# Narragansett Bay
## *Research Reserve*

# Habitat Classification and Inventory for the Narragansett Bay National Estuarine Research Reserve

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ABSTRACT


A classification system was developed for natural and modified habitats in Rhode Island and employed at the Narragansett Bay National Estuarine Research Reserve (NBNERR) on Prudence, Patience, Hope, and Dyer Islands. The classification system builds on previous national and local classification schemes, is hierarchical, and was designed for use in a geographic information system (GIS). It consists of five classification levels including System, Subsystem, Class, Subclass, and Habitat, and applies to upland, wetland, and deepwater habitats. In 2003, a total of 2601 acres of the NBNERR was mapped using this classification system including 652 polygons from 4 systems, 6 subsystems, 20 classes, 26 subclasses, and 72 different habitat types. The highly modified south end of Prudence Island consisted of 33 habitat types dominated by *Red Maple Swamp*, *Coastal Shrubland*, and mosaics of Oak, Maple, and Pitch Pine forests. The north end of Prudence Island and Patience Island were dominated by *Coastal Shrubland* and *Coastal Cherry/Eastern Red Cedar Forest* habitats, and Dyer Island and Hope Island were dominated by *Coastal Shrubland*. The classification system is already enhancing the stewardship and management functions of the NBNERR and should prove useful in other areas of Rhode Island and southern New England.

INTRODUCTION

The Narragansett Bay National Estuarine Research Reserve (NBNERR or

Reserve) is one of 22 reserves that comprise the National Estuarine Research Reserve

System (NERRS). This national network is funded and administered by the National

Oceanic and Atmospheric Administration in partnership with state agencies and nonprofit

organizations.  The goal of the NERRS is to organize and facilitate nationwide, three

primary functions: estuarine research, estuarine education, and environmental

stewardship.

Effective stewardship requires an understanding of habitats. An inventory of

habitats provides a basis for management of plants and wildlife and establishes a baseline

for future monitoring and comparisons with aerial photo archives.  It also facilitates

contemporary ecosystem analysis and interpretation.  Finally, a habitat inventory serves

researchers, educators and environmental managers, as a means of communicating

spatially defined ecological information.  Shaughnessy (1982) inventoried the habitats of

two large units of the NBNERR for the RI Department of Environmental Management in

1982. However, prior to the current study, Reserve habitats had never been completely

inventoried.

The initial objective of this project was to conduct an inventory of the habitats of

the NBNERR and to create a useful, interactive, GIS polygon dataset.  For ease of query

and organization in the GIS data tables, a numerical and hierarchical classification format

was needed, but no such schemes were available for local habitats.  Development of a

suitable classification thus became a second objective.  This report describes the

production and the utility of the classification and inventory, provides metadata for the inventory, and outlines a protocol for future inventories.

STUDY AREA

The NBNERR is a 4,259-acre reserve composed of four islands and adjacent waters in the center of Narragansett Bay, Rhode Island.  Narragansett Bay is an estuary comprised of three drowned glacial river valleys, with average current channel depths ranging from 30 to 50 feet and an estimated freshwater input of 2.4 billion gallons per day (Beck and Beck 1998).  The salinity of the bay ranges from 13 ppt in the upper part to 31 ppt at the mouth.  The largest island in the Reserve, Prudence Island, is 7.0 miles long and 1.4 miles at its widest point, covers approximately 3,500 acres, and reaches 180 feet in elevation.  NBNERR contains seven parcels, which cover over 65% of the Prudence Island land surface.  The Reserve also includes Patience Island (214 acres), Hope Island (94 acres), and Dyer Island (36 acres) in their entireties.  Each of the four islands is composed of sedimentary rock covered by a discontinuous, thin layer of dark till.  Glacial fluvial deposits cover much of the narrow north end of Prudence Island (Hermes et al. 1994). The soils of the Reserve are very diverse, predominantly falling in the US Soil Conservation Service's hydrologic group $C$, with some large areas of sandy group $A$ soils in the North Prudence Unit (Rector 1981).

The topography and soils of the Reserve have been modified by a long history of human land use.  Prudence, Patience, and Hope Islands were cleared and used as pasture and cropland from the mid 1600's until the mid 1800's.  The Islands were taken over by

the U.S. Navy in 1940 for use as a munitions base and Hope and Prudence were heavily

disturbed by clearing, and the construction of roads and bunkers (Beck and Beck 1998).

Following World War II, the Navy returned the properties to the State of Rhode Island,

and they have become vegetated.

METHODS

*NBNERR Classification-*

This project focused on producing a lasting and comprehensive classification scheme

to fit the needs of the Reserve.  Foremost, the scheme needed to separate the Reserve into

useful units.  Natural communities (Enser and Lundgren 2003) or habitats (Cowardin et

al. 1979), as used in this context, are areas of the landscape that are typically

characterized by certain life forms or species, water regimes, substrates, and animal

associations.  Habitat classifications are especially useful to environmental managers

because they provide information about the physical environment, flora, and fauna, which

facilitates interpretation of ecological function.

A classification of habitats (NBNERR classification, Appendix 1) was produced for

the Reserve by inserting common habitat names into a hierarchical structure based on

*Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al.

1979).  The five levels of the resulting hierarchy are *System*, *Subsystem*, *Class*, *Subclass*,

and *Habitat*.  In order to facilitate organization and statistical query of the habitats in

GIS, text, and spreadsheet software programs, the NBNERR habitat types were organized

using a strictly numerical format, with *System*, *Subsystem*, *Class*, and *Subclass* each being

represented by a descending order of magnitude respectively, and *Habitat* falling at the first and second decimal places.  If desired, habitats can be subdivided by adding decimal places; thus the classification is open ended.

The overall hierarchical structure and nearly all of the categories within the *System*, *Subsystem*, *Class*, and *Subclass* levels were adopted directly from Cowardin et al. (1979), while many of the habitat types used in the *Habitat* level were adopted from the *Natural Community Classification of Rhode Island* (*NCCRI*) (Enser and Lundgren 2003) and other sources.  The *Habitat* level was added below the *Subclass* level to facilitate communication by identifying the habitat type with a descriptive, well accepted, and defined common name.  Definitions of classification levels and habitat types are appended to this report (Appendix 2).  A recent draft of the *NCCRI* is also appended to this report (Appendix 3).

The Cowardin system is the national standard for wetland and deepwater habitat classification.  It classifies habitats through five levels as well as a series of modifiers describing water regime, water chemistry, and soil.  A habitat is described by stringing the names (or abbreviations) of its components together.  For example, a salt meadow would be described as: *an estuarine, intertidal, persistent emergent wetland, dominated by Spartina patens and Distichlis spicata, with an irregularly flooded water regime, and mixohaline, hemic soil,* or *E2EM1nP3h* (Golet 2003).  The advantage of the Cowardin et al system is that any wetland can be accurately identified and described regardless of regional differences in common names.  The NBNERR scheme trades off complete national standardization for ease of use.

The Cowardin hierarchical approach was extended to include *Upland* and *Modified* habitats, so that all Reserve habitats could be classified in a consistent fashion. With assistance from Dr Frank Golet of the University of Rhode Island, the *Upland System* was divided into subsystems, classes and subclasses. The *Modified System* was added to permit the classification of habitats that have been modified mechanically or chemically more than once per growing season (i.e., lawns or gardens), that are regularly grazed by livestock (i.e., pastures), or that have been modified to a condition that prohibits natural succession (i.e., barns, houses, and parking lots). *Modified* habitats were adopted from the RIGIS Anderson (1976) level 4, land-use/land-cover classification.

