil's hydric characteristics rather than the series to which it is assigned that determines whether an area is a regulated Pinelands wetlands.

Eight hydric soil field indicators are described in the **Federal Manual**. These are: 1) organic soils; 2) histic epipedons; 3) sulfidic material; 4) aquic or peraquic moisture regime; 5) direct observations of reducing soil conditions; 6) gleyed, low chroma and low chroma/mottled soils; 7) iron and manganese concretions; and 8) in coarse-textured or sandy hydric soils, high organic matter content in the surface horizon, dark vertical streaking of subsurface horizons by organic matter and spodic horizons in wet Spodosols. The **Federal Manual** distinguishes between gleyed soils and other low chroma soils. In the following discussion, low chroma soils (matrix color of 2 or less) resulting from saturated conditions are considered to be synonymous with gleyed soils.

Pinelands Hydric Soils

Hydric Organic Soils

Two hydric organic soils occur in the non-tidal areas of the Pinelands. Muck soils are mapped in all Pinelands counties except Ocean, where similar soils are classified as Manahawkin.

The organic horizon in these soils is 18-36 inches of muck (sapric material). Muck and Manahawkin soils are generally associated with Atlantic white cedar and hardwood swamps. Except where drained, these organic soils are usually easy to recognize in the field and present few delineation problems. Sulfidic material and aquic or peraquic moisture regimes are most often encountered in these soils.

Hydric Mineral Soils

Pitch pine lowlands are usually associated with somewhat poorly drained to very poorly drained sands of the Lakewood topo-drainage catena. Presented in the order of their upland to wetland position in the Lakewood catena hydrosequence, these are the Lakehurst (non-hydric), Atsion and Berryland series. Atsion and Berryland soils are wet Spodosols which meet the **hydric soil criterion.** The non-hydric Lakehurst soils are Entisols.

Lakehurst, Atsion and Berryland soils have an obvious, leached, gray E (A2) horizon which should not be interpreted as an indication of hydric soil conditions. This albic horizon is underlain by a dark B2h horizon which distinguishes the soils of the Lakewood catena from all other Pinelands soils. The depth and thickness of the B2h may be variable or discontinuous even over short distances. This horizon is thinner and lighter in the better drained Lakehurst soils (generally 10YR 4/4 or 7.5YR 4/4 in lower lying areas adjacent to wetlands). The thicker B2h horizons in the Atsion and Berryland soils are associated with longer duration high water tables than those occurring in Lakehurst soils. The color of the B2h in these two hydric soils generally ranges from dark reddish brown (5YR 2/2 and 5YR 3/4) through dark brown (7.5YR 3/2-4/2) to very dark brown (10YR 2/2). The depth of the spodic horizon should not be interpreted as representing the seasonal high water table level.

The hydric characteristics of Berryland soils are unmistakable in the field. A thick, black sandy A horizon, a well developed, dark B2h and low chroma subsoil are conspicuous features of this series. Wetland delineation problems generally arise in the transition from non-hydric Lakehurst to hydric Atsion soils.

Although the thickness of the litter layer, O (F/H) horizon and A horizon increases along the upland to wetland Lakehurst-Atsion-Berryland soil gradient, distinct differences between Lakehurst and Atsion soils may not be obvious in areas where one grades into the other. Thus, high organic matter content in the surface horizon is not a good indicator of hydric conditions in these transitional areas. Mottling due to alternating reducing and oxidizing conditions associated with a fluctuating water table are generally found in the B3 or C horizon of Lakehurst soils. Low chromas usually occur throughout the lower horizons of At-

sion soils, especially where the seasonal water table is within 1 ft of the surface. However, higher chroma soils ranging from dark yellowish brown (10YR 4/6) through yellowish brown (10YR 5/4-5/8) and brownish yellow (10YR 6/6) can occur in the B3 horizon directly below the B2h along the upper wetland boundary where Atsion soils grade into Lakehurst. Although such soils possess characteristics that are transitional between Atsion and Lakehurst soils, they typically display water table levels meeting the Pinelands **wetland hydrology criterion.** In these situations, upgradient and downgradient soils should be inspected to determine the location of the "best" hydric/non-hydric soil boundary.

Sandy alluvial land consists mainly of thick deposits of loose, coarse sand and gravel adjacent to perennial streams in the Outer Coastal Plain portion of the Pinelands. The surface soil is black, dark brown or very dark mucky or sandy soil overlying grayish brown sand. Unclassified soils meeting this description also occur along the edge of flooded swamps or in narrow swamps located along intermittent streams in areas mapped as Atsion, Berryland, Muck or Manahawkin soils. Although these soils lack the thick, black muck horizon of Muck and Manahawkin soils, a histic epipedon (mucky sand or mucky loam) may sometimes be present. The B2h and albic horizon found in the spodosols is also absent in these soils. Like the organic soils found in the Pinelands, the hydric characteristics of these unclassified, saturated sands are obvious in the field. Situations may, however, sometimes occur where yellowish-brown or yellowish horizons are observed in the field. In these cases, wetland boundary decisions should be based on vegetation, topographic position and other field indicators described in the **Federal Manual** rather than on difficult to interpret anomalous horizons.

The Pocomoke, Mullica and Fallsington series are sandy loam or loamy hydric soils that usually support hardwood swamp communities. Pocomoke soils occur in all Pinelands counties except Ocean County where similar soils are mapped as Mullica. The very poorly drained Pocomoke (Mullica) soils typically have a thick black sandy loam A horizon. The high organic matter content in the surface soil is a key field indicator of hydric conditions in this series. A gray E horizon and low chroma soils with or without bright mottles in the B and C horizons distinguishes Pocomoke soils from associated upland soils of the non-hydric Hammonton, Woodstown and Nixonton series. Poorly drained Fallsington soils are also more gray than Woodstown and Hammonton soils but lack the thick black A horizon that is common in Pocomoke soils. The matrix of the B and C horizons of Fallsington soils is also characterized by low chromas with bright mottles.

Pasquotank soils occur primarily along the western boundary of the Pinelands in Burlington County. These soils are frequently associated with non-hydric Nixonton soils and hydric Pocomoke soils. Both Pasquotank and Nixonton are fine sandy loams developed from similar parent materials derived from the Kirkwood deposits. Sands in the Pocomoke soils are not so consistently fine as in the Pasquotank soils. Sweet gum stands or mixed stands composed of sweet gum, red maple and white oak are usually found in wooded areas where Nixonton soils grade into Pasquotank soils. The hydric Pasquotank soils have a darker and thicker surface horizon and grayer subsoils than Nixonton soils, although the distinction between the two types may not be readily apparent in transitional areas. Yellowish brown (10YR 5/6-10YR 5/8) mottles may be found within 1.5 ft in both soils. However, in hydric Pasquotank soils these bright mottles occur in a gray to light brownish gray low chroma matrix. In some areas, the subsoil of Pasquotank soils may be gray to light brownish gray throughout. In Camden County and Gloucester County, somewhat poorly drained, non-hydric Barclay soils occupy the transitional position in the Nixonton-Pasquotank hydrosequence.

Bayboro, Colemantown, Elkton, Keansburg and Othello are Inner Coastal Plain soils which are rarely encountered when delineating wetlands in the Pinelands Area. The key field indicator in all five soils is a low chroma matrix with bright mottles. Bayboro soils are mapped only in Gloucester County. These very poorly drained hydric soils have a black surface layer underlain by mottled gray clay or silty clay. The Colemantown series consists of poorly drained, dark-olive or dark greenish-gray loamy soils that are prominently mottled. The subsoil is highly glauconitic. Colemantown soils are mapped in Camden, Burlington and Gloucester Counties but are most likely to be encountered in Burlington County portions of the Pinelands.

Keansburg soils are very poorly drained loamy soils that have a prominently mottled olive-gray subsoil which contains some glauconite. This series is mapped in Burlington County. The major occurrence of poorly drained, clayey or silty loam Elkton soils is outside the Pinelands within the Delaware River drainage basin in Gloucester County. Othello soils are poorly drained, silty loams mapped in Cumberland County.

WETLAND HYDROLOGY

The Kirkwood-Cohansey aquifer system is an unconfined water table aquifer that underlies the entire Pinelands. Water table levels generally reflect topographic position and respond to variations in precipitation and evapotranspiration. They are usually highest in late winter and early spring, drop during the summer and early fall, and recover following the end of the growing season. The amplitude of annual water table fluctuations is

lowest in wetlands underlain with organic soils (e.g., cedar swamps and hardwood swamps) and greatest in areas of mineral soil (e.g., pitch pine lowlands).

As indicated in the **Federal Manual**, the **wetland hydrology criterion** is often of limited use in delineating precise wetland boundaries because wetland hydrology is not readily apparent in many instances. Although wetland hydrology should always be considered, primary emphasis should be placed on hydrophytic vegetation and hydric soils in the absence of significant hydrologic modifications.

The **Federal Manual** describes eleven hydrologic indicators that can be assessed quickly in the field. These are: 1) visual observation of inundation; 2) visual observation of saturation; 3) oxidized channels (rhizospheres) associated with living roots and rhizomes; 4) water marks; 5) drift lines; 6) water-borne sediment deposits; 7) water-stained leaves; 8) surface scoured areas; 9) wetland drainage patterns; 10) morphological plant adaptations; and 11) hydric soil characteristics. Although all are valid field indicators of wetland hydrology, those associated with surface inundation (e.g., water marks) are usually observed in areas which have obvious hydrophytic vegetation and hydric soil features (e.g., hardwood swamps and cedar swamps) and are not generally essential for the accurate delineation of Pinelands wetlands. However, they do support findings based on vegetation and soil characteristics and serve to satisfy the wetlands hydrology criterion. Regarding morphological plant adaptations associated with flooded or saturated soils, Pinelands wetland tree species do not display buttressed tree trunks, and multiple trunks observed in red maple may represent sprouting following cutting rather than the effects of hydrologic regime.

Visual observation of soil saturation, which requires digging a hole to a depth of 18 inches and observing the level at which water stands in the hole after sufficient time has been allowed for water to drain into the hole, and hydric soil characteristics are important field indicators of wetland hydrology in the Pinelands, especially in areas of mineral soils. However, the validity of visual observation of soil saturation is dependent on the season during which measurements are made as well as short-term and long-term climatic conditions. Because water tables in some Pinelands wetlands can drop more than three feet by the end of the growing season, soil saturation should be observed in early spring (March or April) during an average rainfall year. Observations can be made during periods of above average precipitation if necessary; however, below average periods must be avoided. Depth to water levels should be determined both immediately following and two to three days after a precipitation event. Multiple observations over a one to two month period may be required in some cases, and in situations where rigorous documentation is needed, observations should be made over two or

more growing seasons. Climatic conditions in the previous year (e.g., drought) should be considered when initiating a monitoring program or when interpreting observed water levels.

PART IV. METHODS FOR IDENTIFICATION AND DELINEATION OF WETLANDS

The **Federal Manual** presents four basic wetland identification and delineation methods that are grouped into two general types: (1) offsite procedures and (2) onsite procedures. Offsite procedures are designed for use in the office and rely on available information such as maps, aerial photos and previously collected site-specific information. Three onsite methods are described: (1) routine; (2) intermediate-level; and (3) comprehensive. In the Pinelands, the offsite determination method should be used only in preparation for an onsite determination. All final wetland determinations and delineations must be conducted onsite.

METHOD SELECTED FOR USE IN THE PINELANDS

The routine method described in the **Federal Manual** is designed for small areas (five acres or less) or larger areas supporting homogeneous vegetation. The intermediate-level and comprehensive methods are designed for areas greater than five acres in size or areas supporting highly diverse vegetation, and in the case of the comprehensive method, for situations requiring detailed documentation of the three technical wetland criteria.

The Pinelands Commission has found that the routine method is sufficient for nearly all situations encountered in the Pinelands Area. Although the wetland landscape is extremely patchy, individual patches that can be recognized from aerial photos or in the field (e.g., cedar swamps, hardwood swamps and bogs) tend to be quite homogeneous. Unless otherwise specifically required by the Pinelands Commission or other governmental agency regulating jurisdictional wetlands, the routine method can be used in the Pinelands.

Two approaches for routine delineation of wetland boundaries are described in the **Federal Manual**: 1) the plant community assessment procedure and 2) the hydric soil assessment procedure. In the plant community approach, the hydrophytic vegetation of representative plant communities is characterized, and then the presence of hydric soils and wetland hydrology is verified. The hydric soil approach requires that hydric soil boundaries be delineated first. The presence of hydrophytic vegetation and wetland hydrology is then verified. Both approaches generally produce the same results, and the choice of which one to use depends on available information, expertise and individual or agency preference. The Pinelands Commission has found that the plant community assessment procedure is generally the most effective and straightfoward approach for the identification and delineation of Pinelands wetlands. This method should be used in the Pinelands except in disturbed areas - such as recently or severely burned sites, graded or filled wetlands and old fields - where conditions may require that the hydric soil procedure be used.

The plant community assessment procedure is summarized here. The reader should refer to the complete procedure presented in **Section 4.11** of the **Federal Manual.** All relevant Pinelands revisions previously stated should be incorporated when using it.

Step 1. *Scan the entire project area, if possible, or walk, if necessary, and identify plant community types present.*

Step 2. *Determine whether normal environmental conditions are present.*

Step 3. *Select representative observation area(s).*

Step 4. *Characterize each plant community in the project area.*

Step 5. *Record the indicator status of dominant species in all strata.*

Step 6. *Determine whether the hydrophytic vegetation criterion is met.*

Step 7. *Determine whether soils must be characterized.*

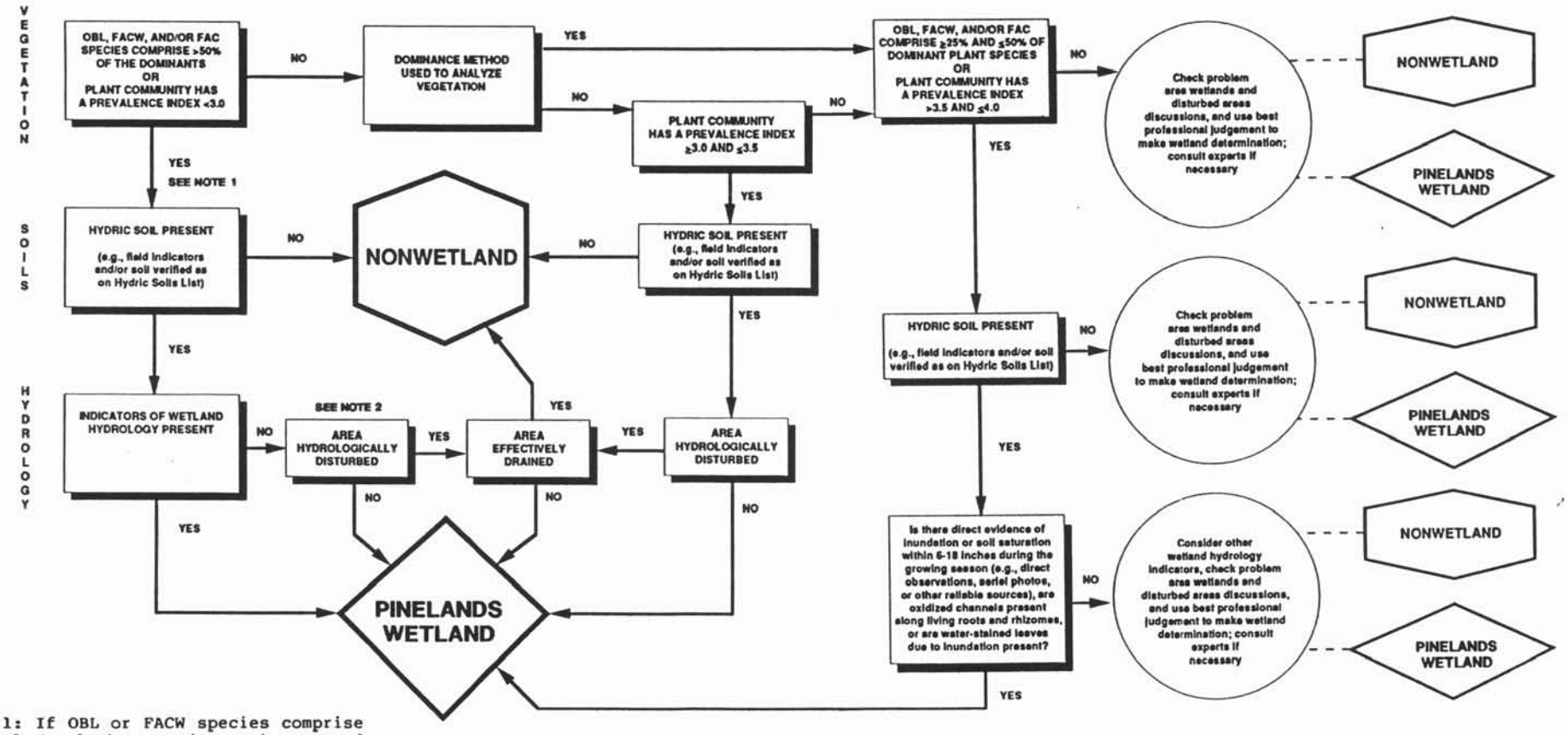
Step 8. *Determine whether the hydric soil criterion is met.*

Step 9. *Determine whether the wetland hydrology criterion is met.*

Step 10. *Make the wetland determination.*

Step 11. *Determine the wetland-nonwetland boundary.*

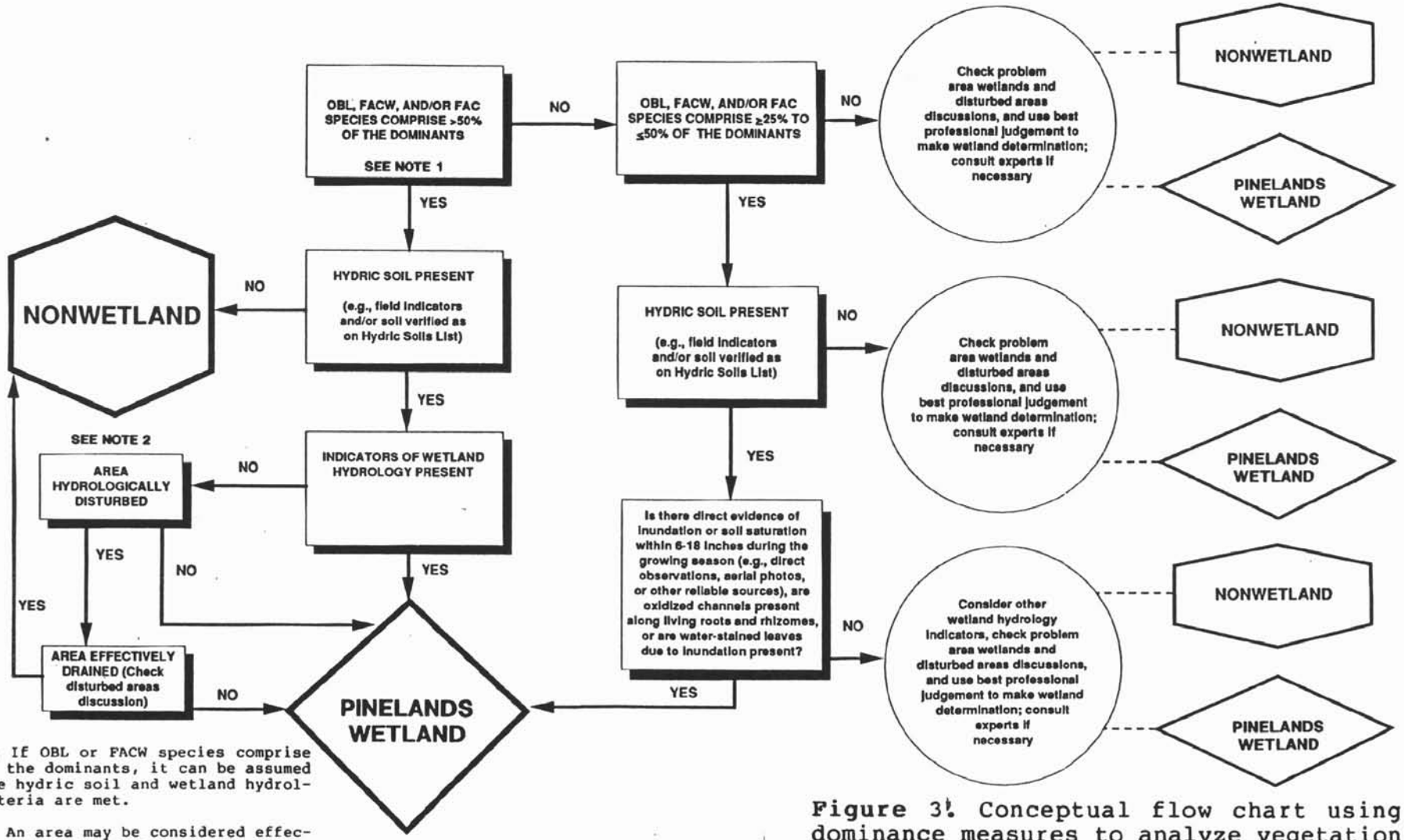
The approach used in making onsite wetland determinations in the New Jersey Pinelands Area is conceptualized in Figures 3 and 4 which are adapted from the **Federal Manual.**



NOTE 1: If OBL or FACW species comprise >50% of the dominants, it can be assumed that the hydric soil and wetland hydrology criteria are met.