*2003 NBNERR Inventory*

An inventory of Reserve habitats was conducted between June and October of 2003. Due to time constraints, deepwater habitats were not inventoried unless they were entirely or mostly enclosed by land. The GIS polygon dataset, *Community_class.shp* (a shapefile), was created with ArcView 3.2 software, against the RIGIS 1997 1:5000 Digital Orthophotograph Quadrat (DOQ) dataset (RIGIS 2003). Polygons were heads-up digitized at 1:3000. Accuracy of the DOQ was field-tested against a Trimble survey-quality GPS unit, and relative accuracy was within four feet over ground. Reserve staff chose a 0.25-acre minimum mapping unit for the project, which was a compromise between the desire for high spatial resolution data and practicality. The 0.25-acre minimum was merely a guideline for mapping, and some polygons fell below this size limit. In salt marshes, polygons as small as 600 ft$^2$ were mapped.

Several resources and techniques were employed to delineate polygons for the dataset. Aerial photos were scanned to 1200 dpi and georectified against the RIGIS RIDOT 1997 DOQ to an accuracy of mean square root error < 1.0, at 1:1000 digital image size using ArcView extension Image Analysis. Reserve boundaries were established by correcting the rough-scale NBNERR boundaries.shp polygon coverage against hard-copy plat maps from the Town of Portsmouth. Shoreline (low tide) boundaries were mapped by heads-up delineation of georectified 1:24,000 true color aerial photographs from a 2003 RIDOT spring flight. Habitat boundaries were determined by interpretation of the spring 2003 aerial photos and 1996 full color, leaf-on, 1:12,000 aerial photos, using a 2× stereoscope, and digital interpretation of the RIGIS 1997 DOQ. RIGIS soils and wetlands data layers were superimposed as references for obscure wetlands boundaries, but boundaries were not taken directly from either source. A Trimble survey quality GPS unit and Pathfinder software were used in the field to locate and digitize boundaries not clearly evident through photo-interpretation.

All polygons were field-checked to determine the proper NBNERR classification. All levels of the classification (*System*, *Subsystem*, *Class*, *Subclass,* and *Habitat*) were verified in the field according to Cowardin et al (1979). Vegetated habitats (≥30% plant cover) were classified based on the tallest plant that covered at least 30% of the area (the dominant life form). Non-vegetated habitats (<30% plant cover) were distinguished by sediment particle size at the land surface. Note was taken of invasive species present in polygons of the North Prudence Unit, the Patience Island Unit, and the Dyer Island Unit; and percent cover of the most abundant invasive was estimated. Precision of boundary

lines was field-checked by relating obvious landmarks to images of aerial photos on printed field maps.

Field data were entered into GIS attribute tables with ArcView 3.1 and Excel software. Each polygon was linked to a specific string of attributes to generate inventory statistics and for querying between the map and the attribute table. Thirteen attribute fields were created to contain specific data for each polygon. Attribute fields are described in the FGDC compliant GIS metadata (Appendix 4).

The GIS shapefile dataset --*Community_class.shp*-- was converted to the GIS coverage dataset --*Habitat.cov*-- with ESRI Arc Toolbox 8.1 software to generate proper topology and area values for each polygon.

A 36-by 48-inch map of NBNERR habitats was created for Reserve archives, display in the NBNERR education center, and general orientation and communication. It was created in ESRI ArcView software and is available for printing in ArcView or jpeg format.

RESULTS

*NBNERR Classification-*

The *NBNERR Habitat Classification* contains seven systems, each of which is subdivided into two subsystems, with the exception of the *Upland System*, which has no subsystems. Each subsystem is further divided into two to eight classes. The *Palustrine System* is divided into *Open Water* and *Terrestrial* subsystems. Classes are subdivided

into as many as six subclasses.  The Seventy-two habitat types are recognized.     The

classification system exists as a Microsoft Word outline, which can be digitally collapsed

or expanded for viewing and printing at any of the five levels of detail, or any

combination of levels.

In GIS and spreadsheet applications, the prescribed order of data can easily be

restored by sorting the classification heading codes. This facilitates quick entering of

attribute data and cross-referencing between the dataset and the classification outline.

Data can be queried by the heading's order of magnitude and its value, and can be viewed

at any level of detail by rounding to the appropriate order.

*2003 NBNERR Inventory*

More than 2600 acres of the NBNERR, including 652 polygons of 72 habitat

types, were mapped according to the NBNERR classification during the summer of 2003

(Table 1). Four systems, 6 subsystems, 20 classes, and 26 subclasses were reported

(Table 2.).  The associated GIS dataset contains thirteen attribute fields that include the

following data for each polygon: NBNERR numeric code; system; subsystem; class;

subclass; habitat type; dominance type; area in square feet, acres, and hectares; perimeter

in feet; and approximate invasive species coverage.  The dataset also includes computer

generated geo-spatial information that allows a digital map of the polygons to be laid

over any existing georectified digital dataset and queried against it, or mapped with it.

Appendix 4 provides additional attribute descriptions and details.

DISCUSSION

*NBNERR Classification*

The NBNERR Classification performed well as a tool for organizing and describing the habitats of the NBNERR.  Its success was due largely to its hierarchical structure, which is based on the Cowardin et al. classification (1979).  The Cowardin et al. structure has been modified for the *Palustrine* and *Upland* systems (Appendix 1).  The *Palustrine System* was subdivided into *Open Water* and *Terrestrial Subsystems*.  This approach has already been used by the National Wetlands Inventory to map small, shallow ponds.  It is useful to break out palustrine ponds at the subsystem level for coarse mapping and for general management, particularly when the classes and subclasses cannot practically be determined.  The *Open Water* subsystem supports only non-persistent emergent vegetation, aquatic beds, or unconsolidated bottoms, and only includes fresh bodies of water with total areas < 8 ha.

The *Upland* system closely follows the Cowardin *Palustrine* format by subdividing habitats by dominant life forms at the class level and using the subclass level for life history modifiers such as *Broad-leaved Deciduous*.  This modification maintains uniformity within the system.

The NBNERR Classification uses two decimal places for numbering the habitat types.  This allows for more than nine habitats from the same subclass.  I did not need to use this modification for the mapping of the Reserve properties, but I believe that it might be necessary for application of the classification to a larger or more complex region.

*2003 NBNERR Inventory*

Due to time, manpower, and equipment constraints, unconfined deepwater habitats of the Reserve were not mapped. Deepwater habitats are essential in the function of coastal systems, and alone are extremely valuable. Understanding of these habitats is of great importance to the NBNERR, and a full deepwater inventory is a top stewardship priority for 2004.

The 2003 inventory data are already being used by Reserve personnel to: communicate resource status to NOAA for possible acquisitions; make educational/outreach brochures; summarize, locate, and communicate Reserve resources to the RI Governor's Office for state recreation planning; facilitate communications for research; summarize invasive species occurrence for potential restoration; and otherwise generally facilitate management decisions. The hard copy map of habitats is also regularly used as a visual reference in all phases of management.

The results of the inventory allow extensive ecological interpretations to be made. For example, some of human impacts on coastal terrestrial systems are revealed (Tables 1 to 3 and Fig. 1). The highly heterogeneous South Prudence Unit supports habitats that have resulted directly from former land-use as a Navy munitions depot. Fill covered bunkers act as hills of well-drained, thin, sandy soils and thus support switchgrass (*Panicum virgatum*) grasslands and pitch pine (*Pinus rigida*) sapling habitats. Raised roadbeds impound small streams to create roadside shrub swamps and young red maple (*Acer rubrum*) wetlands. Nutrient depleted, compacted soils of formerly cleared and farmed fields support only early successional stages ranging from grasses to bayberry and blueberry shrublands to sapling shrublands, while others support only thick monocultures

of greenbrier (*Smilax rotundifolia*). A 25-acre European larch plantation occupies the

northwest corner of the unit, and a network of firebreaks-turned-linear-shrublands cut

through a secondary growth *Pitch Pine-Oak* forest. The 50 acres of *Pitch Pine-Oak*

forest and most of the 110 acres of *Oak-Pine* forest in the South Prudence Unit dominate

the remnants of original loamy soils from which the fertile upper horizons have been

removed. The remaining Poquonock soils are nutrient-poor and well drained (Rector

1981), which provides an ideal environment for pitch pine, given the proper disturbance

regime.

Coastal Shrubland and *Coastal Cherry/Eastern Red Cedar Forest* dominate the

narrow North Prudence Unit and the nearby Patience Unit (Fig. 1). A combination of

clear-cutting and poor farming practices (Beck and Beck 1998) exacerbated by coastal

wind effects has lead to delayed succession. In these areas, the absence of dense trees has

permitted an intense invasion of the non-native climbing vine, Asiatic bittersweet

(*Celastrus orbiculatus*), which dominates the understory and is now topping even the

tallest of the red cedars (*Juniperus virginiana*) and cherries (*Prunus serotina*).

Virtually every Reserve salt marsh has been ditched for mosquito control, which

has completely modified the soil moisture levels of the systems and created linear tracts

of *Smooth Cordgrass Salt Marsh* cutting across fields of fragmented *Salt Meadow*. *Tall*

*Reed Grass Marsh* is established along the edge of most salt marshes on the Reserve, but

the extent of invasion is small relative to mainland Rhode Island.

The above data analyses, observations, inferences, and speculations illustrate only

a sample of the dataset's utility. Many more queries of these data will be performed in the

future. This report was intended to provide an account of first of many regular inventories at the NBNERR using the NBNERR classification scheme.

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Table 1.  Total area of each habitat type of the NBNERR, excluding Hope Island.

| Habitat type | Acres | Hectares | % of Grand Total |
|---|---|---|---|
| *ESTUARINE* | | | |
| Cattail Brackish Marsh | 0.06 | 0.02 | 0.00 |
| Cobble Beach | 82.67 | 33.47 | 3.28 |
| Fringe Marsh | 14.65 | 5.93 | 0.58 |
| Gravel Beach | 2.36 | 0.96 | 0.09 |
| Halophilic Forbs | 1.64 | 0.66 | 0.06 |
| High Tide Bush Shrubland | 22.30 | 9.03 | 0.88 |
| Mud Flat | 3.04 | 1.23 | 0.12 |
| Rose Mallow Marsh | 0.35 | 0.14 | 0.01 |
| Rubble Beach | 5.65 | 2.29 | 0.22 |
| Salt Meadow | 82.93 | 33.57 | 3.29 |
| Sand Beach | 21.94 | 8.88 | 0.87 |
| Sand Bottom Cove | 16.71 | 6.77 | 0.66 |
| Sand Bottom Creek | 5.55 | 2.25 | 0.22 |
| Sand Bottom Pool | 0.39 | 0.16 | 0.02 |
| Sand Flat | 7.99 | 3.23 | 0.32 |
| Smooth Cordgrass Salt Marsh | 48.32 | 19.56 | 1.91 |
| Stunted Smooth Cordgrass Panne | 3.46 | 1.40 | 0.14 |
| Tall Reed Grass Grassland | 6.81 | 2.76 | 0.27 |
| Tidal Mud Bottom Creek | 0.29 | 0.12 | 0.01 |
| Wrack | 0.82 | 0.33 | 0.03 |
| | | | |
| *PALUSTRINE* | | | |
| Low BLD Shrub Swamp | 14.21 | 5.75 | 0.56 |
| Palustrine Unconsolidated Bottom | 0.67 | 0.27 | 0.03 |
| Red Maple Swamp | 436.28 | 176.63 | 17.29 |
| Sapling BLD Shrub Swamp | 0.88 | 0.36 | 0.03 |
| Saturated Wet Meadow | 1.23 | 0.50 | 0.05 |
| Seasonally Flooded Emergent Marsh | 1.52 | 0.62 | 0.06 |
| Tall BLD Shrub Swamp | 16.47 | 6.67 | 0.65 |
| | | | |
| *UPLAND* | | | |
| BLD Open Woodland | 88.64 | 35.89 | 3.51 |
| Bramble Shrubland | 0.60 | 0.24 | 0.02 |
| Coastal Cherry/Eastern Red Cedar Forest | 459.64 | 186.09 | 18.22 |
| Coastal Dune Beachgrass Barren | 0.76 | 0.31 | 0.03 |
| Coastal Dune Beachgrass Grassland | 6.86 | 2.78 | 0.27 |
| Coastal Dune Forbs | 2.25 | 0.91 | 0.09 |
| Coastal Dune Shrubland | 16.31 | 6.60 | 0.65 |
| Coastal Greenbrier Shrubland | 57.05 | 23.10 | 2.26 |
| Coastal Locust Forest | 3.45 | 1.40 | 0.14 |
| Coastal Shrubland | 192.06 | 77.76 | 7.61 |
| Eastern Red Cedar Forest | 39.53 | 16.00 | 1.57 |
| Greenbrier Shrubland | 40.96 | 16.58 | 1.62 |
| Inland Dune/Sand Barren | 0.30 | 0.12 | 0.01 |
| Larch Forest | 24.92 | 10.09 | 0.99 |
| Little Blue Stem Grassland | 7.65 | 3.10 | 0.30 |
| Low BLD Sapling Shrubland | 4.89 | 1.98 | 0.19 |
| Low BLD Shrubland | 15.14 | 6.13 | 0.60 |
| Low Pitch Pine Sapling Open Shrubland | 2.32 | 0.94 | 0.09 |
| Low Pitch Pine Sapling Shrubland | 9.11 | 3.69 | 0.36 |
| Maritime Grassland | 1.98 | 0.80 | 0.08 |
| Mixed Grassland | 15.16 | 6.14 | 0.60 |
| Naturalized Maple Forest | 10.40 | 4.21 | 0.41 |
| Oak - Pine Forest | 110.14 | 44.59 | 4.36 |
| Oak - Red Maple Forest | 451.16 | 182.66 | 17.88 |
| Old Field | 8.30 | 3.36 | 0.33 |
| Pitch Pine - Oak Forest | 50.28 | 20.36 | 1.99 |

Table 1.  Continued.

| Habitat type | Acres | Hectares | % of Grand Total |
|---|---|---|---|
| Pitch Pine Open Woodland | 11.10 | 4.49 | 0.44 |
| Sumac Thicket | 2.75 | 1.11 | 0.11 |
| Switchgrass Grassland | 40.45 | 16.38 | 1.60 |
| Tall BLD Shrubland | 5.34 | 2.16 | 0.21 |
| Tall Pitch Pine Sapling Open Shrubland | 6.26 | 2.53 | 0.25 |
| Tall Pitch Pine Sapling Shrubland | 3.15 | 1.28 | 0.12 |
| White Pine Forest | 0.55 | 0.22 | 0.02 |
| | | | |
| *MODIFIED* | | | |
| Earthen Bridge | 0.15 | 0.06 | 0.01 |
| Institutional | 10.76 | 4.36 | 0.43 |
| Low Density Residential | 0.92 | 0.37 | 0.04 |
| Mowed Lawn Plus Trees | 5.28 | 2.14 | 0.21 |
| Other Transportation | 1.78 | 0.72 | 0.07 |
| Pasture | 13.99 | 5.66 | 0.55 |
| Recreational | 1.14 | 0.46 | 0.05 |
| Stone Pier | 0.72 | 0.29 | 0.03 |
| Total Sum | 2523.39 | 1021.62 | 100.00 |

Table 2.  Total areas of each component of the habitats of the NBNERR 2003.