NOTE 2: An area may be considered effectively drained only if the alteration (e.g., dams, ditches and diversion of water) responsible for the absence of wetland hydrology existed prior to 1979.

Figure 2. Conceptual approaches for making an onsite wetland determination in the New Jersey Pinelands Area.



NOTE 1: If OBL or FACW species comprise >50% of the dominants, it can be assumed that the hydric soil and wetland hydrology criteria are met.

NOTE 2: An area may be considered effectively drained only if the alteration (e.g., dams, ditches and diversion of water) responsible for the absence of wetland hydrology existed prior to 1979.

Figure 3. Conceptual flow chart using dominance measures to analyze vegetation in making an onsite wetland determination in the New Jersey Pinelands Area.

PART V. SUMMARY

This manual describes the approach used by the New Jersey Pinelands Commission to identify and delineate freshwater wetlands in the New Jersey Pinelands Area. It adapts the methods presented in the **Federal Manual** to the unique conditions found in the New Jersey Pinelands and serves as a Pinelands Commission supplement to that manual. The Pinelands approach includes the following revisions to the **Federal Manual:**

1) a modified Pinelands wetland indicator status classification is used to determine whether an area meets the **hydrophytic vegetation criterion;**

2) a soil meets the **hydric soil criterion** if it has a frequently occurring water table at less than 1.5 ft from the surface for a significant period (usually more than 2 weeks) during the growing season regardless of soil permeability, texture or drainage;

3) an area meets the **wetland hydrology criterion** if it has a frequently occurring water table at less than 1.5 ft from the surface for a significant period (usually more than 2 weeks) during the growing season regardless of soil permeability, texture or drainage;

4) the offsite determination method should be used only in preparation for an onsite determination;

5) all final wetland determinations and delineations must be conducted onsite;

6) unless otherwise specifically required by the Pinelands Commission or other governmental agency regulating jurisdictional wetlands, the routine onsite wetland determination method can be used; and

7) the plant community assessment procedure should be used except in disturbed areas - such as recently or severely burned sites, graded or filled wetlands and old fields - where conditions may require that the hydric soil procedure be used.

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APPENDICES

Appendix 1. New Jersey Pinelands wetland management program (N.J.A.C. 7:50-6.1 through 7:50-6.20).

SUBCHAPTER 6. MANAGEMENT PROGRAMS AND MINIMUM STANDARDS

Authority
N.J.S.A. 13:18A-6j

Source and Effective Date
R.1987 d.436, effective November 2, 1987.
See: 18 N.J.R. 2239(a), 19 N.J.R. 2010(a).

Historical Note
This subchapter became effective January 14, 1981 as R.1981 d.13. See: 12 N.J.R. 513(b), 13 N.J.R. 91(e).

1987 Revisions: This subchapter was amended effective November 2, 1987 as R.1987 d.436. See: 18 N.J.R. 2239(a), 19 N.J.R. 2010(a).

INTRODUCTION

This subchapter establishes management programs and minimum standards governing development and land use in the Pinelands. In addition, guidelines for county and municipality preparation of management programs for scenic resources and recreation are provided. All the programs are intended to be implemented by the administration of municipal and county master plans and land use ordinances and by state and federal agencies through the development review procedures established in N.J.A.C. 7:50-4. Prior to certification of county or municipal master plans and land use ordinances, the standards of this subchapter except for those guidelines or optional programs, will be implemented and enforced by the Pinelands Commission. The standards set forth in this subchapter are minimum requirements and a municipality, county, state, or federal agency may adopt more restrictive regulations, provided that such regulations are compatible with the goals and objectives of this Plan.

PART I—WETLANDS

7:50-6.1 Purpose

Coastal and inland wetlands constitute a vital element of the ecological character of the Pinelands. They are critical habitats for many threatened and endangered plant and animal species and play many other important roles including the maintenance of surface and ground water quality. This program is deemed to be the minimum standards necessary to protect the long-term integrity of wetlands.

7:50-6.2 Wetlands management program

In order to be certified under the provisions of N.J.A.C. 7:50-3, a municipal master plan or land use ordinance must provide for the protection of the integrity of wetlands. It is not necessary that the municipal program incorporate the literal terms of the program set out in this Part; rather a municipality may adopt alternative and additional techniques which will achieve equivalent protection of the wetlands defined in this Part, as would be achieved under the provisions of this Part.

7:50-6.3 Wetlands

Wetlands are those lands which are inundated or saturated by water at a magnitude, duration and frequency sufficient to support the growth of hydrophytes. Wetlands include lands with poorly drained or very poorly drained soils as designated by the National Cooperative Soils Survey of the Soil Conservation Service of the United States Department of Agriculture. Wetlands include coastal wetlands and inland wetlands, including submerged lands.

7:50-6.4 Coastal wetlands

(a) Coastal wetlands are banks, low-lying marshes, swamps, meadows, flats, and other lowlands subject to tidal inundation which support or are capable of supporting one or more of the following plants:

1. Salt meadowgrass (Spartina patens);
2. Spike grass (Distichlis spicata);
3. Black grass (Juncus gerardi);
4. Saltmarsh grass (Spartina alterniflora);
5. Saltworts (Salicornia europaea and Salicornia bigelovii);
6. Sea lavender (Limonium carolinianum);
7. Saltmarsh bulrushes (Scirpus robustus and Scirpus paludosus var, atlanticus);
8. Sand spurrey (Spergularia marina);
9. Switch grass (Panicum virgatum);
10. Tall cordgrass (Spartina pectinata);
11. Hightide bush (Iva frutescens var, oraria);
12. Cattails (Typha angustifolia and Typha latifolia);
13. Spike rush (Eleocharis rostellata);
14. Chairmaker's rush (Scirpus americanus);
15. Bent grass (Argostis palustris);
16. Sweet grass (Hierochloe odorata);
17. Wild rice (Zizania aquatica);
18. Olney's threesquare (Scirpus olneyi);
19. Marsh mallow (Hibiscus palustris);

20. Salt reed grass (Spartina cynosuroides);
21. Common reed grass (Phragmites communis);
22. Pickerel grass (Pontederia cordata);
23. Arrowheads (Sagittaria spp.);
24. Spatterdock (Nuphar variegatum);
25. Red maple (Acer rubrum); and
26. Atlantic white cedar (Chamaecyparis thyoides).

(b) Coastal wetlands include those lands which are delineated by the New Jersey Department of Environmental Protection on official maps at a scale of 1:2, 400 listed in N.J.A.C. 7:7A-1.13.

7:50-6.5 Inland wetlands

(a) Inland wetlands include, but are not limited to:

1. Atlantic white cedar swamps which are areas dominated by Atlantic white cedars (Chamaecyparis thyoides) and supporting one or more of the following hydrophytic plants:

i. Red maple (Acer rubrum);
ii. Sweetbay (Magnolia virginiana);
iii. Blackgum (Nyssa sylvatica);
iv. Dangleberry (Gaylussacia frondosa);
v. Highbush blueberry (Vaccinium corymbosum);
vi. Swamp azalea (Rhododendron viscosum);
vii. Fetterbush (Leucothoe racemosa);
viii. Sweet pepperbush (Clethra alnifolia);
ix. Inkberry (Ile glabra);
x. Pitcher plant (Sarracenia purpurea);
xi. Sundew (Drosera spp.);
xii. Cinnamon fern (Osmunda cinnamomea);
xiii. Royal fern (Osmunda regalis); and
xiv. Sphagnum moss (Sphagnum spp.).

2. Hardwood swamps which are areas dominated by red maple (Acer rubrum), blackgum (Nyssa sylvatica) and/or sweetbay (Magnolia virginiana) and supporting one or more of the following hydrophytic plants:

i. Gray birch (Betula populifolia);
ii. Pitch pine (Pinus rigida);
iii. Atlantic white cedar (Chamaecyparis thyoides);
iv. Sweet gum (Liquidambar styraciflua);
v. Sweet pepperbush (Clethra alnifolia);
vi. Highbush blueberry (Vaccinium corymbosum);
vii. Swamp azalea (Rhododendron viscosum);
viii. Fetterbush (Leucothoe racemosa);
ix. Leatherleaf (Chamaedaphne calyculata);

x. Dangleberry (Gaylussacia frondosa);
xi. Cinnamon fern (Osmunda cinnamomea);
xii. Chain fern (Woodwardia spp.); and
xiii. Rushes (Juncus spp.);
xiv. Or other lowland forests dominated by one or more of the following plants:
(1) Sweetgum (Liquidambar styraciflua);
(2) Pin oak (Quercus palustris); and
(3) Willow oak (Quercus phellos).

3. Pitch pine lowlands are areas dominated by pitch pine (Pinus rigida) and supporting one or more of the following hydrophytic plants:
i. Red maple (Acer rubrum);
ii. Blackgum (Nyssa sylvatica);
iii. Gray birch (Betula populifolia);
iv. Leatherleaf (Chamaedaphne calyculata);
v. Dangleberry (Gaylussacia frondosa);
vi. Sheep laurel (Kalmia angustifolia);
vii. Highbush blueberry (Vaccinium corymbosum);
viii. Sweet pepperbush (Clethra alnifolia); and
ix. Wintergreen (Gaultheria procumbens).

4. Bogs which are areas dominated by hydrophytic, shrubby vegetation including:
i. Cranberry (Vaccinium macrocarpon);
ii. Leatherleaf (Chamaedaphne calyculata);
iii. Sheep laurel (Kalmia angustifolia);
iv. Highbush blueberry (Vaccinium corymbosum);
v. Swamp azalea (Rhododendron viscosum);
vi. Sweet pepperbush (Clethra alnifolia);
vii. Dangleberry (Gaylussacia frondosa);
viii. Staggerbush (Lyonia mariana); or
ix. Sphagnum moss (Sphagnum spp.), pitcher plant (Sarracenia purpurea), sundew (Drosera spp.), and sedges (Carex spp.) are among the herbaceous plants which are found in bogs. Active cranberry bogs and shrub thickets dominated by leatherleaf (Chamaedaphne calyculata) are included in this category.

5. Inland marshes which are areas dominated by hydrophytic grasses (Graminaea) and sedges (Carex spp.) and which include one or more of the following plants: pickerelweed (Pontederia cordata), arrow arum (Peltandra virginica), cattail (Typhus spp.), and rushes (Juncus spp.).

6. Lakes and ponds which are seasonal or permanent standing bodies of water.

7. Rivers and streams which are bodies of water which periodically

or continuously contain moving water or which form a link between two bodies of standing water.

7:50-6.6 Development prohibited

Development shall be prohibited in all wetlands in the Pinelands except as specifically authorized in this Part.

7:50-6.7 Significant adverse impact

(a) A significant adverse impact shall be deemed to exist where it is determined that one or more of the following modifications of a wetland will have an irreversible effect on the ecological integrity of the wetland and its biotic components including, but not limited to, threatened or endangered species of plants or animals:

1. An increase in surface water runoff discharging into a wetland;
2. A change in the normal seasonal flow patterns in the wetland;
3. An alteration of the water table in the wetland;
4. An increase in erosion resulting in increased sedimentation in the wetland;
5. A change in the natural chemistry of the ground or surface water in the wetland;
6. A loss of wetland habitat;
7. A reduction in wetland habitat diversity;
8. A change in wetlands species composition; or
9. A significant disturbance of areas used by indigenous and migratory wildlife for breeding, nesting, or feeding.

(b) Determinations under (a) above shall consider the cumulative modifications of the wetland due to the development being proposed and any other existing or potential development which may affect the wetland.

Amended by R.1988 d.405, effective September 19, 1988.
See: 20 N.J.R. 716(a), 20 N.J.R. 2384(a).
In (a), added "including, but not . . .", and in (b), changed "effect" to "affect".

7:50-6.8 Agriculture and horticulture

Horticulture of native Pinelands species and berry agriculture shall be permitted in all wetlands subject to the requirements of Part V of this subchapter. Beekeeping shall be permitted in all wetlands.

7:50-6.9 Forestry

Forestry shall be permitted in all wetlands subject to the requirements of Part IV of this subchapter.

7:50-6.10 Fish and wildlife management

Fish and wildlife management activities shall be permitted in all wetlands subject to the minimum standards of all other parts of this

subchapter; provided that the management activity does not have a significant adverse impact, as set forth in N.J.A.C. 7:50-6.7, on the wetlands in which the activity is carried out; and provided that the activity conforms to all state and federal regulations. On a case by case basis, fish and wildlife management proposals shall be evaluated relative to the scientific research value of the proposal.

7:50-6.11 Low intensity uses

Hunting, fishing, trapping, hiking, boating, and swimming shall be permitted in all wetlands provided that such uses do not involve any structure other than those authorized in N.J.A.C. 7:50-6.12. Other similar low intensity recreational uses shall be permitted provided that any associated development does not have a significant adverse impact, as set forth in N.J.A.C. 7:50-6.7, on the wetland in which the use is carried out.

7:50-6.12 Water-dependent recreational facilities

Docks, piers, moorings, and boat launches for the use of a landowner shall be permitted in all wetlands, provided that the use will not result in a significant adverse impact, as set forth in N.J.A.C. 7:50-6.7, and conforms to all state and federal regulations.

(b) Commercial or public docks, piers, moorings, and boat launches shall be permitted provided that:

1. There is a demonstrated need for the facility that cannot be met by existing facilities;

2. The development conforms with all state and federal regulations; and

3. The development will not result in a significant adverse impact, as set forth in N.J.A.C. 7:50-6.7.

7:50-6.13 Public improvements

(a) Bridges, roads, trails and utility transmission and distribution facilities shall be permitted in wetlands provided that:

1. There is no feasible alternative route or site for the facility that does not involve development in a wetland or, if none, that another feasible route or site which results in less significant adverse impacts on wetlands does not exist;

2. The public need cannot be met by existing facilities or modification thereof;

3. The use represents a need which overrides the importance of protecting the wetland;

4. Development of the facility will include all practical measures to mitigate the adverse impact on the wetland; and

5. The resources of the Pinelands will not be substantially impaired as a result of the facility and its development.

7:50-6.14 Wetland transition areas

No development, except for those uses which are specifically authorized in this subchapter, shall be carried out within 300 feet of any wetland, unless the applicant has demonstrated that the proposed development will not result in a significant adverse impact on the wetland, as set forth in N.J.A.C. 7:50-6.7.

7:50-6.15 through 7:50-6.20 (Reserved)

Appendix 2. A key to the common vascular plants of the Pinelands. Ferren, W.R., Jr., J.W. Braxton and L. Hand. 1979. Common vascular plants of the Pine Barrens. In Pine Barrens: ecosystem and landscape, R.T.T. Forman (ed.). Academic Press, New York, New York. pp. 373-394. Reprinted with permission from Academic Press.

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Common Vascular Plants of the Pine Barrens

WAYNE R. FERREN, JR., JOHN W. BRAXTON, and LOUIS HAND

INTRODUCTION

In 1911, Witmer E. Stone reported 565 vascular plant species for the Pine Barrens of New Jersey. Subtracting plants which he considered "obvious intrusions from other districts," he numbered the native Pine Barrens flora at 386 species, that is, about 15 trees, 50 shrubs, and 320 herbaceous plants. McCormick (1970) suggested that introductions and new discoveries have increased the total number of vascular plant species, varieties, and forms to more than 800. This chapter is a guide to the identification of selected vascular plant species of the Pine Barrens, including both widespread Coastal Plain plants and Pine Barrens endemics. Most trees and shrubs listed by Stone are included, but only a few of the herbaceous plants could be mentioned.

This chapter contains two sections: keys, which include additional descriptive information, and figures. The keys are artificial, that is, genera and species are not necessarily grouped according to evolutionary relationships. The format of the descriptions is as follows: general appearance of the plants; habitat conditions; and characteristics of the bark, twig, bud, leaf, leaf scar, and vascular bundle scar, flower, and fruit. All of this information, however, is not provided for each species. Unless otherwise indicated, measurements refer to height of plant (1 m = 3.3 ft) or length of leaves, petals, etc. (1 cm = 0.4 in). Tree heights refer to the maximum heights attained by the species, but often are considerably greater than heights attained in the Pine Barrens. Habitat conditions given here are general. Wet thickets, for example, include margins of bogs, ponds, and streams and other shrubby areas with wet soil conditions. Bark characteristics refer to mature bark. Dates refer to flowering times, unless indicated as the time of ripened fruit. The following abbreviations are used: spp. (species); Fam. (Family); P. B. (Pine Barrens).

Several frequently used terms are defined as follows: (a) capsule—a dry, dehiscent fruit composed of more than one carpel or seed-bearing portion of the flower; (b) catkin—a dry spike of small, unisexual flowers each in the axil of a bract; (c) nutlet—a small, hard, indehiscent, one-seeded fruit; (d) berry—a fleshy fruit with immersed

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seeds; (e) drupe—a fleshy fruit with a hard or stony inner portion of the ovary wall; (f) persistent—remaining on the plant through the winter.

Illustrations of members of the heath family (Ericaceae) are grouped together for convenient comparison, since this family includes the largest number of woody species in the Pine Barrens. However, the sedge family (Cyperaceae), grass family (Poaceae or Gramineae), and aster or composite family (Asteraceae or Compositae), respectively, are represented by the most species. Descriptions of these and other herbaceous plants are not included.

In developing the keys and descriptions, we have consulted Fernald (1950), Gleason (1952), Gleason and Cronquist (1963), Grimm (1962, 1966), Graves (1956), and Stone (1911). The reader also may find Fairbrothers *et al.* (1965), Harlow (1957, 1959), Harshberger (1916), Peterson and McKenny (1968), and Symonds (1958, 1963) helpful. The nomenclature follows Fernald (1950).