| | Polygons | Acres | Hectares | % Total | | Polygons | Acres | Hectares | % Total |
|---|---|---|---|---|---|---|---|---|---|
| **Sysem** | | | | | **Subclass** | | | | |
| Estuarine | 253 | 343.23 | 138.90 | 13.20 | Sand | 43 | 55.34 | 22.40 | 2.13 |
| Palustrine | 44 | 473.07 | 191.44 | 18.19 | Mud | 2 | 3.33 | 1.35 | 0.13 |
| Upland | 332 | 1749.97 | 708.19 | 67.28 | Bedrock | 8 | 11.48 | 4.65 | 0.44 |
| Modified | 17 | 34.89 | 14.12 | 1.34 | Rubble | 3 | 5.85 | 2.37 | 0.22 |
| | | | | | Cobble | 20 | 84.19 | 34.07 | 3.24 |
| **Subsystem** | | | | | Gravel | 1 | 2.36 | 0.96 | 0.09 |
| Estuarine Subtidal | 10 | 23.29 | 9.43 | 0.90 | Organic | 2 | 0.82 | 0.33 | 0.03 |
| Estuarine Intertidal | 243 | 319.94 | 129.48 | 12.30 | Salt Marsh | 128 | 149.58 | 60.53 | 5.75 |
| Palustrine Open Water | 1 | 0.12 | 0.05 | 0.00 | Brackish Marsh | 18 | 7.40 | 2.99 | 0.28 |
| Palustrine Terrestrial | 43 | 472.95 | 191.40 | 18.18 | Cobble Beach Communit | 1 | 1.64 | 0.66 | 0.06 |
| Upland | 332 | 1749.97 | 708.19 | 67.28 | BLD | 288 | 1445.90 | 585.13 | 55.59 |
| Urban/Built Up | 15 | 20.90 | 8.46 | 0.80 | Unknown | 1 | 0.12 | 0.05 | 0.00 |
| Agricultural | 2 | 13.99 | 5.66 | 0.54 | Persistent | 4 | 2.57 | 1.04 | 0.10 |
| | | | | | Grassland | 39 | 72.10 | 29.18 | 2.77 |
| **Class** | | | | | Broad-leaved Herbs | 7 | 6.59 | 2.67 | 0.25 |
| *ESTUARINE* | | | | | NLE | 20 | 72.96 | 29.53 | 2.80 |
| Unconsolidated Bottom | 9 | 23.00 | 9.31 | 0.88 | NLD | 2 | 24.92 | 10.08 | 0.96 |
| Streambed | 1 | 0.29 | 0.12 | 0.01 | Mixed | 42 | 619.12 | 250.55 | 23.80 |
| Rocky Shore | 11 | 17.33 | 7.01 | 0.67 | Low Density | 2 | 0.92 | 0.37 | 0.04 |
| Unconsolidated Shore | 54 | 121.69 | 49.25 | 4.68 | Roads | 2 | 0.25 | 0.10 | 0.01 |
| Emergent Wetland | 147 | 158.62 | 64.19 | 6.10 | Port | 4 | 2.55 | 1.03 | 0.10 |
| Shrub Wetland | 31 | 22.30 | 9.02 | 0.86 | Government | 6 | 16.04 | 6.49 | 0.62 |
| *PALUSTRINE* | | | | | Developed Recreational | 1 | 1.14 | 0.46 | 0.04 |
| Unconsolidated Bottom | 1 | 0.12 | 0.05 | 0.00 | Pasture | 2 | 13.99 | 5.66 | 0.54 |
| Emergent Wetland | 4 | 2.57 | 1.04 | 0.10 | | | | | |
| Shrub Wetland | 21 | 34.10 | 13.80 | 1.31 | **Grand Totals** | 646 | 2601.16 | 1052.65 | 100.00 |
| Forested Wetland | 18 | 436.28 | 176.56 | 16.77 | | | | | |
| *UPLAND* | | | | | | | | | |
| Barrens and Dunes | 4 | 1.06 | 0.43 | 0.04 | | | | | |
| Herbaceous Upland | 46 | 78.69 | 31.84 | 3.03 | | | | | |
| Shrubland | 182 | 386.15 | 156.27 | 14.85 | | | | | |
| Saplings and Scrub | 9 | 25.73 | 10.41 | 0.99 | | | | | |
| Forested Upland | 91 | 1258.34 | 509.23 | 48.38 | | | | | |
| *MODIFIED* | | | | | | | | | |
| Residential | 2 | 0.92 | 0.37 | 0.04 | | | | | |
| Transportation etc | 6 | 2.80 | 1.13 | 0.11 | | | | | |
| Institutional | 6 | 16.04 | 6.49 | 0.62 | | | | | |
| Other Urban | 1 | 1.14 | 0.46 | 0.04 | | | | | |
| Pasture | 2 | 13.99 | 5.66 | 0.54 | | | | | |

Table 3.  Estimated cover of invasive species on selected units of the NBNERR 2003.

| Invasives | Polygons | Acres | Hectares | % of Unit |
|---|---|---|---|---|
| **North Unit** | | | | |
| Bittersweet 01-10% | 7 | 90.10 | 36.46 | 11.57 |
| Bittersweet 10-25% | 3 | 80.60 | 32.62 | 10.35 |
| Bittersweet 25-50% | 5 | 123.73 | 50.07 | 15.88 |
| Bittersweet 50-75% | 6 | 10.37 | 4.20 | 1.33 |
| Bittersweet 75-100% | 7 | 10.15 | 4.11 | 1.30 |
| Phragmites 10-25% | 2 | 1.65 | 0.67 | 0.21 |
| Phragmites 75-100% | 8 | 3.03 | 1.23 | 0.39 |
| <1% Invasives | 203 | 459.32 | 185.88 | 58.97 |
| Totals | 241 | 778.95 | 315.23 | 100.00 |
| | | | | |
| **Patience Unit** | | | | |
| Bittersweet 01-10% | 1 | 0.91 | 0.37 | 0.43 |
| Bittersweet 10-25% | 7 | 68.73 | 27.81 | 32.18 |
| Bittersweet 25-50% | 7 | 27.86 | 11.27 | 13.04 |
| Bittersweet 50-75% | 7 | 17.85 | 7.22 | 8.36 |
| Bittersweet 75-100% | 8 | 15.79 | 6.39 | 7.39 |
| Japanese knotweed 01-10% | 1 | 1.04 | 0.42 | 0.49 |
| Phragmites 10-25% | 1 | 0.77 | 0.31 | 0.36 |
| Phragmites 75-100% | 3 | 0.82 | 0.33 | 0.38 |
| <1% Invasives | 44 | 79.80 | 32.29 | 37.36 |
| Totals | 79 | 213.57 | 86.43 | 100.00 |
| | | | | |
| **Dyer Unit** | | | | |
| Bittersweet 01-10% | 1 | 0.72 | 0.29 | 2.01 |
| Bittersweet 50-75% | 1 | 0.28 | 0.11 | 0.78 |
| Jimson Weed 10-25% | 2 | 1.75 | 0.71 | 4.89 |
| Multiflora Rose 1-10% | 1 | 9.69 | 3.92 | 27.07 |
| Multiflora Rose 10-25% | 1 | 1.63 | 0.66 | 4.55 |
| <1% Invasives | 22 | 21.72 | 8.79 | 60.69 |
| Totals | 28 | 35.79 | 14.48 | 100.00 |

**LEGEND**

Estarine Habitats
Bedrock Shore
Cattail Brackish Marsh
Cobble Beach
Cobble Beach Forbs
Common Reed Brackish Marsh
Fringe Marsh
Gravel Beach
High Tide Bush Shrubland
Sand Panne
Stunted Smooth Cordgrass Panne
Rose Mallow Brackish Marsh
Rubble Shore
Salt Meadow
Sand Beach
Smooth Cordgrass Salt Marsh
Cove
Creek
Creek Bed
Flat
Pool
Wrack Mat
Palustrine Habitats
BLD Sapling Swamp
Cattail Fresh Marsh
Fern Wet Meadow
Low BLD Shrub Swamp
Pond
Red Maple Swamp
Tall BLD Shrub Swamp
Wet Meadow
Upland Habitats
BLD Woodland
Mixed BLD Saplings
Bayberry Shrubland
Blackberry Shrubland
Blueberry Shrubland
Coastal Cherry-Eastern Red Cedar Forest
Coastal Dune Forbs
Coastal Dune Grassland
Coastal Dune Shrubland
Coastal Dune Sparse Grassland
Coastal Eastern Red Cedar Forest
Coastal Greenbrier Shrubland
Coastal Locust Forest
Coastal Shrubland
Forb Meadow
Greenbrier Shrubland
Inland Sand Barren
Larch Plantation
Little Blue Stem Grassland
Maritime Grassland
Mixed Grassland
Naturalized Maple Forest
Oak - Pine Forest
Oak - Red Maple Forest
Pitch Pine - Oak Forest
Pitch Pine Forest
Pitch Pine Woodland
Pitch Pine Sapling Open Shrubland
Pitch Pine Saplings
Steeplebush Shrubland
Sumac Thicket
Switchgrass Grassland
White Pine Forest
Modified Habitats
Boat Ramp
Earthen Bridge
Low Density Residential
Mowed Grass and Paved Road
Mowed Lawn
Mowed Lawn Plus Buildings
Mowed Lawn Plus Trees
Pasture
Stone Pier
Wooden Dock
Excluded Properties

Bristol, RI

N
W E
S

Patience Island

Prudence Island

Narragansett Bay

Hope Island
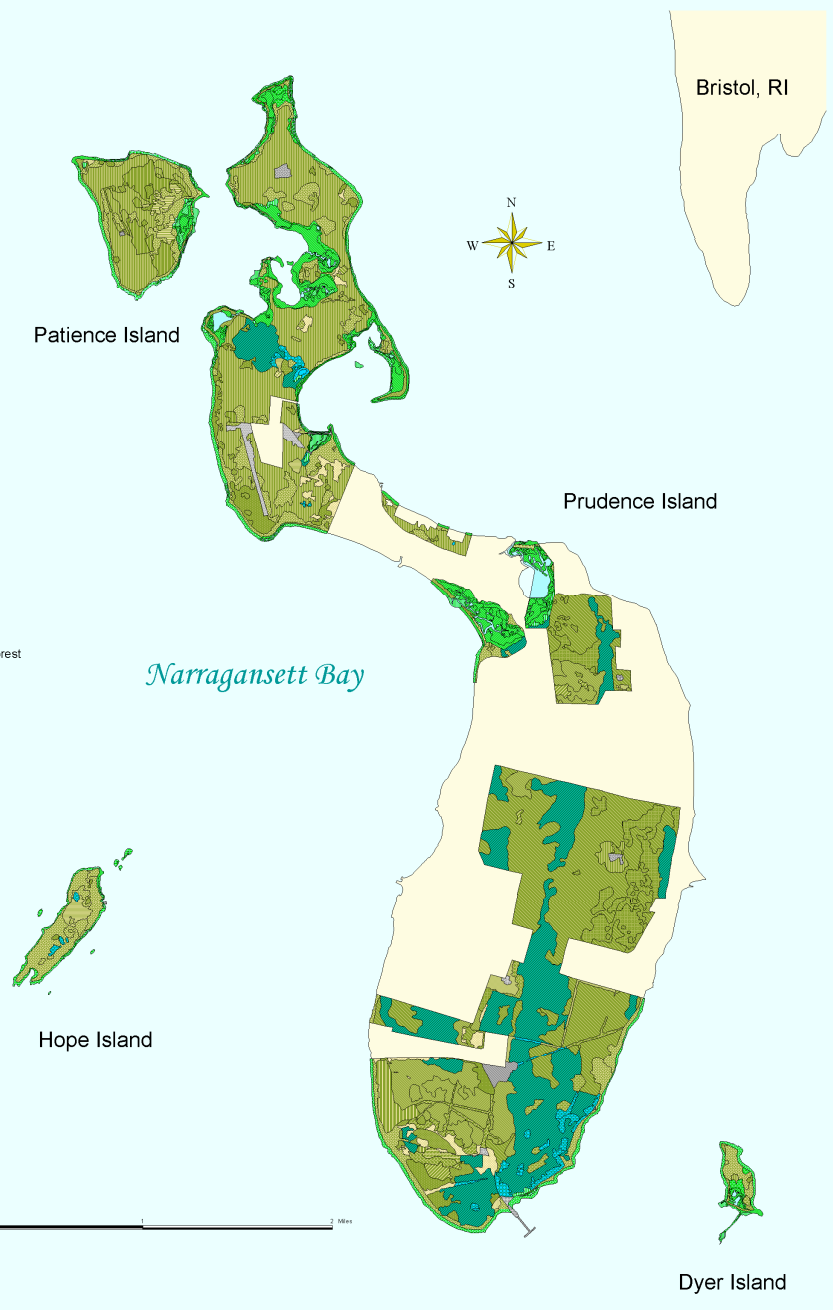
Dyer Island

0        0        1        2 Miles

Figure 1. Habitats of the Narragansett Bay National Estuarine
Research Reserve, 2003.

*Figure 1.* Image of hard copy map depicting habitats of the NBNERR 2003 at 0.15 × original scale.

APPENDIX 1

NBNERR Habitat Classification Scheme

```
1000.  Marine System
       1100.  Subtidal
              1110.  Rock Bottom
                     1111.  Bedrock
                     1112.  Rubble
              1120.  Unconsolidated Bottom
                     1121.  Cobble
                     1122.  Gravel
                     1123.  Sand
                     1124.  Mud
                     1125.  Organic
              1130.  Aquatic Bed
                     1131.  Algal
                     1132.  Rooted Vascular
              1140.  Reef
                     1141.  Coral
                     1142.  Worm
       1200.  Intertidal
              1210.  Aquatic Bed
                     1211.  Algal
                     1212.  Rooted Vascular
              1220.  Reef
                     1221.  Coral
                     1222.  Worm
              1230.  Rocky Shore
                     1231.  Bedrock
                     1232.  Rubble
              1240.  Unconsolidated Shore
                     1241.  Cobble
                     1242.  Gravel
                     1243.  Sand
                     1244.  Mud
                     1245.  Organic
2000.  Estuarine System
       2100.  Subtidal
              2110.  Rock Bottom
                     2111.  Bedrock
                     2112.  Rubble
              2120.  Unconsolidated Bottom
                     2121.  Cobble
                     2122.  Gravel
                     2123.  Sand
                            2123.01 Estuarine Sand Bottom Creek
                            2123.02 Estuarine Sand Bottom Cove
                            2123.03 Estuarine Sand Bottom Pool
                     2124.  Mud
                     2125.  Organic
              2130.  Aquatic Bed
                     2131.  Algal
                     2132.  Rooted Vascular
                     2133.  Floating Vascular
              2140.  Reef
                     2141.  Mollusk
                     2142.  Worm
       2200.  Intertidal
              2210.  Aquatic Bed
                     2211.  Algal
                     2212.  Rooted Vascular
                     2213.  Floating Vascular
              2220.  Reef
                     2221.  Mollusk
                     2222.  Worm
              2230.  Streambed
                     2231.  Cobble
                     2232.  Gravel
                     2233.  Sand
```

```
        2234. Mud
              2234.01 Estuarine Mud Creek Bed
        2325. Organic
    2240. Rocky Shore
        2241. Bedrock
              2241.01 Estuarine Bedrock Shore
        2242. Rubble
              2242.01 Estuarine Rubble Beach
    2250. Unconsolidated Shore
        2251. Cobble
              2251.01 Estuarine Cobble Beach
        2252. Gravel
              2252.01 Estuarine Gravel Beach
        2253. Sand
              2253.01 Estuarine Sand Beach
              2253.02 Estuarine Sand Flat
              2253.03 Estuarine Sand Panne
        2254. Mud
              2254.01 Estuarine Mud Beach
              2254.02 Estuarine Mud Flat
              2254.03 Estuarine Mud Panne
        2255. Organic
              2255.01 Wrack Mat
    2260. Emergent Wetland
        2261. Salt Marsh
              2261.01 Smooth Cordgrass Salt Marsh
              2261.02 Fringe Marsh
              2261.03 Salt Meadow
              2261.04 Stunted Smooth Cordgrass Panne
              2261.05 Glasswort Panne
        2262. Brackish Marsh
              2262.01 Common Reed Brackish Marsh
              2262.02 Cattail Brackish Marsh
              2262.03 Three-square Brackish Marsh
              2263.04 Rose Mallow Brackish Marsh
        2263. Cobble Beach Plant Community
              2263.01 Sea Blight Community
    2270. Shrub Wetland
        2271. BLD
              2271.01 Hightide Bush Shrubland
        2272. BLE
        2273. NLD
        2274. NLE
        2275. Dead
    2280. Forested Wetland
        2281. BLD
        2282. NLD
        2283. BLE
        2284. NLE
        2285. Dead
3000. Riverine System
    3100. Tidal
        3110. Rock Bottom
            3111. Bedrock
            3112. Rubble
        3120. Unconsolidated Bottom
            3121. Cobble
            3122. Gravel
            3123. Sand
            3124. Mud
            3125. Organic
        3130. Aquatic Bed
            3131. Algal
            3132. Rooted Vascular
            3133. Aquatic Bed
            3134. Floating Vascular
```