KEYS TO THE TREES, SHRUBS, AND HERBACEOUS PLANTS

I. PERENNIAL WOODY PLANTS USUALLY WITH SINGLE STEMS REACHING A HEIGHT OF 4 METERS AT MATURITY: Trees, Key I

II. PERENNIAL WOODY PLANTS WHICH ARE SMALLER THAN TREES AND USUALLY WITH SEVERAL STEMS: Shrubs and sub-shrubs, Key II

III. PLANTS WITH NO PERSISTENT WOODY STEM ABOVE THE GROUND: Herbaceous plants, Key III

Trees—Key I

A. LEAVES PERSISTENT AND GREEN IN WINTER . . . B

A. LEAVES NOT PERSISTENT AND NOT GREEN IN WINTER . . . H

B. LEAVES SCALE-LIKE OR NEEDLE-SHAPED . . . C

B. LEAVES BROAD, NOT SCALE-LIKE OR NEEDLE-SHAPED . . . G

C. LEAVES NEEDLE-SHAPED, IN CLUSTERS OF TWO OR THREE, >3.5 CM LONG . . . D (pines: *Pinus* spp.)

C. LEAVES SCALE-LIKE OR NEEDLE-SHAPED, NOT IN CLUSTERS, <6 MM LONG . . . F

D. LEAVES STIFF, IN CLUSTERS OF THREE, 3.5–14 CM LONG; YOUNG TWIGS WITHOUT WHITE COVERING: tree to 25 m (<20 m in P.B.); most common tree of the pinelands and Pine Plains; bark reddish-brown, deeply furrowed; buds pointed, resin-coated; leaves dark green, often sprouting from trunk; May; open cones ovoid, flat at base, 3–7 cm . . . . . Pitch pine, *Pinus rigida* (Pine Fam.) (Fig. 1a)

D. LEAVES FIRM, IN CLUSTERS OF TWO OR SOMETIMES THREE; YOUNG TWIGS WITH WHITE COVERING . . . E

E. LEAVES 3–6(–8) CM LONG, IN CLUSTERS OF TWO; CONES WITH FIRM PRICKLES >2 MM LONG: tree <12 m, often straggling; fringe areas; bark dark brown; shallowly fissured into scaly plates; buds resinous; leaves gray-green, often twisted; Apr.–May; cones ovoid, round at base, 4–8 cm . . . . . Virginia, Jersey, or Scrub pine, *Pinus virginiana* (Pine Fam.)

E. LEAVES (3–)5–11(–13) CM LONG, IN CLUSTERS OF TWO OR SOMETIMES THREE; CONES WITH SOFT PRICKLES <1 MM LONG: tree to 40 m, straight; bark reddish-brown, thick, with large scaly plates; buds scarcely resinous; leaves dark green; May; cones oblong, 4–6 cm . . . . . Shortleaf pine, *Pinus echinata* (Pine Fam.) (Fig. 1b)

F. LEAVES ALL SCALE-LIKE, NONE NEEDLE-SHAPED; CONES 6–9 MM IN DIAMETER, SOMEWHAT WOODY; SEEDS SLIGHTLY WINGED: tree to 25 m, base of trunk swollen; swamps; bark reddish-brown, scaly; Apr. . . . . Atlantic white cedar or White cedar, *Chamaecyparis thyoides* (Pine Fam.) (Fig. 1c)

F. LEAVES NEEDLE-SHAPED ON YOUNG VIGOROUS BRANCHES, SCALE-LIKE ON OLDER BRANCHES; CONES 5–6 MM IN DIAMETER, FLESHY, BLUISH; SEEDS WINGLESS: tree to 30 m; dry open disturbed areas; bark fibrous, peeling lengthwise; Mar.–Apr. . . . . Red cedar, *Juniperus virginiana* (Pine Fam.) (Fig. 1d)

G. LEAVES WITH SMOOTH MARGINS; FRUIT CONE-LIKE: tree to 10 m; swamps; bark thin, smooth, gray; leaves with white coating below; twigs aromatic when broken; leaf buds silky; flowers fragrant, petals 3–5 cm; May–July; fruits 3–5 cm; seeds 8–10 mm . . . . . Sweet bay, *Magnolia virginiana* (Magnolia Fam.) (Fig. 1e)

G. LEAVES WITH SHARP SPINES; FRUIT A BERRY-LIKE DRUPE: tree to 30 m; moist soil along streams; bark light gray with small bumps; leaves oval, leathery; male and female flowers on different plants, May–June; drupe red, 7–10 mm, persistent . . . . . American holly, *Ilex opaca* (Holly Fam.) (Fig. 1f)

H. LEAVES SMOOTH-MARGINED OR FINE-TOOTHED, NOT LOBED OR LARGE-TOOTHED . . . I

H. LEAVES LOBED OR HAVING MARGINS WITH LARGE TEETH, NOT FINE-TOOTHED . . . N

I. LEAVES WITH SMOOTH MARGINS . . . J
I. LEAVES WITH TOOTHED MARGINS . . . K
J. LEAVES BROADEST BELOW MIDPOINT, TIP ROUNDED, HALF-EVERGREEN, SPICY-AROMATIC WHEN CRUSHED, 8-15 CM LONG; FRUIT CONE-LIKE . . . . . Sweet bay, *Magnolia virginiana;* see G above
J. LEAVES BROADEST ABOVE MIDPOINT, TIP WITH SHORT ABRUPT POINT, DECIDUOUS, NOT AROMATIC WHEN CRUSHED, 3-10 CM LONG; FRUIT A BERRY-LIKE DRUPE IN CLUSTERS: tree to 35 m; base of trunk often swollen; wet soil or swamps; bark dark brown, rough; leaves turning crimson early; May-June; drupe 1 cm . . . . . Black gum, *Nyssa sylvatica* (Dogwood Fam.) (Fig. 1g)
K. LEAVES TRIANGULAR OR INVERSELY TRIANGULAR; FLOWERS IN CATKINS . . . L
K. LEAVES OVAL OR ELLIPTICAL; FLOWERS NOT IN CATKINS . . . M
L. BARK CHALKY, WHITE AND SMOOTH; LEAVES TRIANGULAR: tree or shrub with one to several trunks to 10 m; bark not peeling; branchlets with resin dots; leaves 5-9 cm, pointed; catkins 1-2.5 cm, Apr.-May . . . . . Gray or White birch, *Betula populifolia* (Birch Fam.) (Fig. 1h)
L. BARK BLACK, DEEPLY RIDGED; LEAVES INVERSELY TRIANGULAR . . Blackjack oak, *Quercus marilandica;* see T below
M. INNER BARK OF TWIGS AROMATIC; TREE WITH SINGLE TRUNK TO 30 M: LONGEST STEMS OF FRUIT >1 CM LONG; FRUIT BLACKISH, ONE-SEEDED; FLOWERS WITH ONE STYLE: disturbed areas; bark rough, flaky; branchlets with prominent lenticels (corky spots); leaves tapered to a point, ovate, 3.5 cm; May-June . . . . . Black cherry, *Prunus serotina* (Rose Fam.)
M. INNER BARK OF TWIGS NOT AROMATIC; TALL SHRUB TO 8 M, USUALLY WITH SEVERAL CLUMPED TRUNKS; FRUIT APPLE-LIKE, TEN-SEEDED; FLOWERS WITH FIVE STYLES . . . . . Juneberry or Serviceberry, *Amelanchier canadensis;* see o' in Key II, Shrubs
N. LEAVES AND TWIGS OPPOSITE; FRUIT WINGED: tree to 30 m; moist soil or swamps; bark dark gray; branchlets red; leaves with 3-5 toothed lobes, 4-8 cm; flowers small, red, opening before the leaves . . . . . Red maple, *Acer rubrum* (Maple Fam.) (Fig. 1j)
N. LEAVES AND TWIGS ALTERNATE; FRUIT NOT WINGED . . . O
O. LEAVES AND TWIGS AROMATIC, LEAVES USUALLY MITTEN-SHAPED OR THREE-LOBED; FRUIT A DRUPE; BUDS USUALLY SOLITARY; TWIGS GREEN: tree or colonial shrub to 20 m; woods and thickets, Pine Plains; bark red-brown, furrowed, mature twigs dark gray; leaves ovate or 2-3 lobed, 8-15 cm; flowers greenish-yellow, Apr.-May . . . . . Sassafras, *Sassafras albidum* (Laurel Fam.) (Fig. 1i)
O. LEAVES AND TWIGS NOT AROMATIC; FRUIT AN ACORN; BUDS CLUSTERED AT TIP OF DARK TWIG . . . P (Oaks: *Quercus* spp.).
P. LEAVES LARGE-TOOTHED, NOT LOBED . . . Q
P. LEAVES LOBED . . . R
Q. LEAVES 5-12 CM LONG; LENGTH OF LEAF MORE THAN TWICE WIDTH; 3-7 TEETH ON EACH MARGIN; SHRUB OR SMALL TREE, RARELY ABOVE 4 M; BARK LIGHT BROWN, SCALY . . . . . Dwarf chestnut oak, *Quercus prinoides;* see h in Key II, Shrubs
Q. LEAVES 12-20 CM LONG; LENGTH OF LEAF LESS THAN TWICE WIDTH; 10-16 TEETH ON EACH MARGIN; TREE TO 30 M; BARK DARK WITH GROOVES V-SHAPED IN CROSS-SECTION . . . . . Chestnut oak, *Quercus prinus* (Beech Fam.) (Fig. 1k)
R. LOBES ROUNDED, NOT BRISTLE-POINTED; BARK ON MATURE TREES PALE, OFTEN FLAKY; ACORNS MATURING IN ONE YEAR . . . S (White oaks)
R. LOBES NOT ROUNDED, BRISTLE-POINTED; BARK ON MATURE TREES DARK, FURROWED, NOT FLAKY; ACORNS MATURING OVER TWO YEARS . . . T (Black oaks)
S. TWIGS AND MATURE LEAVES HAIRLESS; LOBES OF LEAVES SLANTING AT ACUTE ANGLES TO LEAF MIDRIB: tree to 50 m; dry pinelands; leaves inversely egg-shaped, white beneath when mature, 10-25 cm; May; acorn 2-3 cm, cup- or bowl-shaped . . . . . White oak, *Quercus alba* (Beech Fam.) (Fig. 1l)
S. TWIGS HAIRY; LEAVES HAIRY BENEATH; MIDDLE PAIR OF LEAF LOBES LONGER THAN THE OTHERS AND NEARLY PERPENDICULAR TO THE MIDRIB, GIVING THE WHOLE LEAF A SHAPE LIKE A LATIN CROSS: tree or tall shrub rarely beyond 20 m; dry pinelands; bark red- to gray-brown, scaly and ridged; leaves leathery, rough above due to star-like hairs, 9-20 cm; May; acorns stalkless, ovoid, 1-2 cm . . . . . Post oak, *Quercus stellata* (Beech Fam.) (Fig. 1m)
T. LEAVES NOT DEEPLY LOBED, SHAPED LIKE A BROAD INVERTED TRIANGLE: tree to 15 m, usually to 7 m in pinelands, shrubby in Pine Plains; leaves yellow-green, hairy beneath, rounded at base, 10-25 cm; May; acorns on short stems, ovoid, 1-2 cm, cup conical . . . . . Blackjack oak, *Quercus marilandica* (Beech Fam.) (Fig. 1n)
T. LEAVES DEEPLY LOBED, NOT SHAPED LIKE A BROAD INVERTED TRIANGLE . . . U
U. UNDERSIDE OF LEAVES GRAYISH-WHITE AND DENSELY HAIRY; LEAF LOBES SHORT-TRIANGULAR; SHRUB OR SMALL TREE TO 6 M . . . . . Scrub oak or bear oak, *Quercus ilicifolia;* see a in Key II, Shrubs
U. UNDERSIDE OF LEAVES GREEN OR YELLOWISH-BROWN, HAIRY, OR HAIRLESS; LEAF LOBES USUALLY TAPERING TO NARROW POINTS; LARGE TREES . . . V
V. UNDERSIDE OF MATURE LEAVES GREEN AND HAIRLESS (SOMETIMES WITH HAIR TUFTS AT FORKS OF VEINS BENEATH); LENGTH OF LONGEST LOBES 2-6 TIMES THE WIDTH OF THE NARROWEST PART OF THE CENTRAL PORTION OF LEAF: tree to 25 m; dry pinelands; bark light brown, finely fissured, inner bark red; leaves very shiny, green above, scarlet in fall, elliptical or oblong-ovate, deeply divided, 7-15 cm; buds smooth, or woolly only above middle; May; acorn ovoid, 2.5 cm . . . . . Scarlet oak, *Quercus coccinea* (Beech Fam.) (Fig. 1o)
V. UNDERSIDE OF LEAVES EITHER YELLOW-BROWN AND HAIRY OR GREEN AND HAIRLESS; LENGTH OF LONGEST LOBES LESS THAN TWICE THE WIDTH OF THE NARROWEST PART OF THE CENTRAL PORTION OF LEAF: tree to 30 m; dry pinelands; bark rough, inner bark yellow-orange; leaves dark green above, oblong to ovate, often shallowly divided, 10-25 cm; densely woolly, grayish; May; acorn ovoid, 2.5 cm . . . . . Black oak, *Quercus velutina* (Beech Fam.) (Fig. 1p)

Shrubs—Key II

A. PROSTRATE OR TRAILING SHRUBS, SUB-SHRUBS OR SHRUBS LESS THAN 30 CM HIGH . . . B
A. ERECT OR CLIMBING SHRUBS USUALLY MORE THAN 30 CM HIGH . . . O
B. STEMS FLESHY AND JOINTED; LEAVES SMALL, SCALE-LIKE AND DECIDUOUS, BEARING IN THEIR AXILS CLUSTERS OF SMALL BARBED HAIRS: a cactus; dry open sand; flowers yellow, 5 cm wide, June–July; berries inversely egg-shaped, red, or purple, 2.5–5 cm, Aug.–Oct. . . . . Prickly pear, *Opuntia humifusa* (Cactus Fam.)
B. STEMS NEITHER FLESHY NOR JOINTED; LEAVES WITHOUT BARBED HAIRS IN THEIR AXILS . . . C
C. LEAVES FLATTENED, SCALE-LIKE OR AWL-LIKE BUT NOT OVER 3 MM WIDE . . . D
C. LEAVES BROADER, USUALLY OVER 3 MM WIDE . . . F
D. LEAVES FLATTENED, ALTERNATE OR IN THREES, BLUNT; FLOWERS SMALL, PURPLISH IN HEADS AT TIPS OF BRANCHES; FRUIT BERRY-LIKE: diffusely branched, evergreen shrub; Pine Plains; flowers small in the axils of scaly bracts, in terminal heads, Mar.–May; drupe small, brown . . . . . Broom crowberry, *Corema conradii* (Crowberry Fam.)
D. LEAVES SCALE-LIKE OR AWL-LIKE; FLOWERS YELLOW, WHITE, OR ROSE, SOLITARY; FRUIT A CAPSULE . . . E
E. LOW AND BUSHY; LEAVES SCALE-LIKE, HAIRY; FLOWERS YELLOW; FRUIT A CAPSULE ENCLOSED IN THE CALYX . . . E′ (*Hudsonia* spp.).
E′. LEAVES HAIRY BUT GREENISH, PROLONGED, AND POINTED; FLOWERS SOLITARY ON HAIRY STALKS: dry open sands; leaves 6 mm; flowers May–July; capsules small . . . Golden heather, *Hudsonia ericoides* (Rockrose Fam.) (Fig. 2a)
E′. LEAVES WOOLLY, GRAYISH, NOT PROJECTING FROM THE STEM; FLOWERS STALKLESS: dry open sands, more frequently along the coast . . . . . Beach heather, *Hudsonia tomentosa* (Rockrose Fam.)
E. PROSTRATE AND CREEPING; LEAVES AWL-LIKE, SMALL; FLOWERS WHITE OR ROSE; FRUIT A VISIBLE CAPSULE, TRANSVERSELY OPENING: dry open sand, leaves sharply acute, evergreen, 3–8 mm; flowers solitary, numerous, 5–8 mm wide, Apr.–May; capsule nearly spherical, 2 mm long . . . . . Pyxie moss, *Pyxidanthera barbulata* (Diapensia Fam.) (Fig. 2b)
F. LEAVES COMPOUND (3–5 FOLIATE); FRUITS ARE COMPACT CLUSTERS OF SMALL, ONE-SEEDED DRUPELETS ARRANGED ON A DISC; STEMS WITH BRISTLES: trailing evergreen shrub; swampy ground; stems bristly, glandular, rooting at the tips; leaves bluntly toothed; flowers 5–9 mm, June–July; drupelets July–Aug. . . . . Swamp dewberry, *Rubus hispidus* (Rose Fam.) (Fig. 2c)
F. LEAVES SIMPLE; FRUITS NOT ARRANGED ON A DISC; STEMS WITHOUT BRISTLES . . . G
G. LEAVES, LEAF SCARS AND BUDS OPPOSITE OR SOMETIMES IN THREES . . . H
G. LEAVES, LEAF SCARS AND BUDS ALTERNATE . . . I
H. FLOWERS LIGHT YELLOW, ENCLOSED IN A PAIR OF LARGE, HEART-SHAPED SEPALS; STEMS WITH TWO WING-LIKE RIDGES . . . H′ (*Ascyrum* spp.).
H′. LEAVES BROADLY OBLONG, THE UPPER CLASPING: pale green shrub; moist or dry open sands; flowers solitary, terminal, July–Sept. . . . . St. Peter's Wort, *Ascyrum stans* (St. John's Wort Fam.) (Fig. 2d)
H′. LEAVES LINEAR TO OBLONG, NARROWED TO BASE: a similar shrub of dry open sand . . . . . St. Andrew's Wort, *Ascyrum hypericoides* (St. John's Wort Fam.)
H. FLOWERS WHITE OR PINK, NOT ENCLOSED IN A PAIR OF SEPALS; STEMS NOT TWO-WINGED: evergreen shrub to 1 m; dry or damp open sand; leaves crowded, ovate, 6–12 mm; flowers small, numerous in terminal clusters, May–June; capsule 2–3-celled . . . . . Sand myrtle, *Leiophyllum buxifolium* (Heath Fam.) (Fig. 3e)
I. LARGEST LEAVES USUALLY <2.5 CM LONG . . . J
I. LARGEST LEAVES USUALLY >2.5 CM LONG . . . K
J. TRAILING SHRUB OF DRY SANDY SOIL: evergreen; flexible branches; leaves inversely egg-shaped, shiny, untoothed, 0.9–3 cm; flowers white or pink, 5 mm, in terminal clusters, Apr.–May; drupe dull red, persistent . . . . . Bearberry, *Arctostaphylos uva-ursi* (Heath Fam.) (Fig. 3a)
J. TRAILING SHRUB OF WET PEATY OR SANDY SOIL: evergreen; bogs, swamps, shores; stems elongate and much branched; leaves oblong-elliptical, 16–17 mm; flowers solitary, pink, 2–6 per branch, June–July; berry red, 1–2 cm wide, persistent . . . . . Cranberry, *Vaccinium macrocarpon* (Heath Fam.) (Fig. 3g)
K. ERECT, BRANCHING SHRUBS, LEAVES DECIDUOUS . . . L
K. PROSTRATE OR TRAILING SHRUBS OR SUB-SHRUBS; LEAVES EVERGREEN . . . M
L. LEAVES RESIN-DOTTED; FRUIT A DRUPE WITH TEN NUTLETS: buds of two sizes, scales of the smaller buds not long-pointed; leaves untoothed; leaf scars with one bundle scar; flowers tubular, purple-tinged, May–June; drupe berry-like, July–Sept. . . . L′ (*Gaylussacia* spp.).
L′. TWIGS HAIRY AND RESIN-DOTTED; LEAVES THICK, DARK GREEN ABOVE; DRUPE HAIRY AND RESIN-DOTTED: height to 0.5 m, colonial; dry pinelands; flower clusters with persistent, leaf-like bracts . . . . . Dwarf huckleberry, *Gaylussacia dumosa* (Heath Fam.) (Fig. 3i)
L′. TWIGS SMOOTH; LEAVES THIN, DULL WHITE BENEATH; DRUPE DARK BLUE WITH WHITE COATING: height to 2 m; dry woods and clearings; flowers 3–4.5 mm in lax, open clusters with small, deciduous bracts . . . . . Dangleberry, *Gaylussacia frondosa* (Heath Fam.)
L′. TWIGS SLIGHTLY HAIRY TO SMOOTH; LEAVES RESIN-DOTTED ON BOTH SURFACES; DRUPE BLACK, WITHOUT WHITE COATING: dry or moist woods, thickets and clearings; flowers resin-dotted in short, stalkless clusters with small, deciduous bracts . . . . . Black huckleberry, *Gaylussacia baccata* (Heath Fam.)
L. LEAVES NOT RESIN-DOTTED; FRUIT A MANY-SEEDED BERRY: colonial to 0.5 m; dry woods, clearings; twigs smooth or hairy; scales of the smaller buds with long-pointed tips; leaves oval, dull, white beneath, smooth or hairy, untoothed or finely toothed, 1.5–5 cm; flowers white or greenish, often pink-tinged, 4–6 mm, May; berry dark blue with a white coating, June–July . . . . . Low blueberry or Lowbush blueberry, *Vaccinium vacillans* (Heath Fam.) (Fig. 3h)

M. FRUIT FLESHY, RED; PLANT AROMATIC, WINTERGREEN: colonial sub-shrub 5-15 cm, dry or moist woods, thickets; leaves elliptical, obtusely toothed, 1.5-5 cm; flowers cylindrical, few, nodding, white, June-Aug.; capsule surrounded by a fleshy calyx, persistent .....Wintergreen, *Gaultheria procumbens* (Heath Fam.) (Fig. 3b)

M. FRUIT DRY, BROWN; PLANT NOT STRONGLY AROMATIC ... N

N. STEMS NEARLY HERBACEOUS, ASCENDING; LEAVES SMOOTH, VARIEGATED WITH WHITE; FLOWERS AND CAPSULES 1-5 IN ERECT TERMINAL CLUSTERS: colonial sub-shrub, 5-20 cm; dry woods; leaves remotely toothed, 3-7 cm; flowers white, 2 cm wide, June-July; capsule five-celled with flattened summit .....Spotted wintergreen, *Chimaphila maculata* (Wintergreen Fam.) (Fig. 3c)

N. STEMS SLIGHTLY WOODY, PROSTRATE OR TRAILING; LEAVES STIFF-HAIRY AND NOT VARIEGATED; FLOWERS AND CAPSULES IN SMALL AXILLARY OR TERMINAL CLUSTERS: evergreen; dry sand or loam; leaves oval, clasping; flowers rose to white, 8-15 mm, Apr.-May; capsule five-celled with flattened summit .....Trailing arbutus, *Epigaea repens* (Heath Fam.) (Fig. 3d)

O. SHRUBS WITH COMPOUND LEAVES (THREE OR MORE LEAFLETS) ... P

O. SHRUBS WITH SIMPLE LEAVES ... Q

P. STEMS AND PETIOLES BRISTLY OR PRICKLY; LEAFLETS 3(-5); FLOWERS USUALLY SHOWY, WHITE; FRUITS ARE COMPACT CLUSTERS OF SMALL, ONE-SEEDED DRUPELETS ARRANGED ON A DISC: colonial; dry sands; stems erect or arching to 1 m; leaves woolly beneath; flowers 1-3 per cluster, May-July; drupelets dry, July-Aug. .....Sand blackberry, *Rubus cuneifolius* (Rose Fam.)

P. STEMS AND PETIOLES SMOOTH OR FINELY DOWNY; LEAFLETS 9(-21); FLOWERS SMALL, YELLOW-GREEN; FRUITS SMALL, HAIRY, DRY, AND DRUPE-LIKE IN ERECT, TERMINAL CLUSTERS: colonial shrub or small tree; disturbed areas; twigs stout with a large pith; leaflets shiny, leaf axis with wings; leaf scar with five bundle scars; flowers numerous in terminal clusters, July-Sept.; drupes red, Sept.-Oct. .....Dwarf sumac, *Rhus copallina* (Sumac Fam.)

Q. SHRUBS WITH OPPOSITE OR WHORLED LEAVES, LEAF SCARS AND BUDS ... R

Q. SHRUBS WITH ALTERNATE LEAVES, LEAF SCARS AND BUDS ... X

R. LEAVES LEATHERY IN TEXTURE, EVERGREEN ... S

R. LEAVES VERY SLIGHTLY (IF AT ALL) LEATHERY, DECIDUOUS ... T

S. LEAVES OPPOSITE, USUALLY <1.25 CM LONG; FLOWERS WHITISH; FRUITS 2-3-CELLED, EGG-SHAPED CAPSULES IN DENSE, TERMINAL CLUSTERS .....Sand myrtle, *Leiophyllum buxifolium*. See H. in Key II.

S. LEAVES OFTEN IN WHORLS OF THREE AND LARGER, BUT MOSTLY <5 CM LONG; FLOWERS DEEP PINK; FRUITS FIVE-CELLED, GLOBE-SHAPED, LONG-STALKED CAPSULES IN CLUSTERS ALONG THE TWIGS OF THE PREVIOUS YEAR: height to 1 m; wet or dry sandy soil; leaves thin, elliptical, 3-5 cm; flowers on glandular stems, 8-13 mm wide, May-June ...Sheep laurel, *Kalmia angustifolia* (Heath Fam.) (Fig. 3k)

T. LEAVES COMMONLY CONTAIN CLUSTERS OF SMALLER LEAVES IN THEIR AXILS ... U

T. LEAVES USUALLY WITHOUT CLUSTERS OF SMALLER LEAVES IN THEIR AXILS ... V

U. FLOWERS YELLOW AND FOUR-PETALLED; CAPSULES ENCLOSED IN A PAIR OF HEART-SHAPED SEPALS; STEMS WITH TWO WING-LIKE RIDGES BELOW LEAF SCARS .....St. Peters wort, *Ascyrum stans*, and St. Andrew's wort, *A. hypericoides*. See H' in Key II, Shrubs.

U. FLOWERS YELLOW AND FIVE-PETALLED; CAPSULES WITH FIVE SEPALS AT BASE; STEMS TWO-EDGED BELOW LEAF SCARS: much-branched shrub 0.5-2 m; wet open areas; leaves narrow; flowers numerous in branched, terminal clusters, July-Sept.; capsule slender-conical .....Bushy St.John's wort, *Hypericum densiflorum* (St. John's Wort Fam.)

V. LEAVES ALWAYS OPPOSITE; FLOWERS ARRANGED IN FLAT-TOPPED, TERMINAL CLUSTERS; FRUIT A DRUPE ... V' (*Viburnum* spp.)

V'. BUDS YELLOW-BROWN; TWIGS DULL; LEAVES DULL ABOVE AND SHALLOWLY TOOTHED: height 1-4 m; wet woods and thickets, swamps; buds with one pair of visible scales; twigs with a terminal bud; leaves 2.5-15 cm; leaf scars with three bundle scars; flowers ill-scented, May-June; drupes changing from whitish-yellow to pink to blue-black, Aug.-Sept. .....Northern witherod, *Viburnum cassinoides* (Honeysuckle Fam.) (Fig. 2e)

V'. BUDS RED-BROWN; TWIGS SHINY; LEAVES SHINY ABOVE; LEAF MARGIN RECURVED, APPEARING UNTOOTHED: a similar shrub or small tree .....Southern witherod, *Viburnum nudum* (Honeysuckle Fam.)

V. LEAVES OFTEN ARRANGED IN THREES; FLOWERS NOT ARRANGED IN FLAT-TOPPED CLUSTERS; FRUIT NOT A DRUPE ... W

W. LEAVES LANCE-SHAPED; FRUIT AN URN-SHAPED CAPSULE IN THE LEAF AXILS; PLANT CHIEFLY WOODY TOWARD THE BASE; FLOATING BRANCHES WITH CORKY THICKENINGS: soft-wooded shrub; swamps, pond, and stream margins; stem angled, arching, rooting at tips; flowers purple in axillary clusters, July-Sept. .....Swamp loosestrife, *Decodon verticillatus* (Loosestrife Fam.) (Fig. 2f)

W. LEAVES OVAL OR ELLIPTICAL; FLOWERS AND FRUITS IN LONG-STALKED, DENSE, BALL-SHAPED HEADS; PLANT WITHOUT FLOATING BRANCHES: height 1-3 m; swamps, pond, and stream margins; buds buried in bark and not visible; leaves smooth, 8-15 cm; leaf scars with one bundle scar; flowers small, tubular, four-parted, July-Aug.; fruit a small nutlet ..... Buttonbush, *Cephalanthus occidentalis* (Madder Fam.) (Fig. 2g)

X. PLANTS CLIMBING BY MEANS OF TENDRILS; STEMS WITH THORNS: prickly vines; leaves broad, ribbed; flowers greenish in axillary umbels; fruit a berry ... X' (*Smilax* spp.).

X'. LEAVES ROUNDED; BERRIES RED: swamps, wet thickets; flowers May-June; fruit in autumn, persistent ..... Walter's greenbrier, *Smilax walteri* (Lily Fam.)

X'. LEAVES ROUNDED; BERRIES BLUE: wet thickets; flowers May-June; fruit in autumn, persistent ..... Greenbrier, *Smilax rotundifolia* (Lily Fam.)

X'. LEAVES OBLONG; BERRIES BLACK: evergreen; swamps; flowers Aug.-Sept.; fruit in autumn of second season, persistent .....Laurel-leaved greenbrier, *Smilax laurifolia* (Lily Fam.)

X'. LEAVES TRIANGULAR-OVATE; BERRIES BLUE-BLACK: moist sandy ground; stems herbaceous; flowers June–July; fruit in autumn, persistent ..... Halbert-leaved Smilax, *Smilax pseudo-china* (Lily Fam.)

X'. LEAVES ELLIPTICAL OR OVATE, WHITE BENEATH; BERRIES BLUE: dry sandy soil; flowers May–June; fruit in autumn, persistent ..... Glaucous-leaved greenbrier, *Smilax glauca* (Lily Fam.)

X. PLANTS NOT CLIMBING; STEMS WITHOUT THORNS ... Y

Y. LEAVES VERY NARROW, MORE OR LESS STIFF, <3 MM WIDE: ..... Broom crowberry, *Corema conradii*. See D in Key II, Shrubs

Y. LEAVES WITH BROADER BLADES, >3 MM WIDE ... Z

Z. LEAVES LOBED, OR TOOTHED AND LOBED ... a

Z. LEAVES NOT LOBED, THE MARGINS EITHER TOOTHED OR UNTOOTHED ... c

a. LEAVES NOT ESPECIALLY AROMATIC WHEN CRUSHED; FRUIT AN ACORN; BUDS USUALLY CLUSTERED AT THE TIP OF TWIGS: shrub or small tree to 6 m, often to only 1.5 m in pinelands and Pine Plains; bark dark brown, smooth, thin; leaves shiny, dark green above, white-felted beneath, variable in shape, 5–12 cm; leaf scars with five or more bundle scars; May; acorns borne in pairs, short-stalked, 1 cm ..... Scrub oak or bear oak, *Quercus ilicifolia* (Beech Fam.) (Fig. 2i)

a. LEAVES AROMATIC WHEN CRUSHED; FRUIT NOT AN ACORN; BUDS USUALLY NOT CLUSTERED AT THE TIPS OF TWIGS ... b

b. LEAVES LONG AND NARROW WITH DEEP, ROUNDED LOBES ON EACH SIDE OF MIDRIB; LEAF SCARS WITH THREE BUNDLE SCARS: shrub to 1.5 m, less in dry open areas; male catkins clustered, cylindrical, nodding; female catkins nearly spherical, Apr.–May; nutlets ellipsoid in a burr 1.2 cm thick. ..... Sweet fern, *Comptonia peregrina* (Bayberry Fam.) (Fig. 2h)

b. LEAVES BROAD, USUALLY MITTEN-SHAPED OR THREE-LOBED; LEAF SCARS WITH A SINGLE BUNDLE SCAR ..... Sassafras, *Sassafras albidum*. See O in Key I, Trees.

c. LEAF MARGINS TOOTHED ... d

c. LEAF MARGINS UNTOOTHED ... f

d. LEAVES WITH MINUTE YELLOW RESIN DOTS AT LEAST ON THE LOWER SURFACE, AROMATIC WHEN CRUSHED: evergreen shrub, rarely small tree; wet (-dry) thickets, woods; twigs blackish; leaves shiny, oblong; catkins May–June; nuts wax-covered, persistent, 3.5–4.5 mm ..... Wax myrtle, *Myrica heterophylla* (Bayberry Fam.)

d. LEAVES NOT RESIN-DOTTED ... e

e. LEAVES LEATHERY IN TEXTURE, USUALLY EVERGREEN ... f

e. LEAVES NOT LEATHERY, MOSTLY DECIDUOUS ... g

f. PLANTS LOW AND MUCH BRANCHED; LEAF MARGINS WITH A FEW SMALL TEETH OR UNTOOTHED; LEAVES WITH MINUTE RUSTY AND SILVERY SCALES; FRUIT A MANY-SEEDED, FLATTENED CAPSULE: height to 1.5 m; swamps, bog, pond, and stream margins; leaves elliptical, 1.5–5 cm; flowers white, 6–7 mm in a one-sided, leafy cluster, Apr.–May; capsule five-celled with flattened or nearly round summit ..... Leatherleaf, *Chamaedaphne calyculata* (Heath Fam.) (Fig. 3l)

f. TALLER, ERECT SHRUB; LEAF MARGINS USUALLY WITH SOME LOW OR BLUNTISH TEETH ABOVE THE MIDDLE; LEAVES DARK GREEN AND SHINY ABOVE, PALER WITH BLACK SPOTS BENEATH; FRUIT A DRUPE, DRY, BLACK: height 1–3 m; wet woods and thickets, swamps, leaves 1.5–5 cm; male flowers several and female solitary in the leaf axils on different plants, June–July; drupe persistent ..... Inkberry, *Ilex glabra* (Holly Fam.) (Fig. 2k)

g. TWIGS BEARING CATKINS ... h

g. TWIGS NEVER BEARING CATKINS ... i

h. LEAF MARGINS WITH COARSE TEETH; LEAF SCARS WITH FIVE OR MORE BUNDLE SCARS; FRUIT AN ACORN; BUDS USUALLY CLUSTERED AT THE TIPS OF TWIGS; PLANTS OF DRY PINELANDS: shrubs rarely above 4 m; leaves gray-downy beneath, bright green above; May; acorns borne in pairs, short stalked, 1 cm ..... Dwarf chestnut oak, *Quercus prinoides* (Beech Fam.) (Fig. 2j)

h. LEAF MARGINS WITH FINE, SHARP TEETH; LEAF SCARS WITH THREE BUNDLE SCARS; FRUITS ARE SMALL NUTLETS BORNE IN PERSISTENT, WOODY CONE-LIKE STRUCTURES; PLANTS OF WET WOODS AND SWAMPS: tall shrub or small tree; leaves elliptical to inversely egg-shaped; male catkins pendulous, clustered; female catkins short, ovoid, Mar.–Apr. ..... Common alder, *Alnus serrulata* (Birch Fam.)

i. FLOWERS AND FRUITS ARRANGED IN ELONGATE, ONE-SIDED CLUSTERS AT THE TIPS OF BRANCHES: height 1–4 m; wet thickets; leaves finely toothed, 3–8 cm; leaf scars with one bundle scar; flowers white or pinkish, May–June; capsule ovoid ..... Fetterbush, *Leucothoe racemosa* (Heath Fam.) (Fig. 3n)

i. FLOWERS AND FRUITS NOT ARRANGED IN ONE-SIDED CLUSTERS ... j

j. UPPER LEAF SURFACES WITH DARK GLANDS ALONG THE MIDRIB; FRUIT LIKE A BERRY-SIZED APPLE: colonial shrub 0.3–4 m; low woods, swamps, wet thickets; leaves elliptical to inversely egg-shaped, 3–7 cm; leaf margin with a gland between each incurved tooth; flowers white in flattish, terminal clusters, Apr.–May ... j' (*Pyrus* spp.)

j'. TWIGS HAIRY; LEAVES WOOLLY BENEATH; FRUIT RED, SEPT.–OCT. ..... Red chokeberry, *Pyrus arbutifolia* (Rose Fam.) (Fig. 2m)

j'. TWIGS AND LEAVES SMOOTH; FRUIT BLACK, JULY–AUG. ..... Black chokeberry, *Pyrus melanocarpa* (Rose Fam.)

j. UPPER LEAF SURFACES WITHOUT SUCH GLANDS ... k

k. LEAF MARGINS DOUBLY TOOTHED: height 1–3 m; wet thickets, swamps; twigs ending in a terminal bud; outer bud scales falling off early, inner scales hairy; leaves inversely egg-shaped, untoothed in lower half, straight-veined, 3.5–7 cm; leaf scars with one bundle scar; flowers white, fragrant in erect, cylindrical, terminal clusters, July–Aug.; capsule rounded, three-celled ..... Sweet pepperbush, *Clethra alnifolia* (Sweet Pepperbush Fam.) (Fig. 2n)