3140. Streambed
    3141. Bedrock
    3142. Rubble
    3143. Cobble
    3144. Gravel
    3145. Sand
    3146. Mud
    3147. Organic
3150. Rocky Shore
    3151. Bedrock
    3152. Rubble
3160. Unconsolidated Shore
    3161. Cobble
    3162. Gravel
    3163. Sand
    3164. Mud
    3165. Organic
3170. Emergent Wetland
    3171. Nonpersistent
3200. Lower Perennial
3210. Unconsolidated Bottom
    3211. Gravel
    3212. Sand
    3213. Mud
    3214. Organic
3220. Aquatic Bed
    3221. Aquatic Moss
    3222. Rooted Vascular
    3223. Floating Vascular
3230. Rocky Shore
    3231. Bedrock
    3232. Rubble
3240. Unconsolidated Shore
    3241. Cobble
    3242. Gravel
    3243. Sand
    3244. Mud
    3245. Organic
3250. Emergent Wetland
    3251. Nonpersistent
3300. Upper Perennial
3310. Rock Bottom
    3311. Bedrock
    3312. Rubble
3320. Unconsolidated Bottom
    3321. Cobble
    3322. Gravel
    3323. Sand
    3324. Mud
3330. Aquatic Bed
    3331. Algal
    3332. Aquatic Moss
    3333. Rooted Vascular
    3334. Floating Vascular
3340. Rocky Shore
    3341. Bedrock
    3342. Rubble
3350. Unconsolidated Shore
    3351. Cobble
    3352. Gravel
    3353. Sand
    3354. Mud
    3355. Organic
3360. Emergent Wetland
    3361. Nonpersistent
3400. Intermittent

```
3410. Streambed
        3411. Bedrock
        3412. Rubble
        3413. Cobble
        3414. Gravel
        3415. Sand
        3416. Mud
        3417. Organic
4000. Lacustrine System
    4100. Limnetic
        4110. Rock Bottom
                4111. Bedrock
                4112. Rubble
        4120. Unconsolidated bottom
                4121. Cobble
                4122. Gravel
                4123. Sand
                4124. Mud
                4125. Organic
        4130. Aquatic Bed
                4131. Algal
                4132. Aquatic Moss
                4133. Rooted Vascular
                4134. Floating Vascular
    4200. Littoral
        4210. Rock Bottom
                4211. Bedrock
                4212. Rubble
        4220. Unconsolidated Bottom
                4221. Cobble
                4222. Gravel
                4223. Sand
                4224. Mud
                4225. Organic
        4230. Aquatic Bed
                4231. Algal
                4232. Aquatic Moss
                4233. Rooted Vascular
                4234. Floating vascular
        4240. Rocky Shore
                4241. Bedrock
                4242. Rubble
        4250. Unconsolidated Shore
                4251. Cobble
                4252. Gravel
                4253. Sand
                4254. Mud
                4255. Organic
        4260. Emergent Wetland
                4261. Nonpersistent
5000. Palustrine System
    5100. Palustrine Open Water
        5110. Rock Bottom
                5111. Bedrock
                5112. Rubble
        5120. Unconsolidated Bottom
                5121. Cobble
                5122. Gravel
                5123. Sand
                5124. Mud
                5125. Organic
        5130. Aquatic Bed
                5131. Algal
                5132. Aquatic Moss
                5133. Rooted Vascular
                5134. Floating vascular
```

```
        5140.  Emergent Wetland
              5141.  Nonpersistent
    5200.  Terrestrial Wetland
        5210.  Unconsolidated Shore
              5211.  Cobble
              5212.  Gravel
              5213.  Sand
              5214.  Mud
              5215.  Organic
        5220.  Moss-Lichen Wetland
              5221.  Moss
              5222.  Lichen
        5230.  Emergent Wetland
              5231.  Nonpersistent
                     5231.1 Fern Wet Meadow
              5232.  Persistent
                     5232.01 Mixed Species Wet Meadow
                     5232.02 (Emergent Fen)
                     5232.03 Cattail Fresh Marsh
                     5232.04 Common Reed Fresh Marsh
        5240.  Shrub Wetland
              5241.  BLD
                     5241.01 Low BLD Shrub Swamp
                     5241.02 (Shrub Fen)
                     5241.03 (Huckleberry Bog)
                     5241.04 Tall Mixed BLD Shrub Swamp
                     5241.05 Willow Swamp
                     5241.06 Alder Swamp
                     5241.07 BLD Sapling Swamp
              5242.  NLD
              5243.  BLE
                     5243.01 (Leatherleaf Bog)
              5244.  NLE
              5245.  Dead
        5250.  Forested Wetland
              5251.  BLD
                     5251.01 Red Maple Swamp
                     5251.02 Pin Oak Swamp
              5252.  NLD
              5253.  BLE
              5254.  NLE
              5255.  Mixed
              5256.  Dead
6000.  Upland System
    6100.  Upland
        6110.  Barrens and Dunes
              6111.  Bedrock
              6112.  Rubble
              6113.  Cobble
              6114.  Gravel
              6115.  Sand
                     6115.01 Coastal Dune Sparse Grassland
                     6115.02 Coastal Dune Beach Heather Barren
                     6115.03 (Inland Dune)
                     6115.04 Inland Sand Barren
        6120.  Herbaceous Upland
              6121.  Grassland
                     6121.01 Coastal Dune Grassland
                     6121.02 Maritime Grassland
                     6121.03 Switchgrass Grassland
                     6121.04 Little Bluestem Grassland
                     6121.05 Mixed Grassland
              6122.  Broad-leaved Herbs
                     6122.01 Coastal Dune Forbs
                     6122.02 Goldenrod Meadow
                     6122.03 Milkweed Meadow
```

6130. Upland Shrubland
    6131. BLD
        6131.01 Coastal Shrubland
        6131.02 Coastal Sumac Thicket
        6131.03 Coastal Dune Shrubland
        6131.04 Blueberry Shrubland
        6131.05 Bayberry Shrubland
        6131.06 Steeplebush Shrubland
        6141.07 Coastal Greenbrier Shrubland
        6141.08 Greenbrier Shrubland
        6142.09 Blackberry Shrubland
    6132. NLD
    6133. BLE
    6134. NLE
    6135. Dead
6140. Upland Saplings and Scrub
    6141. BLD
        6141.1 Mixed BLD Saplings
    6142. NLD
    6143. BLE
    6144. NLE
        6144.01 Pitch Pine Sapling Shrubland
        6144.02 Pitch Pine Sapling Open Shrubland
    6145. Dead
6150. Forested Upland
    6151. BLD
        6151.01 Oak-Red Maple Forest
        6151.02 Naturalized Maple Stand
        6151.03 Black Locust Woodland
        6151.04 BLD Woodland
    6152. NLD
        6152.01 Larch Forest
    6153. BLE
    6154. NLE
        6154.01 Coastal Eastern Red Cedar Forest
        6154.02 Pitch Pine Forest
        6154.03 Pitch Pine Open Woodland
        6154.04 White Pine Forest
    6155. Mixed
        6155.01 Coastal Black Cherry-Eastern Red Cedar Forest
        6155.02 Pitch Pine-Oak Forest
        6155.03 Oak-Pine Forest
    6156. Dead
7000. Modified System
  7100. Urban or Built Up Land
    7110. Residential
        7111. Low Density
        7112. Medium-low Density
        7113. Medium Density
        7114. Medium-high Density
        7115. High Density
    7120. Commercial
    7130. Industrial
    7140. Transportation, Communications and Utilities
        7141. Roads
            7141.01 Paved Road
            7141.02 Dirt Road
            7141.03 Earthen Bridge
            7141.04 Boat Ramp
        7142. Airport
        7143. Railroad
        7144. Sewage Treatment Facilities
        7145. Waste Disposal
        7146. Power Lines
        7147. Other (Aquatic Use)
            7147.01 Stone Pier