k. LEAF MARGINS WITH REGULARLY-SPACED SINGLE TEETH, OR TEETH RATHER OBSCURE . . . l
l. LEAVES MORE OR LESS CLUSTERED NEAR THE TIPS OF THE BRANCHES: height 1-2 m; wet woods and thickets, swamps; twigs hairy; terminal bud usually much larger than lateral buds; leaves inversely egg-shaped, margins hairy, 3-6 cm; leaf scars with one bundle scar; flowers fragrant, white, 2-3 cm wide, tube 2-3 cm long, in terminal clusters, June-July; capsule glandular-hairy, cylindrical, 1-2 cm . . . . . Swamp azalea, *Rhododendron viscosum* (Heath Fam.) (Fig. 3m)
l. LEAVES WELL SPACED ALONG THE BRANCHES . . . m
m. TWIGS SHOWING PARTITIONS IN THE PITH WHEN CUT LENGTHWISE; CAPSULE TWO-CELLED: height to 3 m; swamps, wet thickets; buds pointed outward from the twig; leaves oblong, pointed, 3-8 cm; leaf scars with three bundle scars; petals white; not united, 5-6 mm; flowers in loose, open, terminal clusters, 4-15 cm, June . . . . . Virginia willow, *Itea virginica* (Saxifrage Fam.) (Fig. 2o)
m. TWIGS SHOWING A CONTINUOUS PITH WHEN CUT LENGTHWISE; IF FRUIT IS A CAPSULE, FIVE-CELLED . . . n
n. LEAFSTALKS SLENDER, USUALLY 6 MM OR MORE LONG . . . o
n. LEAFSTALKS MODERATE OR STOUT, <6 MM LONG . . . p
o. FRUIT JUICY, APPLE-LIKE WITH ABOUT TEN SMALL SEEDS; BUDS NARROW, SEVERAL TIMES LONGER THAN WIDE; BUD SCALES DARK-TIPPED; LEAF SCARS WITH THREE BUNDLE SCARS . . . o' (*Amelanchier* spp.)
o'. COLONIAL SHRUB 0.2-1.5 M; DRY OPEN AREAS, THICKETS, LOW WOODS: leaves unexpanded at flowering, woolly beneath when young, oblong to elliptical, 3-5 cm; leaf scars with three bundle scars; petals 6-7 mm; flowers in dense, erect clusters, Apr.-May; fruit purple-black, 6-8 mm, June-July . . . . . Coastal Juneberry, Shadbush, *Amelanchier obovalis* (Rose Fam.)
o'. SHRUB OR SMALL TREE WITH SEVERAL TRUNKS TO 8 M; WET SOIL AND SWAMPS: leaves half grown at flowering, woolly beneath when young, oblong to elliptical, 3-6 cm; leaf scars with three bundle scars; petals 7-10 mm; Apr.-May; fruit blackish, June-July . . . . . Juneberry, Serviceberry, *Amelanchier canadensis* (Rose Fam.) (Fig. 2p)
o. FRUIT A BERRY-LIKE DRUPE WITH LARGE SEED-LIKE NUTLETS; BUDS SHORT, NOT MUCH LONGER THAN WIDE; BUD SCALES NOT DARK-TIPPED; LEAF SCARS WITH ONE BUNDLE SCAR . . . o" (*Ilex* spp.)
o". LEAVES DULL ABOVE, SPARSELY HAIRY BENEATH; CALYX SEGMENTS HAIRY: height 1-4 m; swamps, stream and pond margins; leaves lanceolate, toothed; male flowers several per cluster, female solitary but grouped, axillary on different plants, June-July; drupe bright red, 5-7 mm, persistent . . . . . Winterberry, *Ilex verticillata* (Holly Fam.) (Fig. 2l)
o". LEAVES SHINY ABOVE, SMOOTH BENEATH; CALYX SEGMENTS SMOOTH: similar shrub; flowers May-June; drupe scarlet, 7-10 mm . . . . . Smooth winterberry, *Ilex laevigata* (Holly Fam.)
p. TWIGS MINUTELY WARTY-DOTTED, GREEN OR REDDISH, SMOOTH OR HAIRY, WITH BUDS OF TWO SIZES . . . . . p' (*Vaccinium* spp., blueberries). Also see L in Key II, Shrubs, for Low blueberry, *Vaccinium vacillans*.
p'. LEAVES UNTOOTHED OR TOOTHED, HAIRY ALONG THE VEINS OR SMOOTH: shrub to 4 m; swamps, peaty thickets, low woods; scales of the smaller buds with long-pointed tips; leaves 4-8 cm; flowers white or pink-tinged, tubular, ovoid, 6-13 mm, May; berry blue or blue-black with a white coating, 6-12 mm wide, July-Aug. . . . . Highbush blueberry, *Vaccinium corymbosum* (Heath Fam.) (Fig. 3i).
p'. LEAVES UNTOOTHED, SMOOTH, WHITE BENEATH: similar shrub; flowers dull white, 4-6 mm; berry 5-8 mm . . . . . New Jersey blueberry, *Vaccinium caesariense* (Heath Fam.)
p'. LEAVES UNTOOTHED, WOOLLY BENEATH: similar shrub; flowers greenish or yellowish-white, often pink-tinged, Apr.-May; berry dull black, 5-8 mm . . . . . Black highbush blueberry, *Vaccinium atrococcum* (Heath Fam.)
p. TWIGS NOT WARTY-DOTTED AND WITH BUDS MORE OR LESS ALIKE . . . q
q. LEAF MARGINS WITH SMALL AND RATHER OBSCURE TEETH; TWIGS WITHOUT A TERMINAL BUD, TIPS DYING BACK TO A LATERAL BUD; FRUIT A SMALL ROUNDISH CAPSULE: height to 4 m; swamps, wet thickets; buds with two visible scales and closely pressed against the twig; leaves inversely egg-shaped; leaf scars with one bundle scar; flowers numerous, white, nearly spherical, 3-5 mm in branched, terminal clusters, June-July; capsule 2.5-3 mm, persistent . . . . . Maleberry, *Lyonia ligustrina* (Heath Fam.) (Fig. 3o)
q. LEAF MARGINS WITH SHARP AND QUITE CONSPICUOUS TEETH; TWIGS ENDING IN A TERMINAL BUD, FRUITS BERRY-LIKE BUT WITH LARGE SEED-LIKE NUTLETS: Winterberry, *Ilex verticillata*, and Smooth winterberry, *I. laevigata*. See O in Key II, Shrubs.
r. LEAVES MORE OR LESS LEATHERY; EVERGREEN OR DECIDUOUS . . . s
r. LEAVES NOT LEATHERY, DECIDUOUS . . . u
s. LEAVES WHITENED BENEATH, SPICY-AROMATIC WHEN CRUSHED; FLOWERS LARGE AND SOLITARY; TALL SHRUB OR SMALL TREE . . . . . Sweet bay, *Magnolia virginiana*. See G in Key I, Trees.
s. LEAVES NEITHER WHITENED BENEATH NOR SPICY-AROMATIC WHEN CRUSHED; FLOWERS SMALLER AND IN AXILS OF BRACTS OR IN TERMINAL CLUSTERS . . . t
t. LOW SHRUB OF BOGS AND STREAM MARGINS; LEAVES 2.5-7.5 CM LONG WITH MINUTE SILVERY SCALES, FLOWERS WHITE, BELL-SHAPED IN AXILS OF LEAF-LIKE BRACTS . . . . . Leatherleaf, *Chamaedaphne calyculata*. See I in Key II, Shrubs.
t. SHRUB OR SMALL TREE GROWING IN SANDY WOODS; LEAVES 5-9 CM LONG, SMOOTH AND LUSTROUS ABOVE, FLOWERS WHITE TO DEEP PINK, SAUCER-SHAPED IN FLATTENED TERMINAL CLUSTERS: height usually 2-3 m; moist or dry sandy woods or clearings, swamps; leaves thick, elliptical, 5-10 cm; flowers glandular, 1.5-3 cm, May-June; fruit a flattened capsule, 5-7 mm wide . . . . . Mountain laurel, *Kalmia latifolia* (Heath Fam.) (Fig. 3l)
u. LEAVES WITH YELLOW RESIN DOTS AT LEAST ON THE LOWER SURFACE; FRUIT A BERRY-LIKE DRUPE . . . . . *Gaylussacia* spp. See L in Key II, Shrubs.
u. LEAVES NOT RESIN-DOTTED . . . v
v. LEAVES WITH MINUTE BLACK DOTS ON THE LOWER SURFACE; FRUIT A PYRAMID-SHAPED CAPSULE: height to 2 m; low

woods and thickets, swamps; buds with three or more visible scales and not closely pressed against the twig; leaves elliptical, hairy on veins beneath, 2-6 cm; leaf scars with one bundle scar; flowers white, urn-shaped, 0.8-1.3 cm, nodding in terminal clusters, May-June; capsules persistent on erect stems ..... Staggerbush, *Lyonia mariana* (Heath Fam.) (Fig. 3p)

v. LEAVES NOT BLACK-DOTTED BENEATH; FRUIT A BERRY OR GLOBE-SHAPED CAPSULE ... w

w. TWIGS MINUTELY WARTY-DOTTED, OTHERWISE SMOOTH OR HAIRY, USUALLY GREENISH OR REDDISH; BUDS OF TWO SIZES, THE LARGER WITH SEVERAL SCALES, THE SMALLER USUALLY WITH TWO VISIBLE SCALES; FRUIT A BERRY ..... Blueberries, *Vaccinium* spp. See P in Key II, Shrubs.

w. TWIGS NOT WARTY-DOTTED, OTHERWISE SMOOTH OR MINUTELY DOWNY, YELLOWISH-BROWN TO ASHY-GRAY; ALL BUDS MORE OR LESS ALIKE; FRUIT A SMALL GLOBE-SHAPED CAPSULE ..... Maleberry, *Lyonia ligustrina*. See Q in Key II, Shrubs.

Herbaceous Plants—Key III

A. FERN-LIKE OR MOSS-LIKE PLANTS WITHOUT TRUE FLOWERS; REPRODUCTION BY SPORES ... B

A. PLANTS WITH TRUE FLOWERS; REPRODUCTION TYPICALLY BY SEEDS ... E

B. LEAVES SMALL, VERY NUMEROUS, AND OVERLAPPING; PLANTS TRAILING ..... Club moss, *Lycopodium* spp. (Club moss Fam.); three spp. occur in P.B. bogs; *L. alopecuroides* (Fig. 4a), spores Sept.-Oct.

B. FRONDS (LEAVES) LARGE AND NOT CLOSELY OVERLAPPING, BUT COMPOUND AND WITH ERECT FROND STEM ... C (Ferns; about ten spp. occur in the P.B.)

C. PLANTS OF SANDY, USUALLY DRY, OPEN AREAS ..... Bracken, *Pteridium aquilinum* (Fern Fam.) (Fig. 4b), colonial fern of the pinelands, spores July-Aug.

C. PLANTS OF WET HABITATS ... D

D. STERILE FRONDS CLUSTERED AROUND THE REDDISH-BROWN FERTILE FRONDS; BASE OF STEM WOOLLY ..... Cinnamon fern, *Osmunda cinnamomea* (Flowering Fern Fam.) (Fig. 4c), one of two spp. which occur in swamps and other wet habitats.

D. STERILE AND FERTILE FRONDS ARRANGED ALONG UNDERGROUND STEMS; EITHER ALIKE, OR THE FERTILE FROND WITH NARROW SUB-DIVISIONS ..... Chain fern, *Woodwardia* spp. (Fern Fam.); two spp. occur in wet thickets and swamps.

E. PLANTS GRASS-LIKE OR RUSH-LIKE; LEAVES GENERALLY DIVIDED INTO OBVIOUS SHEATH AND BLADE; FLOWERS NOT CONSPICUOUSLY COLORED ... F

E. PLANTS NEITHER GRASS-LIKE NOR RUSH-LIKE, OR IF SO, THEN THE FLOWERS CONSPICUOUSLY COLORED; LEAVES GENERALLY WITH BLADES ONLY OR BLADES HAVING SHEATHING BASES ... N

F. FLOWERS NOT IN AXILS OF DRY BRACTS BUT ARRANGED IN OPEN OR DENSE TERMINAL CLUSTERS; FRUIT A THREE-CELLED CAPSULE ..... Rush, *Juncus* spp. (Rush Fam.); about 12 spp. of Rush occur in various habitats; *J. militaris* (Fig. 4d), streams, fruit July-Aug.

F. FLOWERS IN THE AXILS OF DRY, OVERLAPPING BRACTS FORMING SPIKELETS; FRUIT A GRAIN OR GRAIN-LIKE ... G

G. LEAVES IN TWO ROWS ON THE STEM, THEIR LOWER PARTS FORMING SHEATHS AROUND THE STEM BUT THEIR MARGINS NOT UNITED UP TO THEIR SUMMITS TO FORM TUBES; STEMS OFTEN HOLLOW AT THE NODES, NOT TRIANGULAR; TWO BRACTS TO EACH FLOWER ... H (Poaceae or Gramineae; about 70 spp. belonging to the Grass Fam. occur in the P.B.)

G. LEAVES, WHEN PRESENT, IN THREE ROWS ON THE STEM, THEIR LOWER PARTS FORMING TUBES AROUND THE STEM; STEMS SOLID AND USUALLY TRIANGULAR; ONE BRACT TO EACH FLOWER ... J (Cyperaceae; about 75 spp. belonging to the Sedge Fam. occur in the P.B.)

H. FLOWERS ONE PER SPIKELET; SPIKELETS USUALLY SCATTERED IN A DIFFUSELY-BRANCHED CLUSTER ..... Panic grass, *Panicum* spp. (Grass Fam.); about 30 spp. occur in various habitats.

H. FLOWERS TWO TO MANY PER SPIKELET; SPIKELETS NOT IN A DIFFUSELY-BRANCHED CLUSTER ... I

I. FLOWERS TWO PER SPIKELET, ONE OF WHICH IS STERILE AND STALKED; SPIKELETS ARRANGED IN LATERAL AND TERMINAL, LONG-HAIRY CLUSTERS WHICH PROTRUDE FROM SHEATHING LEAVES; MARGINS OF SHEATHS NOT UNITED ..... Beard grass, *Andropogon* spp. (Grass Fam.); three spp. and one variety occur in the P.B.; Broom sedge, *A. virginicus* (Fig. 4e), dry sands, or wet open ground in var. *abbreviatus*, Aug.-Sept.

I. FLOWERS SEVERAL TO MANY PER SPIKELET; SPIKELETS ARRANGED IN NARROW, DENSE, TERMINAL CLUSTERS WHICH LACK LONG HAIRS AND SHEATHING LEAVES; LEAF SHEATHS UNITED NEARLY TO THEIR SUMMITS ..... Blunt manna-grass, *Glyceria obtusa* (Grass Fam.) (Fig. 4f); stream and pond margins, July-Aug.

J. FLOWERS PERFECT (MALE AND FEMALE STRUCTURES PRESENT); SPIKELETS ALIKE ... K

J. FLOWERS UNISEXUAL, MALE AND FEMALE FLOWERS IN DIFFERENT SPIKES; SPIKELETS OF TWO KINDS ..... Sedge, *Carex* spp. (Sedge Fam.); about 25 spp. occur in various habitats; *C. pensylvanica* (Fig. 4g), dry open sands, pinelands, fruit May-June.

K. SPIKELETS MANY-FLOWERED; FRUIT WITH OR WITHOUT A TUBERCLE (ENLARGED BASE OF STYLE) AND BRISTLES ... L

K. SPIKELETS 1-2 FLOWERED; FRUIT WITH A TUBERCLE; BRISTLES USUALLY PRESENT ..... Beak-rush, *Rhynchospora* spp. (Sedge Fam.); about 12 spp. occur in various wet habitats, fruit usually July-Sept.

L. STEMS WITH A BASAL SHEATH AND NO LEAF BLADES, TERMINATED BY A SINGLE SPIKELET; FRUIT WITH A TUBERCLE AND USUALLY WITH BRISTLES ..... Spike-rush, *Eleocharis* spp. (Sedge Fam.); about eight spp. occur in various wet habitats; *E. olivacea* (Fig. 4h), bogs and other moist open ground, fruit July-Oct.

L. STEMS USUALLY LEAFY; SPIKELETS TWO TO MANY; FRUIT WITHOUT A TUBERCLE ... M

M. BRISTLES FEW OR NONE FROM BASE OF FRUIT; ONE SPIKELET, APPEARING TERMINAL ..... Water club rush, *Scirpus subterminalis* (Sedge Fam.) (Fig. 4i); stream beds, fruit July-Aug.; four additional spp. occur in the P.B.

M. BRISTLES NUMEROUS, ELONGATE, AND SILKY; SPIKELETS IN COTTONY CLUSTERS WITH LEAFY BRACTS .....
Cotton-grass, *Eriophorum* spp. (Sedge Fam.); two spp. occur in the P.B.; *E. virginicum* (Fig. 4j), bogs, fruit Aug.-Sept.
N. FLOWERS IN HEADS AND BORNE ON A DISC, SURROUNDED BY BRACTS . . . O
N. FLOWERS NOT BORNE ON A DISC AND NOT SURROUNDED BY BRACTS . . . T
O. LEAVES BASAL, GRASS-LIKE; HEADS SOLITARY ON LEAFLESS STEM, WHITE .....Pipewort, *Eriocaulon* spp.
(Pipewort Fam.); three spp. occur in various wet habitats; *E. septangulare* (Fig. 4k), bogs and ponds, July-Oct.
O. LEAVES NEITHER ALL BASAL NOR GRASS-LIKE; HEADS USUALLY GROUPED TOGETHER ON BRANCHING, LEAFY STEMS, VARIOUSLY COLORED . . . P (Asteraceae or Compositae; about 60 spp. belonging to the Aster or Composite Fam. occur in the P.B.)
P. FLOWERS OF EACH HEAD ALIKE: EITHER ALL TUBULAR OR ALL LIGULATE (BEARING A FLATTENED, SPREADING LIMB) . . . Q
P. FLOWERS OF EACH HEAD DIFFERENT: INNER TUBULAR, OUTER LIGULATE . . . R
Q. FLOWERS ALL TUBULAR, WHITE; FRUITS WITH A ROW OF BRISTLES AT THE SUMMIT; FLOWER CLUSTERS BRANCHED AND FLAT-TOPPED; LEAVES UNTOOTHED OR TOOTHED, OPPOSITE OR WHORLED .....Thoroughwort, *Eupatorium* spp. (Aster Fam.); eight spp. occur in the P.B.; White boneset, *E. album* (Fig. 4l), dry sandy open areas, Aug.-Sept.
Q. FLOWERS ALL LIGULATE, GOLDEN-YELLOW; FRUIT WITH TWO ROWS OF SCALES AND BRISTLES AT SUMMIT; FLOWER CLUSTERS FEW-BRANCHED; STEMS GROUPED; LEAVES MOSTLY BASAL .....Dwarf dandelion, *Krigia virginica* (Aster Fam.), dry open sands, roadsides.
R. LIGULATE OR OUTER FLOWERS WHITE, BLUE, OR PINK .....Aster, *Aster* spp. (Aster Fam.); ten spp. occur in various habitats; Showy aster, *A. spectabilis* (Fig. 4m), dry sandy open areas, July-Sept.
R. LIGULATE OR OUTER FLOWERS YELLOW . . . S
S. INNER FRUITS BEARING TWO ROWS OF BRISTLES AT THEIR SUMMITS .....Golden aster, *Chrysopsis* spp. (Aster Fam.); two spp. occur in dry sandy open areas of the P.B., Aug.-Sept.
S. INNER FRUITS BEARING ONE ROW OF BRISTLES AT THEIR SUMMITS .....Goldenrod, *Solidago* spp. (Aster Fam.); 13 spp. occur in various habitats; Fragrant goldenrod, *S. odora* (Fig. 4n), dry sandy open areas, July-Aug.
T. PLANTS OF WET HABITATS . . . U
T. PLANTS OF SANDY, USUALLY DRY HABITATS . . . k
U. LEAVES SUBMERSED OR FLOATING; FLOWERS EMERGENT . . . V
U. LEAVES, STEMS, AND FLOWERS USUALLY EMERGENT AND ASCENDING IN SHALLOW WATER OR NOT IN WATER . . . X
V. LEAVES DISSECTED OR WITH VERY FINE LEAVES BEARING TRAPS OR BLADDERS; FLOWERS BILATERALLY SYMMETRICAL ON EMERGENT STEMS; PLANTS USUALLY SUBMERSED OR ROOTED IN MUD .....Bladderwort, *Utricularia* spp. (Bladderwort Fam.); 11 spp. occur in wet habitats; *U. fibrosa* (Fig. 4o), bogs and ponds, June-Aug.
V. LEAVES BROAD, HEART-SHAPED, AND FLOATING; FLOWERS RADIALLY SYMMETRICAL, TERMINATING LEAFLESS STEM; PLANTS ALSO WITH UNDERGROUND STEMS . . . W
W. FLOWERS WIDELY EXPANDING, PETALS WHITE OR PINK, SHOWY .....Water lily, *Nymphaea odorata* (Water lily Fam.), ponds and open water of bogs, June-Sept.
W. FLOWERS NEARLY SPHERICAL, PETALS SMALL, SEPALS YELLOW, RED- OR GREEN-TINGED .....Spatterdock, *Nuphar variegatum* (Water lily Fam.), ponds and streams, May-Sept.
X. LEAVES EMERGENT AND ASCENDING OR FLOATING, OBLONG TO ELLIPTICAL AND WITHOUT DISTINCT MIDVEIN; FLOWERS YELLOW AND IN A SPIKE .....Golden club, *Orontium aquaticum* (Arum Fam.) (Fig. 4p), bogs, ponds, and streams, Apr.-May
X. LEAVES OTHERWISE; FLOWERS NOT IN A SPIKE . . . Y
Y. LEAVES PARALLEL-VEINED; FLOWER PARTS MOSTLY IN THREE'S . . . Z
Y. LEAVES NET-VEINED; FLOWER PARTS MOSTLY IN FOUR'S OR FIVE'S . . . e
Z. LEAVES ARROWHEAD- OR LANCE-SHAPED; FLOWERS WHITE .....Arrowhead, *Sagittaria* spp. (Arrowhead Fam.); three spp. occur in the P.B.; *S. engelmannii* (Fig. 5a), bogs and stream and pond margins, June-Sept.
Z. LEAVES GRASS-LIKE; FLOWERS WHITE, YELLOW, OR BLUE . . . a
a. FLOWERS BILATERALLY SYMMETRICAL, WHITE AND IN ELONGATED, TERMINAL CLUSTERS .....White-fringed orchid, *Habenaria blephariglottis* (Orchid Fam.) (Fig. 5b), bogs, July-Aug.; 17 additional spp. of orchids occur in the P.B.
a. FLOWERS RADIALLY SYMMETRICAL, NOT WHITE . . . b
b. FLOWERS BLUE ON STEMS PROTRUDING FROM A SHEATHING LEAF-LIKE BRACT .....Blue-eyed grass, *Sisyrinchium* spp. (Iris Fam.); four spp. occur in the P.B.; *S. atlanticum* (Fig. 5c), bogs and other wet open areas, May-June
b. FLOWERS YELLOW, NOT PROTRUDING FROM A LEAF-LIKE BRACT . . . c
c. STEM AND FLOWERS WOOLLY; FLOWERS SOLITARY ON SHORT STEMS IN A BRANCHED TERMINAL CLUSTER . . . d
c. STEM WITHOUT HAIRS; FLOWERS NUMEROUS IN A SOLITARY HEAD-LIKE CLUSTER CONTAINING STIFF BROWN BRACTS .....Yellow-eyed grass, *Xyris* spp. (Yellow-eyed grass Fam.); five spp. occur in the P.B.; *X. caroliniana* (Fig. 5d), wet peaty or sandy areas, July-Sept.
d. UPPER STEM AND FLOWER CLUSTER DENSELY WHITE-WOOLLY .....Golden crest, *Lophiola americana* (Amaryllis Fam.), bogs and swamps, June-July
d. UPPER STEM AND FLOWER CLUSTER RUST-COLORED AND WOOLLY .....Redroot, *Lachnanthes tinctoria* (Redroot Fam.), swamps and bogs, frequently in abandoned cranberry bogs, July-Aug.
e. LEAVES MODIFIED INTO PITCHER-SHAPED STRUCTURES OR WITH STALKED GLANDS, INSECTIVOROUS . . . f
e. LEAVES NOT MODIFIED FOR INSECT CATCHING . . . g
f. LEAVES PITCHER-SHAPED, CAPABLE OF HOLDING WATER; FLOWER SOLITARY FROM A LEAFLESS STEM .....
Pitcher plant, *Sarracenia purpurea* (Pitcher plant Fam.) (Fig. 5e), bogs and White cedar swamps, Mar.-June

f. LEAVES LINEAR, SPATULATE, OR ROUNDED AND COVERED WITH STALKED GLANDS; FLOWERS SEVERAL TO MANY ALONG A LEAFLESS STEM ..... Sundew, *Drosera* spp. (Sundew Fam.); three spp. occur in the P.B.; *D. intermedia* (Fig. 5f), bogs, swamps and open wet areas July-Aug.