APPENDIX 2

Definitions of Levels and *Habitats* of the NBNERR Classification

<u>DEFINITIONS OF THE SYSTEMS, SUBSYSTEMS, CLASSES AND SUBCLASSES</u>

<u>OF THE NBNERR</u>

*SYSTEMS*

Refer to *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al, 1979) for a description of all systems except for *Upland* and *Modified*.
1. *Upland* System: An upland habitat is any terrestrial habitat that does not meet the definitions of Wetland or Deepwater Habitat according to the definitions in *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al, 1979).
2*. Modified* System: A modified habitat is any habitat that is modified by mechanical or chemical manipulation more than once per growing season, is regularly grazed by livestock, or has been modified to a condition that prohibits natural succession. Refer to Anderson et al (1976) for subsystems, classes and subclasses of modified habitats.

*SUBSYSTEMS*

Refer to *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al, 1979) for a description of all subsystems except for those of the *Modified System*, and those listed below. Refer to Anderson et al (1976) for descriptions of subsystems of the *Modified* system.

1. *Palustrine Open Water* subsystem: Wetland habitats that fit the description of lacustrine littoral wetlands according to Cowardin et al. (1979), but have a total area of ≤ 8 ha (20 acres). These open freshwater habitats that are permanently or semipermanently flooded with at least some portion that is either permanently flooded or directly connected (at least seasonally) to a permanently flooded body of water (such as a semipermanently flooded lagoon adjacent to a lake), and include *Nonpersistent Emergent* habitats contained within the basin, but exclude *Persistent Emergent* habitats and *Unconsolidated Shore* habitats. These are typically shallow ponds.
2. *Palustrine Terrestrial Wetland* subsystem: All freshwater wetland habitats that fit the description of palustrine wetlands according to Cowardin et al. (1979), except for those that are described by the *Palustrine Open Water* subsystem. Typically, these are all persistent wetland habitats, those non-persistent wetland habitats not associated with permanent or semi-permanent water bodies, and *Unconsolidated Shores* adjacent to *Palustrine Open Water* habitats.

*CLASSES*

Refer to *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al, 1979) for a description of all classes except for those in the *Upland* and *Modified* systems, and the following:

1. *Barrens and Dunes* class: Any upland area with <30% cover of vegetation. This may include sparsely vegetated habitats and rocky outcrops.
2. *Herbaceous Upland* class: Upland areas covered with <30% woody vegetation and ≥30% non-woody vegetation.
3. *Shrubland* class: Any upland area fitting the description of the *shrub* class according to Cowardin et al. (1979), but excluding all true trees.
4. *Saplings and Scrub* class: Any upland area covered by ≥30% true trees that are less than 6 m (20 ft) tall, due to immaturity or stunted growth.

Refer to Anderson et al (1976) for descriptions of classes of the *Modified* system.

*SUBCLASSES*

Refer to *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al, 1979) for a description of all subclasses except for those in the *Modified System*, and the following:
1. *Salt Marsh* subclass: A halophytic grassland on alluvial sediments bordering saline water bodies where water fluctuates either tidally or non-tidally (Mitsch and Gosselink 2000), with mean soil-water salinity >18.0 ppt.
2. *Brackish Marsh* subclass: Estuarine emergent wetland occurring along the margins of tidal river or at the upper margin of some high salt marshes where mean soil-water salinity ranges from 0.5-18.0 ppt.
3. *Grassland* and *Broad-leaved Herbs* subclasses are all areas dominated by those respective life forms.
4. *Mixed* subclass: Forested areas with any combination of BLD, NLD, BLE, NLE leaf types where no one type dominates by >75% of total crown cover.

Subclasses of the *Modified* system are defined by RIGIS (2004) as follows:
1. *High Density* subclass: Residential area with >8 dwelling units/acre.
2. *Medium High Density* subclass: Residential area with 4 to 7.9 dwelling units/acre.
3. *Medium Density* subclass: Residential area with 1 to 3.9 dwelling units/acre.
4. *Medium Low Density* subclass: Residential area with.5 to .9 dwelling units/acre.
5. *Low Density* subclass: Residential area with <.5 dwelling units/acre.
6. *Roads* subclass: Roads (wider than 40 ft).
7. *Airports* subclass: Runways, terminals, parking, storage.
8. *Railroads* subclass: Terminals, parking, repair areas.
9. *Water and Sewage* subclass: Treatment facilities land and associated buildings.
10. *Waste Disposal Areas* subclass: Active landfills and junkyards.
11. *Power Lines* subclass: Rights-of-way of 100 feet or more width
12. *Other Transportation* subclass: Water based transportation facilities, commercial docks.
13. *Developed Recreational* subclass: Urban parks, zoos, stadiums, golf courses, playfields, marinas.
14. *Schools* subclass: School buildings and grounds.

15. *Hospitals* subclass: Hospital buildings and grounds.
16. *Government* subclass: Government owned developed land.

APPENDIX 3

*A Natural Community Classification of Rhode Island*
(Enser and Lundgren 2003)

# A Natural Community Classification of Rhode Island

The classification is organized by **Systems**, which refer to complexes of communities that share the influence of similar hydrologic, geomorphologic, chemical, and biological factors. There are six systems in Rhode Island: **Marine, Estuarine, Riverine, Lacustrine, Palustrine**, and **Terrestrial**. These primary categories are subdivided into **Subsystems**. For example, the Marine and Estuarine systems are divided into **Subtidal** and **Intertidal** subsystems. The Palustrine system is divided into **Open Mineral Soil Wetlands, Forested Mineral Soil Wetlands, Open Peatlands**, and **Forested Peatlands**.

The communities identified in each system and subsystem are distinguished by physiognomy (primary growth form of the vegetation), composition of resident organisms, and ecological processes. The names assigned to each community are merely labels that are not intended to identify all of the dominant species or all of the significant features. Communities may be named for a physiographic location (maritime beach); the physiognomy of the vegetation (dwarf shrub bog); or, dominant species (black spruce bog).

The descriptions of each community include dominant species (most abundant or greatest percent cover) and characteristic species (commonly found in the community, although not necessarily abundant). Identified species provide a representative sample and an individual community may not contain all of the species listed in the description. Moreover, the description includes only a very small portion of the total number of species present in the community. Descriptions may also include information on important environmental characteristics (hydrology, substrate, topography, etc.) and disturbance patterns (e.g., periodic flooding, fire). For most communities a generalized distribution in Rhode Island is included.

**Natural Communities of Rhode Island**

I. **Marine System.**  This system consists of open ocean, the associated coastline that is exposed to wind and waves, and shallow saline coastal bays lacking significant freshwater inflow.  The limits extend from mean high water seaward, beyond the limits of rooted vascular vegetation.  Salinity is greater than 18.0 parts per thousand (ppt) ocean-derived salts.

    A. **Marine Subtidal**.  This subsystem includes the area below the lowest tide that is permanently flooded with water.  Salinity levels are fairly constant within a range of 25.0-30.0 ppt.

        1. **Marine Subtidal Community.**  A broadly defined community describing life in the open ocean from the lowest tide level along the shore to the seaward limits of rooted vascular vegetation, or photic zone.  This community includes all substrate types (ranging from rock bottom to unconsolidated bottom).
            Dist:   Open ocean along southern coast, around Block Island, extending into Narragansett Bay.