g. LEAVES PROMINENTLY THREE-VEINED; LEAF MARGINS TOOTHED; FLOWERS BRIGHT PURPLE ..... Meadow beauty, *Rhexia* spp. (Melastoma Fam.); three spp. occur in the P.B.; *R. virginica* (Fig. 5g), bogs and swamps, July-Sept.

g. LEAVES NOT PROMINENTLY THREE-VEINED; LEAF MARGINS NOT TOOTHED ... h

h. LEAVES OPPOSITE ... i

h. LEAVES ALTERNATE ... j

i. LEAVES USUALLY GLANDULAR- OR BLACK-DOTTED; FLOWERS YELLOW OR PINK ..... St. John's wort, *Hypericum* spp. (St. John's wort Fam.); five spp. occur in bogs, swamps and other wet or moist habitats

i. LEAVES NOT GLANDULAR- OR BLACK-DOTTED; FLOWERS WHITE ..... Lance-leaved Sabatia, *Sabatia difformis* (Gentian Fam.) (Fig. 5h), bogs and swamps, July-Aug.

j. FLOWERS ORANGE-YELLOW IN DENSE TERMINAL CLUSTERS ..... Orange milkwort, *Polygala lutea* (Milkwort Fam.) (Fig. 5i), moist sandy areas, June-Oct.; seven additional milkworts occur in the P.B.

j. FLOWERS BLUE, WELL SPACED ALONG THE STEM ..... Nuttall's lobelia, *Lobelia nuttallii* (Bluebell Fam.) (Fig. 5j), moist sandy areas, July-Sept.; two additional Lobelias occur in the P.B.

k. LEAVES GRASS-LIKE AND TUFTED; FLOWERS MANY IN A LARGE, DENSE, ELONGATE CLUSTER FROM STEM WITH NUMEROUS BRACT-LIKE LEAVES ..... Turkeybeard, *Xerophyllum asphodeloides* (Lily Fam.) (Fig. 5k), open sandy areas, May-July

k. LEAVES NEITHER GRASS-LIKE NOR TUFTED; FLOWERS NEITHER WHITE NOR IN LARGE ELONGATE CLUSTERS ... l

l. FLOWERS BILATERALLY SYMMETRICAL ... m

l. FLOWERS RADIALLY SYMMETRICAL ... p

m. LEAVES COMPOUND (THREE OR MORE LEAFLETS) ... n

m. LEAVES SIMPLE ... o

n. LEAVES TRI-FOLIATE; FLOWERS BRIGHT YELLOW; PODS NEARLY SPHERICAL, PURPLE; PLANTS SMOOTH ..... Wild indigo, *Baptisia tinctoria* (Pea Fam.) (Fig. 5l), open sandy soil, pinelands, Pine Plains, clearings, June-July

n. LEAVES MANY-FOLIATE; FLOWERS YELLOWISH-WHITE, MARKED WITH PURPLE; PODS LINEAR AND FLAT; PLANTS VERY HAIRY ..... Goat's rue, *Tephrosia virginica* (Pea Fam.) (Fig. 5m), open sandy soil, pinelands and Pine Plains, June-July

o. FLOWERS YELLOW, SLIGHTLY BILATERALLY SYMMETRICAL, SHOWY; LEAVES DEEPLY LOBED; PLANTS GLANDULAR ..... Fern-leaved false foxglove, *Gerardia pedicularia* (Figwort Fam.), pinelands, Aug.-Sept.

o. FLOWERS WHITISH, SMALL, TWO-LIPPED; LEAF MARGINS UNTOOTHED, BUT FLOWER BRACTS TOOTHED; PLANTS SLIGHTLY HAIRY ..... Cow-wheat, *Melampyrum lineare* (Figwort Fam.) (Fig. 5n), open sandy soil, pinelands and Pine Plains, May-Aug.

p. PLANTS WITH MILKY JUICE; FLOWERS WITHOUT PETALS, BUT HAVING FIVE STALKLESS, GREEN GLANDS ..... Wild ipecac, *Euphorbia ipecacuanhae* (Spurge Fam.) (Fig. 5o), open sands, Apr.-May

p. PLANTS WITHOUT MILK JUICE; FLOWERS EITHER WITH PETALS, OR LACKING PETALS IN SMALL FLOWERS ... q

q. LEAVES AWL-SHAPED, BRACT-LIKE; ALL FLOWERS WITH PETALS ... r

q. LEAVES OVATE, ELLIPTICAL, OR OBLONG; SOME SMALL FLOWERS LACKING PETALS ... s

r. LEAVES DENSE AND OVERLAPPING, UPPER DISTANT, OPPOSITE; FLOWERS WHITE, FEW ON ERECT STEMS FROM A SEMI-WOODY BASE ..... Pine Barren sandwort, *Arenaria caroliniana* (Pink Fam.) (Fig. 5p), open sands, June-July

r. LEAVES ALL DISTANT, OPPOSITE; FLOWERS YELLOW-ORANGE, MANY TERMINATING BRANCHES OF A SINGLE ANNUAL STEM ..... Pineweed or Orange grass, *Hypericum gentianoides* (St. John's wort Fam.), open sands, disturbed areas, July-Sept.

s. PETALS FIVE, YELLOW, SHOWY, AND EASILY DECIDUOUS, OR SMALL AND WITHOUT PETALS ..... Frostweed, *Helianthemum canadense* (Rockrose Fam.), sandy soil, pinelands, May-July

s. PETALS THREE, GREENISH OR PURPLISH, SMALL, AND PERSISTENT ..... Pinweed, *Lechea* spp. (Rockrose Fam.); five spp. occur in sandy soil, pinelands, fruit July-Oct.

SUMMARY

The common trees (19 species), shrubs (53 species), and some herbaceous plants (44 genera) of the Pine Barrens of New Jersey have been identified with the aid of keys. Additional descriptive information was provided for trees and shrubs (Figs. 1-5).

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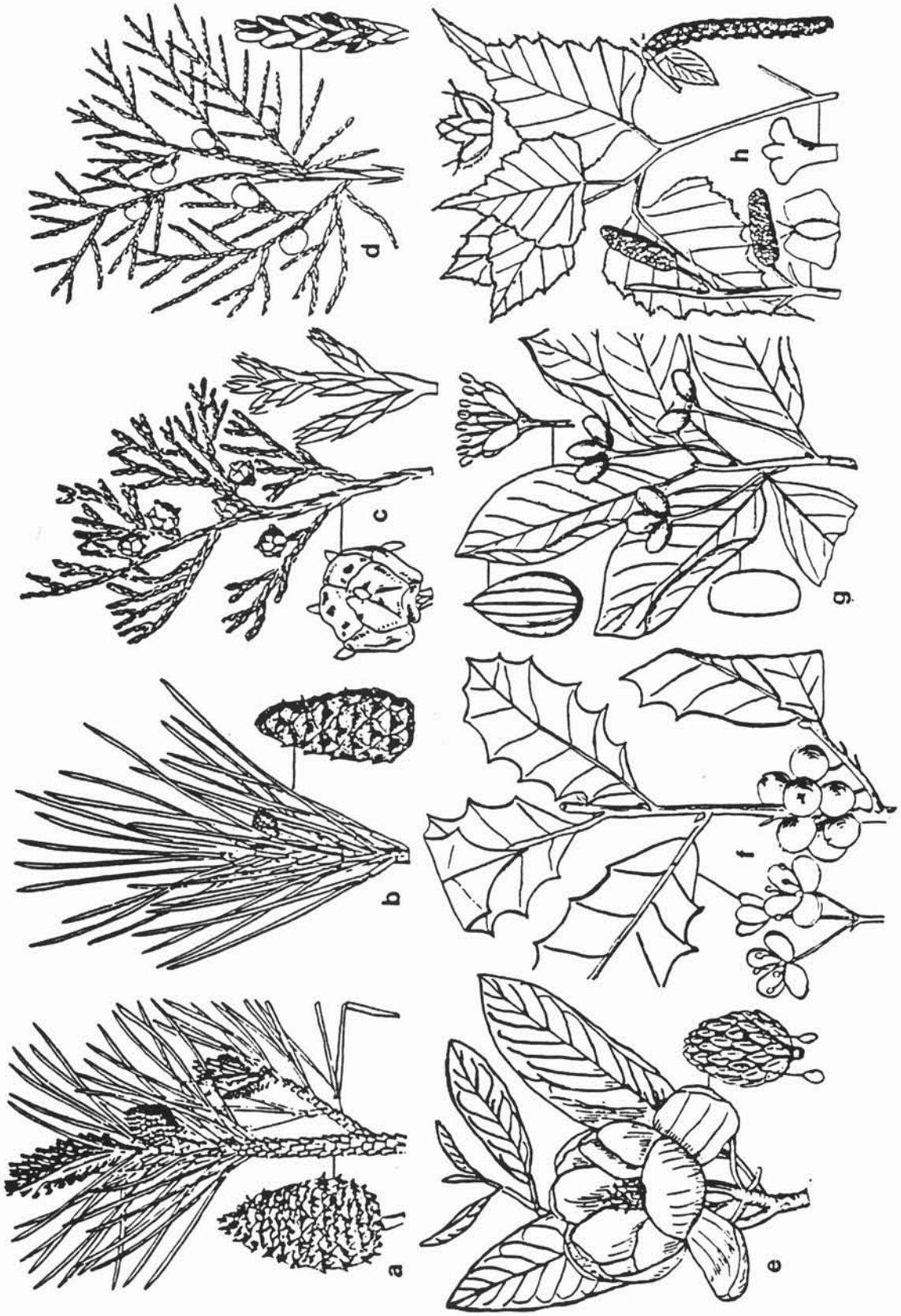
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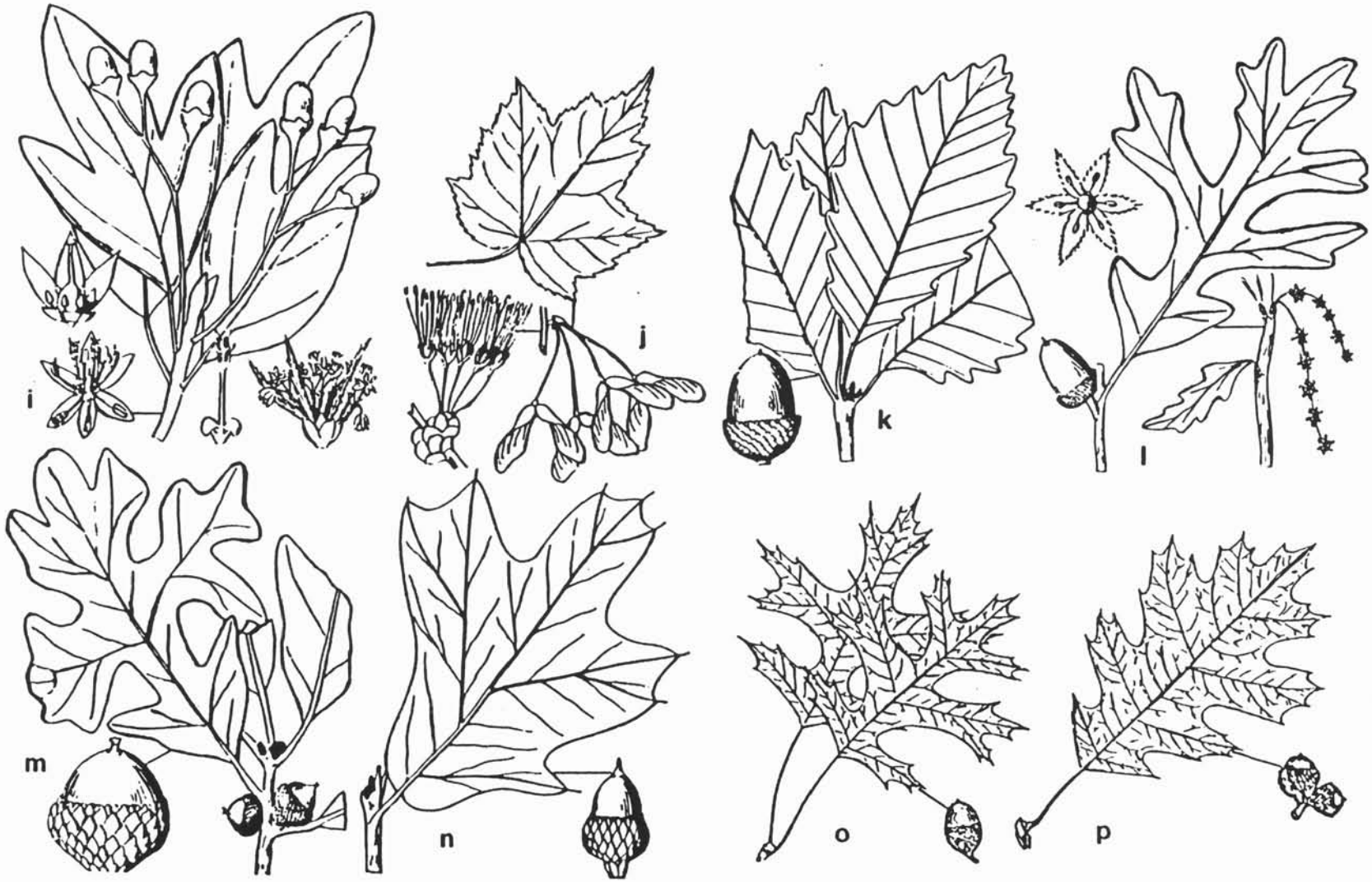

Fig. 1. Common trees of the Pine Barrens. (a) *Pinus rigida*; (b) *P. echinata*; (c) *Chamaecyparis thyoides*; (d) *Juniperus virginiana*; (e) *Magnolia virginiana*; (f) *Ilex opaca*; (g) *Nyssa sylvatica*; (h) *Betula populifolia*; (i) *Sassafras albidum*; (j) *Acer rubrum*; (k) *Quercus prinus*; (l) *Q. alba*; (m) *Q. stellata*; (n) *Q. marilandica*; (o) *Q. coccinea*; (p) *Q. velutina*. Drawings differ in scale.

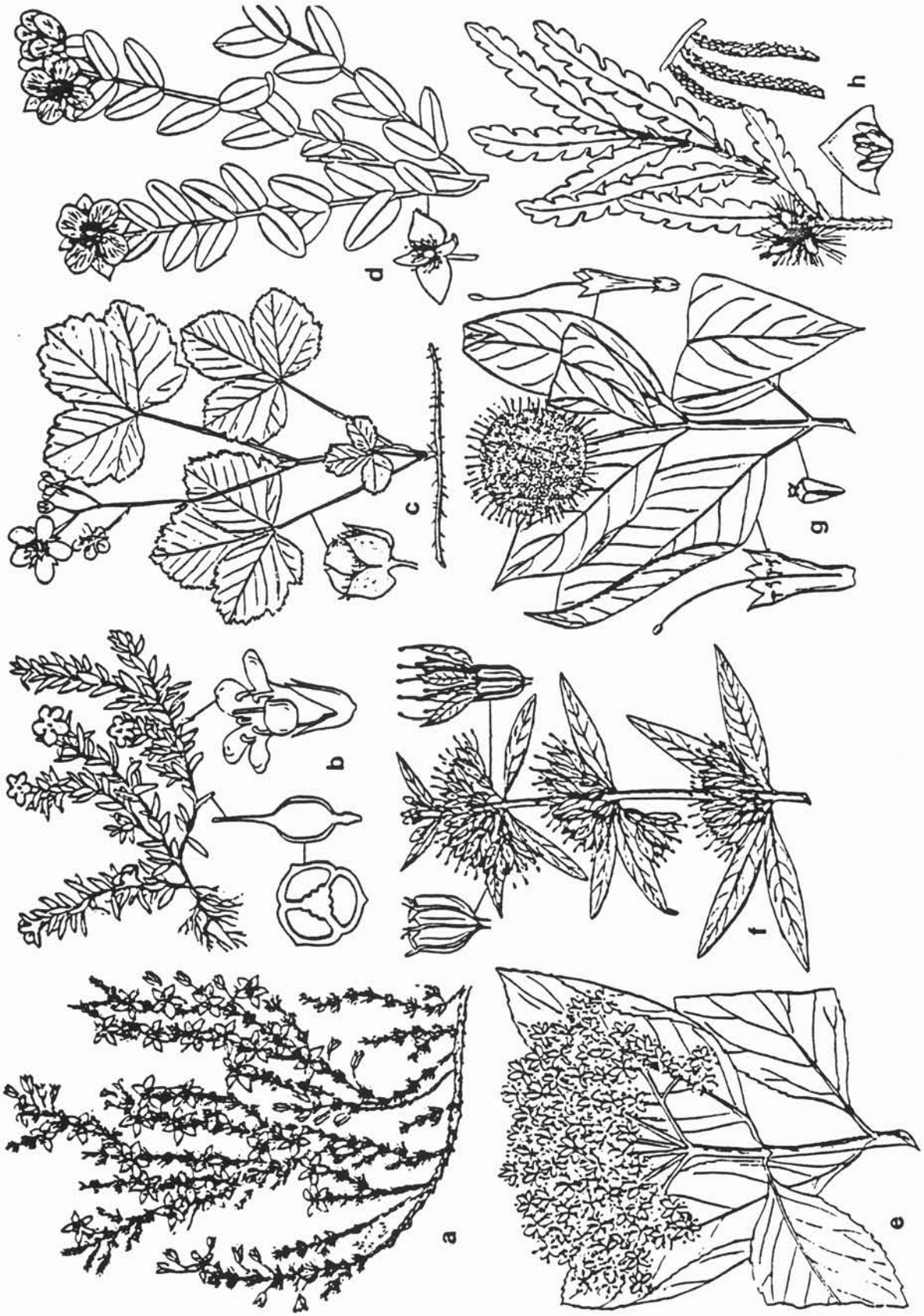
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Fig. 2. Common shrubs of the Pine Barrens I. (a) *Hudsonia ericoides*; (b) *Pyxidanthera barbulata*; (c) *Rubus hispidus*; (d) *Ascyrum stans*; (e) *Viburnum cassinoides*; (f) *Decodon verticillatus*; (g) *Cephalanthus occidentalis*; (h) *Comptonia peregrina*; (i) *Quercus ilicifolia*; (j) *Q. prinoides*; (k) *Ilex glabra*; (l) *I. verticillata*; (m) *Pyrus arbutifolia*; (n) *Clethra alnifolia*; (o) *Itea virginica*; (p) *Amelanchier canadensis.* Drawings differ in scale.


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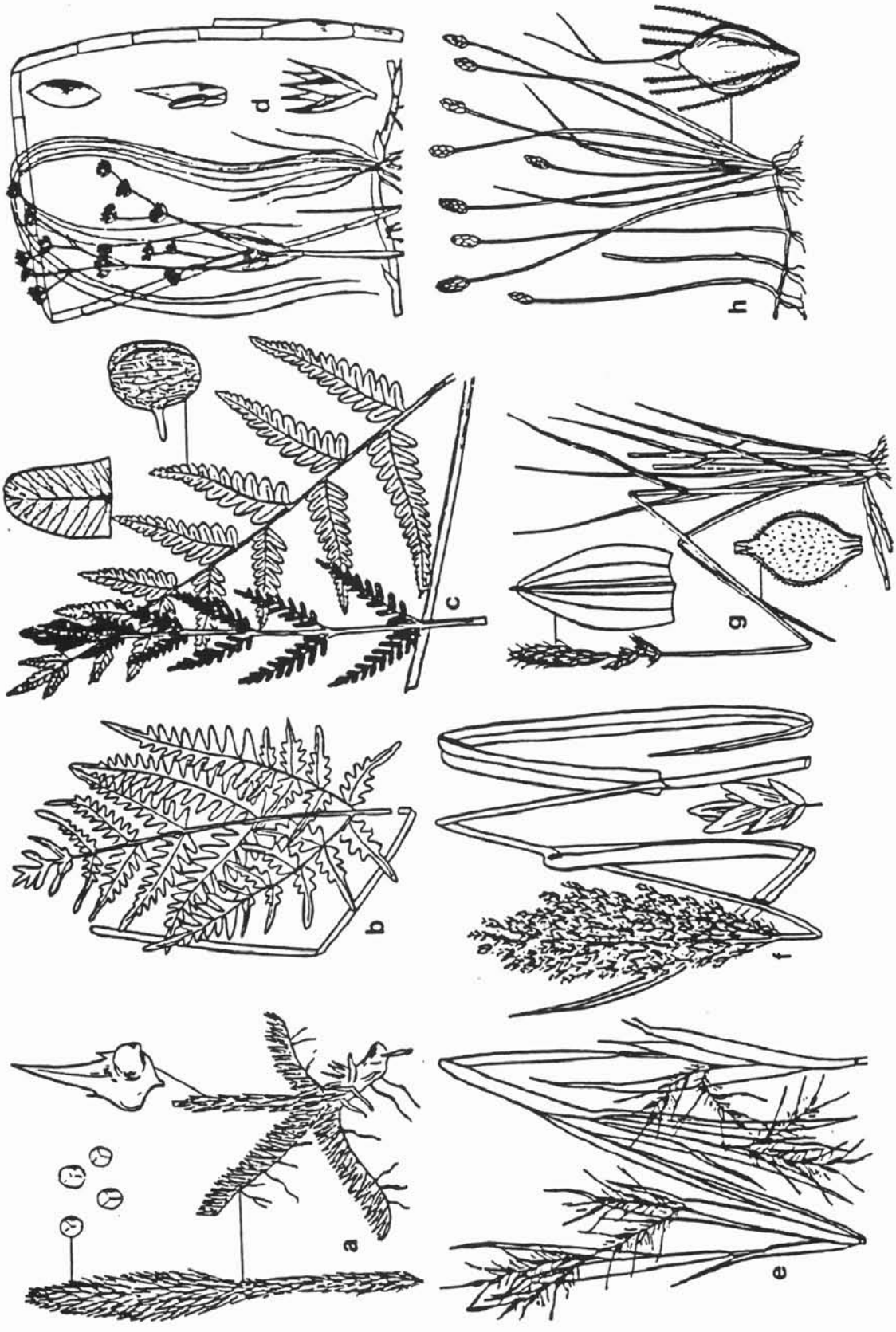
Fig. 3. Common shrubs (Heath and Wintergreen Families) of the Pine Barrens II. (a) *Arctostaphylos uva-ursi*; (b) *Gaultheria procumbens*; (c) *Chimaphila maculata*; (d) *Epigaea repens*; (e) *Leiophyllum buxifolium*; (f) *Chamaedaphne calyculata*; (g) *Vaccinium macrocarpon*; (h) *V. vacillans*; (i) *V. corymbosum*; (j) *Gaylussacia dumosa*; (k) *Kalmia angustifolia*; (l) *K. latifolia*; (m) *Rhododendron visosum*; (n) *Leucothoe racemosa*; (o) *Lyonia ligustrina*; (p) *L. mariana*. Drawings differ in scale.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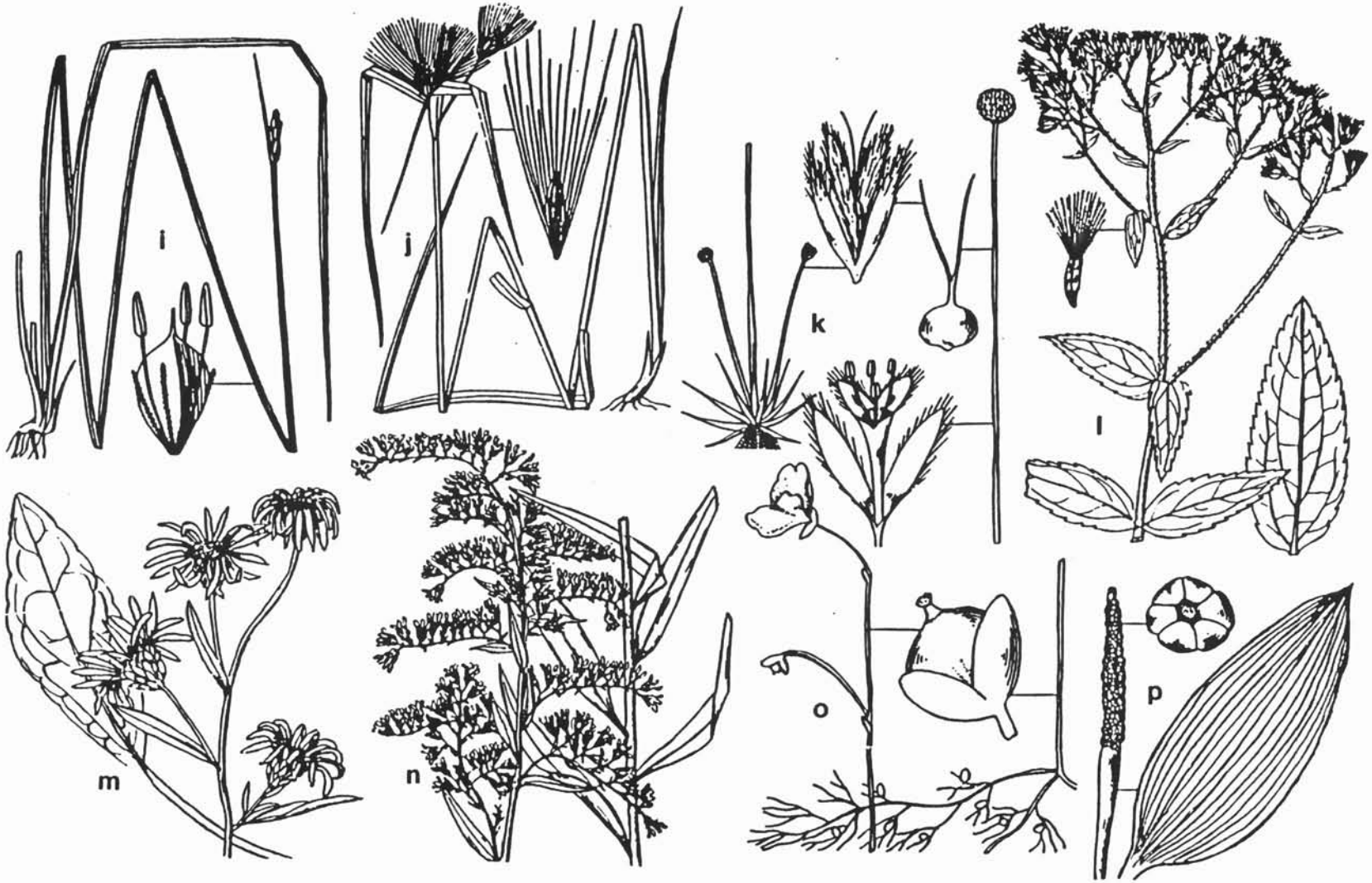

Fig. 4. Common herbaceous plants of the Pine Barrens I. (a) *Lycopodium alopecuroides*; (b) *Pteridium aquilinum*; (c) *Osmunda cinnamomea*; (d) *Juncus militaris*; (e) *Andropogon virginicus*; (f) *Glyceria obtusa*; (g) *Carex pensylvanica*; (h) *Eleocharis olivacea*; (i) *Scirpus subterminalis*; (j) *Eriophorum virginicum*; (k) *Eriocaulon septangulare*; (l) *Eupatorium album*; (m) *Aster spectabilis*; (n) *Solidago odora*; (o) *Utricularia fibrosa*; (p) *Orontium aquaticum*. Drawings differ in scale.

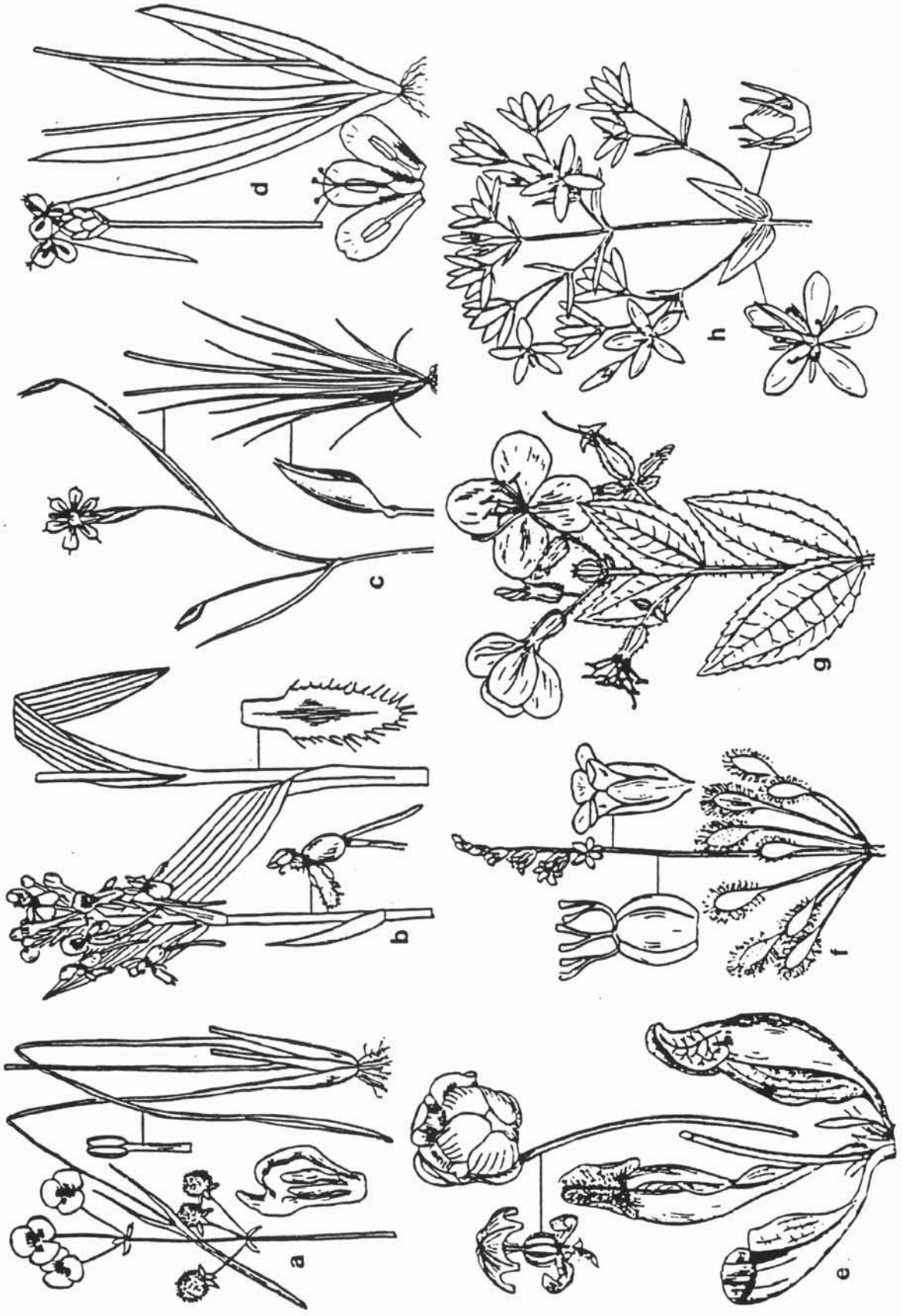
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Fig. 5. Common herbaceous plants of the Pine Barrens II. (a) *Sagittaria engelmannii*; (b) *Habenaria blephariglottis*; (c) *Sisyrinchium atlanticum*; (d) *Xyris caroliniana*; (e) *Sarracenia purpurea*; (f) *Drosera intermedia*; (g) *Rhexia virginica*; (h) *Sabatia difformis*; (i) *Polygala lutea*; (j) *Lobelia nuttallii*; (k) *Xerophyllum asphodeloides*; (l) *Baptisia tinctoria*; (m) *Tephrosia virginiana*; (n) *Melampyrum lineare*; (o) *Euphorbia ipecachuanae*; (p) *Arenaria caroliniana*.

Appendix 3. Selected Pinelands Wetland References. Major wetland topics addressed by each reference are indicated by bold letters: **F** = fire; **G** = field guide/key; **H** = hydrology; **S** = soils; **V** = vegetation.

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Appendix 4. Hydric soils and associated non-hydric soils of the Pinelands. Soil profile descriptions from county soil surveys are summarized by soil series. Soil textures are sand (S), sandy loam (SL), loamy sand (LS), sandy clay loam (SCL) and sandy clay (SC).

Appendix 4a. Atsion Series

Horizon	Depth (in)		Munsell Color	Munsell Number	Texture
ATLANTIC COUNTY					
A1	0	5	BLACK	10YR 2/1	S
A2	5	17	LIGHT GRAY	10YR 6/1	S
B2h	17	24	DARK BROWN	7.5YR 3/2	S
B3	24	37	GRAY-BROWN	10YR 5/2	S
C	37	60	GRAY-BROWN	10YR 5/2	S
BURLINGTON COUNTY					
AP	0	8	DARK GRAY	10YR 4/1	S
A2	8	18	LIGHT GRAY	10YR 6/1	S
B2h	18	24	VERY DARK BROWN	7.5YR 2/2	LS
B3	24	36	VERY DARK GRAY	10YR 3/1	S, 5% pebbles
C	36	60	BROWN	10YR 5/3	S, 5% pebbles
CUMBERLAND COUNTY					
O1	4	2			Litter
O2	2	0	BLACK	10YR 2/1	Peat
A1	0	2	BLACK	10YR 2/1	S
A2	2	19	LIGHT GRAY	10YR 7/1	S
B2h	19	24	DARK RED-BROWN	5YR 2/2	S
C1	24	36	VERY DARK GRAY	10YR 3/1	S
C2	36	60	STRONG BROWN	7.5YR 5/6	S
GLOUCESTER COUNTY (LEON)					
Ap	0	6	DARK GRAY TO	10YR 4/1	S, 1% pebbles
			VERY DARK GRAY	10YR 3/1	
A2	6	16	LIGHT GRAY	10YR 6/1	S
B	16	20	VERY DARK GRAY-BROWN TO	10YR 3/2	LS or S
			VERY DARK BROWN	10YR 2/2	
C	20	40	GRAY	2.5Y 6/1	S, 0-10% pebbles
OCEAN COUNTY					
A1	0	5	BLACK	10YR 2/1	S
A2	5	18	LIGHT GRAY	10YR 7/1	S
B2h	18	24	DARK RED-BROWN	5YR 3/2	LS
Cg	24	60	LIGHT GRAY	10YR 6/1	S

Appendix 4b. Berryland Series

Horizon	Depth (in)		Munsell Color	Munsell Number	Texture
ATLANTIC COUNTY					
A1	0	10	BLACK	10YR 2/1	S, 5% pebbles
A2g	10	15	PINK-GRAY	7.5YR 6/2	S, 10% pebbles
B2h	15	22	VERY DARK GRAY-BROWN	10YR 3/2	LS, 5% pebbles
B3g	22	32	LIGHT BROWN-GRAY	10YR 6/2	S, 10% pebbles
Cg	32	64	LIGHT BROWN-GRAY	10YR 6/2	S, 10% pebbles
BURLINGTON COUNTY					
Ap	0	10	BLACK	10YR 2/1	S
A2	10	16	GRAY	10YR 6/1	S
B2h	16	24	DARK RED-BROWN	5YR 3/2	LS
B3	24	60	GRAY-BROWN	10YR 5/2	S, 10% pebbles
CAPE MAY COUNTY					
A1	0	9	VERY DARK GRAY	10YR 3/1	S, 3% pebbles
B2h	9	17	DARK RED-BROWN	5YR 3/2	S
B3g	17	30	GRAY	5Y 6/1	S, 5% pebbles
			PALE YELLOW MOTTLES	5Y 8/3	
Bh	30	38	DARK RED-BROWN	5YR 2/2	S, 15% pebbles
			VERY DARK BROWN STAINS ALONG ROOTS	10YR 2/2	
C	38	60	GRAY	5YR 6/1	Stratified S
			THIN GREEN-GRAY BANDS	5GY 6/1	SCL bands
CUMBERLAND COUNTY					
O1	3	2			Litter
O2	2	0	VERY DARK BROWN	10YR 2/2	Organic Matter
A1	0	10	BLACK	10YR 2/1	S
A2	10	13	LIGHT GRAY	10YR 6/1	S
B21h	13	15	DARK RED-BROWN	5YR 2/2	S
B22h	15	20	BROWN	7.5YR 4/4	S
B3	20	25	PALE BROWN	10YR 6/3	S
			RED-YELLOW MOTTLES	5YR 7/8	
B2h	25	30	DARK RED-BROWN	5YR 3/2	S
C	34	60	GRAY-BROWN	10YR 5/2	S
			LIGHT GRAY AND	10YR 7/2	
			YELLOW-BROWN MOTTLES	10YR 5/4	
GLOUCESTER COUNTY (ST. JOHNS)					
Ap	0	9	BLACK OR	10YR 2/1	LS or
			VERY DARK GRAY	10YR 3/1	S, <5% pebbles
A2	9	12	GRAY	10YR 5/1	S
B2	12	16	VERY DARK BROWN TO	10YR 2/2-	LS
			DARK BROWN	7.5YR 3/2	
B3	16	20	DARK BROWN	10YR 3/3	LS
C1	20	32	GRAY-BROWN	2.5YR 5/2	S
C2	32	40	GRAY	5YR 6/1	S
OCEAN COUNTY					
A1	0	11	BLACK	10YR 2/1	S, 5% pebbles
A2g	11	15	GRAY	10YR 5/1	S, 5% pebbles
B2h	15	24	VERY DARK BROWN	10YR 2/2	LS, 5% pebbles
B3g	24	35	LIGHT BROWN-GRAY	10YR 6/2	S, 5% pebbles
Cg	35	60	LIGHT GRAY	10YR 7/2	S, 10% pebbles

Appendix 4d. Manahawkin Series

Horizon	Depth (in)		Munsell Color	Munsell Number	Texture
OCEAN COUNTY					
Oa1-Oa4	0	39	BLACK	5YR 2/1	Muck
IIC1	39	46	GRAY	10YR 5/1	S
IIC2	46	60	GRAY	10YR 6/1	Gravelly S, 20% pebbles

Appendix 4e. Mullica Series

Horizon	Depth (in)		Munsell Color	Munsell Number	Texture
OCEAN COUNTY					
O2	3	0			Litter
A1	0	12	BLACK	10YR 2/1	SL
B21tg	12	16	GRAY-BROWN	2.5Y 5/2	SL, clay bridges
B22tg	16	25	LIGHT BROWN-GRAY	2.5 6/2	SL, clay bridges
			LIGHT OLIVE BROWN MOTTLES	2.5Y 5/6	
C1g	25	36	LIGHT BROWN-GRAY	2.5 6/2	LS, 5% pebbles
C2g	36	60	LIGHT BROWN-GRAY	2.5Y 6/2	S

Appendix 4f. Pasquotank Series

Horizon	Depth (in)		Munsell Color	Munsell Number	Texture
BURLINGTON COUNTY					
Ap	0	9	DARK GRAY	10YR 4/1	Fine SL
A2g	9	14	GRAY-BROWN	2.5Y 5/2	Fine SL
			LIGHT BROWN-GRAY AND	2.5Y 6/2	Fine SL
			YELLOW-BROWN MOTTLES	10YR 5/6	
B2tg	14	30	LIGHT BROWN-GRAY	2.5Y 6/2	Very Fine SL
			YELLOW-BROWN MOTTLES	10YR 5/8	
Cg	30	60	LIGHT GRAY	5Y 6/1	S
GLOUCESTER COUNTY					
Ap	0	8	DARK GRAY, SOMETIMES	10YR 4/1	Fine SL,
			WITH STRONG BROWN MOTTLES	7.5YR 5/8	2-5% pebbles
A2g	8	14	GRAY	10YR 6/1	Fine SL
			MOTTLES	NONE GIVEN	
B2g	14	30	GRAY	10YR 6/1	Fine SL
			MOTTLES	NONE GIVEN	
C	30	36	YELLOW-BROWN	10YR 5/8	Gravelly fine S, 10-20% pebbles

Appendix 4g. Pocomoke Series

Horizon	Depth (in)		Munsell Color	Munsell Number	Texture
ATLANTIC COUNTY					
O1	3	0			
A1	0	10	BLACK	10YR 2/1	SL
A2g	10	18	GRAY	10YR 5/1	SL
B2tg	18	28	GRAY	5Y 6/1	SL, clay bridges
			PALE OLIVE MOTTLES	5Y 6/1	between sand grains
C1g	28	40	GRAY	10YR6/1	S, 20% pebbles
C2g	40	60	GRAY-BROWN	10YR 5/2	S
BURLINGTON COUNTY					
Ap	0	10	BLACK	10YR 2/1	Fine SL
A2g	10	15	LIGHT GRAY	10YR 6/1	Fine SL
			YELLOW-BROWN AND	10YR 5/4	
			WHITE MOTTLES	10YR 8/2	
B2tg	15	28	GRAY	5Y 5/1	Fine SL, 5% pebbles
			YELLOW-BROWN MOTTLES	10YR 5/6	sand grains weakly
			DIMINISHING WITH DEPTH		bridged
IICg	28	60	ALTERNATING LAYERS OF	10YR 7/1	S, gravelly S
			LIGHT GRAY AND	and	and
			YELLOW-BROWN	10YR 5/4	SL
CAPE MAY COUNTY					
A1	0	8	VERY DARK-GRAY	10YR 3/1	SL, 2% pebbles
A2g	8	12	GRAY	10YR 5/1	LS, 2% pebbles
B2tg	12	27	GRAY	N 6/0	SL, weakly bridged
IICg	27	60	LIGHT BROWN-GRAY	2.5Y 6/2	S, 10% pebbles
CUMBERLAND COUNTY					
A1	0	9	VERY DARK BROWN	10YR 2/2	SL
A2g	9	12	GRAY	10YR 6/1	SL
B2g	12	27	GRAY	10YR 6/1	SL, sand grains
			LIGHT GRAY AND	10YR 7/1	bridged
			YELLOW-BROWN MOTTLES	10YR 5/6	
IICg	27	60	STRATIFIED LIGHT BROWN-GRAY	10YR 6/2	S
			LIGHT GRAY AND	10YR 7/1	
			YELLOW-BROWN MOTTLES	10YR 5/6	
GLOUCESTER COUNTY					
Ap	0	8	BLACK	10YR 2/1	SL, 5% pebbles
A2g	8	20	GRAY	10YR 5/1	SL
Bg	20	28	GRAY-BROWN	10YR 5/2	SCL
			YELLOW-BROWN MOTTLES	10YR 5/8	
Cg	28	42	YELLOW-BROWN	10YR 5/8	SL or LS,
			GRAY-BROWN MOTTLES	10YR 5/2	5-10% pebbles

Appendix 4h. Hammonton Series (non-hydric)

Horizon	Depth (in)		Munsell Color	Munsell Number	Texture
ATLANTIC COUNTY					
Ap	0	8	VERY DARK GRAY-BROWN	2.5Y 3/2	LS
A2	8	18	YELLOW-BROWN	10YR 5/4	LS
B2t	18	36	YELLOW-BROWN	10YR 5/6	SL, <5% pebbles
			LIGHT GRAY AND	5Y 7/2	
			BROWN-YELLOW MOTTLES	10YR 6/8	
IIC	36	60	BROWN-YELLOW	10YR 6/6	S, 5% pebbles
			LIGHT GRAY AND	5Y 7/2	
			BROWN-YELLOW MOTTLES	10YR 6/8	
CAPE MAY COUNTY					
Ap	0	10	DARK GRAY-BROWN	10YR 4/2	LS
A2	10	18	YELLOW-BROWN	10YR 5/4	LS
B2t	18	28	YELLOW-BROWN	10YR 5/4	SL, sand grains
			LIGHT BROWN-GRAY MOTTLES	2.5Y 6/2	bridged with clay
IIC	28	60	PALE BROWN	10YR 6/3	Stratified LS and
			BROWN-YELLOW MOTTLES	10YR 6/8	SL, 5% pebbles
CUMBERLAND COUNTY					
Ap	0	10	BROWN	10YR 4/3	SL
B1t	10	16	YELLOW-BROWN	10YR 5/4	SL
			LIGHT BROWN-GRAY AND	10YR 6/2	
			DARK YELLOW-BROWN MOTTLES	10YR 6/4	
B2t	16	24	YELLOW-BROWN	10YR 5/6	SL
C1	24	42	YELLOW	10YR 7/6	LS
			VERY PALE BROWN AND	10YR 7/4	
			LIGHT GRAY MOTTLES	10YR 7/2	
C2	42	60	YELLOW-BROWN	10YR 5/6	Stratified gravelly S, 15% pebbles
OCEAN COUNTY					
Ap	0	10	DARK GRAY-BROWN	10YR 4/2	SL, 1% pebbles
B2t	10	28	YELLOW-BROWN	10YR 5/6	SL, 10% pebbles, clay bridges
B3	28	35	YELLOW-BROWN	10YR 5/6	LS
			LIGHT BROWN-GRAY MOT.	10YR 6/2	
C1	35	48	BROWN-YELLOW	10YR 6/8	S
			LIGHT GRAY MOTTLES	10YR 7/2	
C2	48	60	LIGHT GRAY	10YR 7/2	S
			BROWN-YELLOW MOTTLES	10YR 6/8	

Appendix 4i. Klej Series (non-hydric)

Horizon	Depth (in)		Munsell Color	Munsell Number	Texture
ATLANTIC COUNTY					
A11	0	2	DARK GRAY-BROWN	10YR 4/2	LS
A12	2	10	PALE BROWN	10YR 6/3	LS
B21	10	24	YELLOW-BROWN	10YR 5/6	LS
B22	24	36	BROWN-YELLOW	10YR 6/6	LS
			LIGHT BROWN-GRAY MOTTLES	10YR 6/2	
C1	36	52	BROWN-YELLOW	10YR 6/6	S
			LIGHT GRAY MOTTLES	10YR 7/2	
C2g	52	60	LIGHT GRAY	10YR 7/2	S
			PALE BROWN MOTTLES	10YR 6/3	
BURLINGTON COUNTY					
Ap	0	10	DARK GRAY-BROWN	10YR 4/2	S, <1% pebbles
AC	10	20	LIGHT OLIVE BROWN	2.5Y 5/4	S
C1	20	32	LIGHT YELLOW-BROWN	2.5Y 6/4	S
			LIGHT GRAY MOTTLES	2.5Y 7/2	
C2	32	60	PALE YELLOW	2.5Y 7/4	S, <1% pebbles
CAPE MAY COUNTY					
Ap	0	12	DARK GRAY-BROWN	10YR 4/2	LS
A2	12	18	BROWN	10YR 4/3	LS
C1	18	32	LIGHT YELLOW-BROWN	10YR 6/4	S
			LIGHT BROWN-GRAY	10YR 6/2	
			AND LIGHT GRAY MOTTLES	10YR 7/2	
C2	32	45	LIGHT YELLOW-BROWN	10YR 6/4	S
			LIGHT GRAY AND	10YR 7/2	
			YELLOW-BROWN MOTTLES	10YR 5/8	
C3	45	60	BROWN-YELLOW	10YR 6/6	S
			LIGHT BROWN-GRAY	10YR 6/2	
			AND LIGHT GRAY MOTTLES	10YR 7/2	
CUMBERLAND COUNTY					
Ap	0	10	DARK GRAY-BROWN	10YR 4/2	LS
B2	10	37	LIGHT YELLOW-BROWN	10YR 6/4	LS
			BROWN-YELLOW AND	10YR 6/6	
			LIGHT GRAY MOTTLES	10YR 7/2	
Cg	37	60	WHITE	2.5Y 8/2	S
			LIGHT YELLOW-BROWN	10YR 6/4	
			MOTTLES		
Ap	0	12	DARK BROWN	10YR 3/3	LS
C1	12	30	YELLOW-BROWN	10YR 5/8	S
C2	30	40	STRONG BROWN	7.5YR 5/8	S
			MOTTLES	NONE GIVEN	
OCEAN COUNTY					
A1	0	2	VERY DARK GRAY-BROWN	10YR 3/2	LS
A2	2	5	BROWN-GRAY	10YR 5/2	LS
B21	5	30	BROWN-YELLOW	10YR 6/6	LS
B22	30	38	YELLOW	10YR 7/6	LS
			LIGHT GRAY MOTTLES	10YR 7/2	
C	38	60	LIGHT GRAY	10YR 7/2	S
			YELLOW-BROWN MOTTLES	10YR 5/6	

Appendix 4j. Lakehurst Series (non-hydric)

Horizon	Depth (in)		Munsell Color	Munsell Number	Texture
ATLANTIC COUNTY					
A1	0	2	BLACK	10YR 2/1	S
A2	2	11	LIGHT GRAY	10YR 6/1	S
B2h	11	14	DARK RED-BROWN	5YR 3/2	LS
B3	14	32	YELLOW-BROWN	10YR 5/6	S
			LIGHT GRAY MOTTLES	10YR 7/2	
C1g	32	39	LIGHT BROWN-GRAY	10YR 6/2	S
			YELLOW-BROWN MOTTLES	10YR 5/4	
C2g	39	60	LIGHT BROWN-GRAY	10YR 6/2	S, 10% pebbles
			PALE BROWN MOTTLES	10YR 6/3	
BURLINGTON COUNTY					
A1	0	3	GRAY	10YR 5/1	S
A2	3	15	LIGHT GRAY	10YR 6/1	S
B2h	15	18	DARK BROWN	7.5 YR 4/2	LS
B3	18	40	YELLOW-BROWN	10YR 5/6	S
			GRAY-BROWN MOTTLES	10YR 5/2	
C	40	60	PALE BROWN	10YR 6/3	S
CUMBERLAND COUNTY					
O1	6	3			Litter
O2	3	0	DARK BROWN	7.5YR 3/2	
A1	0	1	DARK GRAY	10YR 4/1	S
A2	1	10	LIGHT BROWN-GRAY	10YR 6/2	S
B21h	10	11	DARK BROWN	7.5YR 4/4	S
B22h	11	20	STRONG BROWN	7.5YR 5/6	S
B3	20	40	RED-YELLOW GRADING TO	7.5YR 6/6	S
			YELLOW; MOTTLES OF	10YR 7/6	
			SIMILAR VALUE AND CHROMA		
C	40	60	BROWN; MOTTLES OF	10YR 5/3	S
			SIMILAR VALUE AND CHROMA		
GLOUCESTER COUNTY					
Ap	0	4	DARK GRAY	2.5Y 4/1	S
A2	4	16	LIGHT GRAY	10YR 6/1	S
B2	16	22	DARK BROWN	7.5YR 4/4	LS
B3	22	30	YELLOW-BROWN	10YR 5/6	S
C1g	30	54	LIGHT YELLOW-BROWN	10YR 6/4	S
	-		WITH MOTTLES	NONE GIVEN	
C2g	54	60	YELLOW-BROWN	10YR 5/6	S
			WITH MOTTLES	NONE GIVEN	
OCEAN COUNTY					
O1	1	0			Litter
A1	0	2	VERY DARK GRAY	10YR 3/2	S
A2	2	12	GRAY	10YR 6/1	S
B21h	12	14	DARK BROWN	7.5YR 4/2	S
B22	14	46	YELLOW-BROWN	10YR 5/6	S
B3	24	46	LIGHT YELLOW-BROWN	2.5Y 6/4	S
			LIGHT GRAYISH MOTTLES	2.5Y 7/2	
Cg	46	60	LIGHT GRAY	2.5Y 7/2	S
			YELLOW-BROWN MOTTLES	10YR 5/6	

Appendix 4k. Woodstown Series (non-hydric)

Horizon	Depth (in)		Munsell Color	Munsell Number	Texture
ATLANTIC COUNTY					
Ap	0	10	DARK GRAY-BROWN	10YR 4/2	SL
B21t	10	24	LIGHT OLIVE BROWN	2.5Y 5/6	SCL, clay films some clay bridges
B22t	24	32	OLIVE BROWN	2.5Y 6/6	SCL, clay films
			GRAY-BROWN MOTTLES	2.5Y 5/2	on peds
IIC1	32	42	PALE OLIVE	5Y 6/3	LS
			GRAY-BROWN MOTTLES	2.5Y 5/2	
IIC2g	42	60	LIGHT BROWN-GRAY	2.5Y 6/2	S
			LIGHT OLIVE GRAY MOTTLES	5Y 6/2	
BURLINGTON COUNTY					
Ap	0	10	DARK GRAY-BROWN	10YR 4/2	Fine SL, 1% pebbles
A2	10	14	LIGHT OLIVE BROWN	2.5Y 5/4	Fine sandy loam
B1	14	24	YELLOW-BROWN	10YR 5/6	Fine sandy loam
B2t	24	34	YELLOW-BROWN	10YR 5/6	Fine sandy loam
			DARK BROWN MOTTLES GRADING	7.5YR 4/4	
			TO DARK BROWN MOTTLES	7.5YR 4/2	
C	34	60	ALT. LAYERS OF LIGHT	2.5Y 6/4	Alternating layers
			YELLOW-BROWN SAND AND		of S/LS, 5% pebbles
			YELLOW-BROWN LOAMY SAND	10YR 5/6	
CAPE MAY COUNTY					
Ap	0	10	DARK GRAY-BROWN	10YR 4/2	SL
A2	10	15	PALE BROWN	10YR 6/3	SL
B2t	15	29	DARK YELLOW-BROWN	10YR 4/4	SCL, thin clay
			LIGHT BROWN-GRAY MOTTLES	10YR 6/2	films on peds
B3	29	34	DARK YELLOW-BROWN	10YR 4/4	SL
			LIGHT BROWN-GRAY AND	10YR 6/2	Thin clay films on
			PALE BROWN MOTTLES	10YR 6/3	ped faces
C	34	60	STRONG BROWN	7.5YR 5/8	LS
			LIGHT BROWN-GRAY AND	10YR 6/2	
			PALE BROWN MOTTLES	10YR 6/3	
CUMBERLAND COUNTY					
Ap	0	8	DARK GRAY-BROWN	10YR 4/2	SL
B1t	8	26	YELLOW-BROWN	10YR 5/6	SL, clay films
			PALE BROWN MOTTLES	10YR 6/3	and bridges
B2t	26	30	LIGHT YELLOW-BROWN	10YR 6/4	SL, clay films
			YELLOW-BROWN MOTTLES AND	10YR 5/6	and bridges
			LIGHT GRAY MOTTLES	10YR 7/2	
B3t	30	36	LIGHT YELLOW-BROWN	10YR 6/4	SL, clay films
			YELLOW-BROWN AND	10YR 5/6	and bridges
			LIGHT GRAY MOTTLES	10YR 7/2	
IIC	36	60	VERY PALE BROWN,	10YR 7/4	LS
			STRONG BROWN AND	7.5YR 5/6	
			LIGHT GRAY	10YR 7/2	

Appendix 5. Routine onsite determination method data form.

DATA FORM
ROUTINE ONSITE DETERMINATION METHOD[1]

Field Investigator(s): _____ Date: _____
Project/Site: _____ State: _____ County: _____
Applicant/Owner: _____ Plant Community #/Name: _____
Note: If a more detailed site description is necessary, use the back of data form or a field notebook.

Do normal environmental conditions exist at the plant community?
Yes _____ No _____ (If no, explain on back)
Has the vegetation, soils, and/or hydrology been significantly disturbed?
Yes _____ No _____ (If yes, explain on back)

VEGETATION

Dominant Plant Species	Indicator Status	Stratum	Dominant Plant Species	Indicator Status	Stratum
1.			11.		
2.			12.		
3.			13.		
4.			14.		
5.			15.		
6.			16.		
7.			17.		
8.			18.		
9.			19.		
10.			20.		

Percent of dominant species that are OBL, FACW, and/or FAC _____
Is the hydrophytic vegetation criterion met? Yes _____ No _____
Rationale: _____

SOILS

Series/phase: _____ Subgroup:[2] _____
Is the soil on the hydric soils list? Yes _____ No _____ Undetermined _____
Is the soil a Histosol? Yes _____ No _____ Histic epipedon present? Yes _____ No _____
Is the soil: Mottled? Yes _____ No _____ Gleyed? Yes _____ No _____
Matrix Color: _____ Mottle Colors: _____
Other hydric soil indicators: _____
Is the hydric soil criterion met? Yes _____ No _____
Rationale: _____

HYDROLOGY

Is the ground surface inundated? Yes _____ No _____ Surface water depth: _____
Is the soil saturated? Yes _____ No _____
Depth to free-standing water in pit/soil probe hole: _____
List other field evidence of surface inundation or soil saturation.

Is the wetland hydrology criterion met? Yes _____ No _____
Rationale: _____

JURISDICTIONAL DETERMINATION AND RATIONALE

Is the plant community a wetland? Yes _____ No _____
Rationale for jurisdictional decision: _____

[1] This data form can be used for the Hydric Soil Assessment Procedure and the Plant Community Assessment Procedure.
[2] Classification according to "Soil Taxonomy."