        2. **Marine Subtidal Aquatic Bed.**  Community of rooted vegetation occurring in quiet waters below the lowest tide level where fluctuations in salinity are minor.  Characteristic plants include eelgrass (*Zostera marina*), sea lettuce (*Ulva lactuca*), and other macroalgae including *Enteromorpha* spp. and *Cladophora*.
            Dist:   In lower Narragansett Bay fringing shore and islands.

    B. **Marine Intertidal**.  This subsystem includes the area between the highest and lowest tide level.  The substrate is periodically exposed and flooded by semidiurnal tides, and salinity levels can fluctuate widely.

        1. **Marine Intertidal Mud flat**.  Quiet water community with a substrate composed of silt or sand rich in organic matter and poorly drained at low tide.  The substrate may be covered with algae.  Characteristic organisms include polychaetes, mudsnail (*Ilyanassa obsoleta*), softshell clam (*Mya arenaria*), and blue mussel (*Mytilus edulis*).  This community is an important feeding area for shorebirds and some areas may be critical as migratory bird concentration areas.
            Dist:   In salt ponds and coves along the seacoast and in Narragansett Bay.

        2. **Marine Intertidal Gravel/Sand Beach.**  Community washed by high-energy waves, with sand and gravel substrates that are well-drained at low tide.  These communities are subject to high fluctuations in salinity and moisture.  It is characterized by benthic invertebrate fauna including polychaetes and amphipods.  This community is an important feeding area for migratory shorebirds, a characteristic species being the sanderling (*Calidris alba*).
            Dist:   Along the seacoast and lower Narragansett Bay.

3. **Marine Intertidal Rocky Shore**.  Community of rocky shores exposed to high-

energy waves.  Organisms include those capable of withstanding wave impact and periodic desiccation, including attached algae, sea mussel (*Mytilus edulis*), sea star (*Asterias* spp.), sea urchin (*Arbacia punctulata*), and rock barnacle (*Balanus balanoides*).  The community is typically species rich with over 60% of the substrate covered with attached organisms.  Characteristic algae are *Ascophyllum nodosum, Fucus* spp., *Enteromorpha* spp., and *Rhizoclonium* spp.
>    Dist:    Islands and shore of lower Narragansett Bay.


II. **Estuarine System**.  This system consists of deepwater tidal habitats and adjacent tidal wetlands that are semi-enclosed by land but have open, partly obstructed, or ephemeral access to open ocean, and in which ocean water is partially diluted by freshwater influx.  This system extends from the upstream limit of tidal influence seaward to an imaginary line closing the mouth of a bay or river.  Salinity is usually <18.0 parts per thousand (ppt) ocean-derived salts.

A. **Estuarine Subtidal**.  This subsystem includes the area below the lowest tide where the substrate is permanently flooded and continuously submerged.

1. **Tidal River**.  The aquatic community of continuously flooded substrates that support no emergent vegetation.  A vertical salinity gradient is found in which the surface layer of fresh water (0.5 ppt) floats over a deeper brackish layer (0.5-18.0 ppt).  Characteristic fish include anadromous species including alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), and shad (*Alosa sapidissima*).
>    Dist:    Rivers within Narragansett Bay region.

2. **Brackish Subtidal Aquatic Bed.**  A community of continuously flooded substrates supporting rooted aquatic vegetation.  Water is generally less than 6.6 ft (2 m) deep at low tide, and salinity ranges between 0.5 - 30.0 ppt.  The characteristic plant of higher salinity beds is eelgrass (*Zostera marina*) with associated macroalgae including the genera *Enteromorpha, Chaetomorpha, Gracilaria, Agardhiella,Ectocarpus*, and *Pilayella*.  Lower salinity beds are characterized by widgeon grass (*Ruppia maritima*), wild celery (*Vallisneria americana*), horned pondweed (*Zannichellia palustris*), sago pondweed (*Potamogeton pectinatus*), clasping-leaved pondweed (*Potamogeton perfoliatus*), and naiads (*Najas* spp.), along with algal forms *Enteromorpha, Cladopora*, and *Chara*.
>    Dist:    Salt ponds along the seacoast in Washington and Newport Counties.

3. **Tidal Creek**.  Aquatic community of a continuously flooded creek that drains

the tidal waters of a coastal salt marsh.  Water is brackish to saline (0.5-30.0 ppt).
Water levels fluctuate with the tides; the creek bottom is permanently flooded,
but the banks are exposed at low tide. Characteristic plants include widgeon grass
(*Ruppia maritima*) and several cyanophyta.  Fiddler crabs (*Uca* spp.) are common
burrowers in the banks.  Typical fish include mummichog (*Fundulus
heteroclitus*), striped killifish (*Fundulus majailis*), and threespine stickleback
(*Gasterosteus aculeatus*).
>    Dist:    Tidal marshes along the seacoast and Narragansett Bay.

4. **Fresh Subtidal Aquatic Bed**.  The aquatic community of continuously flooded
substrates supporting rooted aquatic vegetation.  This community occurs along
rivers and streams at the upper limit of tidal fluctuation where salinity is <0.5 ppt.
A characteristic plant is waterweed (*Elodea* spp.), along with wild celery
(*Vallisneria americana*) and pondweeds (*Potamogeton* spp.).  Coontail
*(Ceratophyllum demersum)* may also be found in this community.
>    Dist:    More information needed.

B. **Estuarine Intertidal.**  This subsystem includes areas between the highest and lowest
tide levels where the substrate is regularly exposed and flooded by semi-diurnal tides.
Some areas are only irregularly exposed as low tide; other areas are only irregularly
flooded at high tide.

1. **Brackish Intertidal Mud Flat**.  A sparsely vegetated community characterized
by low-growing, rosette-forming aquatic plants.  This community occurs on
exposed intertidal mud flats where vegetation is usually submerged only during
highest tides. Water is brackish (0.5-16.0 ppt).  Flats subject to daily flooding and
higher salinity levels may be devoid of macrophytes; characteristic plants of less
frequently flooded and more brackish flats include mudwort (*Limosella
australis*), horned pondweed (*Zannichellia palustris*), and spike rush (*Eleocharis
parvula*).  Other species typical of this community in Connecticut and
Massachusetts that are extirpated from Rhode Island are River-arrowhead
*(Sagittaria subulata)* and Pygmy-weed *(Crassula aquatica).*
>    Dist:    Brackish ponds and edges of tidal marshes along the seacoast and
>             Narragansett Bay.

2. **Low Salt Marsh**.  A coastal marsh community in sheltered areas in a zone
extending from mean high tide down to sea level, or to about 6.6 ft (2 m) below
mean high tide.  This community is regularly flooded by semidiurnal tides and is
usually limited to the edges of tidal creeks and the borders of tidal flats.  The
vegetation is often a monotypic stand of salt marsh cordgrass (*Spartina
alterniflora*) in combination with dense mats of marine algae.  Characteristic
animals include fiddler crabs (*Uca* spp.) and seaside sparrow (*Ammodramus
maritimus*).

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3. **High Salt Marsh**.  A coastal marsh community in sheltered areas in a zone extending from mean high tide up to the limit of spring tidal flooding.  This community is irregularly flooded by spring and flood tides.  High salt marsh vegetation typically consists of a mosaic of patches, each dominated by a single graminoid species, including salt-meadow cordgrass (*Spartina patens*), spike grass (*Distichlis spicata*), and black grass (*Juncus gerardii*).  Other characteristic plants include sea-lavender (*Limmonium carolinianum*), salt marsh aster (*Aster tenuifolius*), seaside gerardia (*Agalinis maritima*) and spearscale (*Atriplex patula*).  The salt marsh snail (*Melampus bidentatus*) is a common animal of this community, and nesting birds include clapper rail (*Rallus longirostris*) and sharp-tailed sparrow (*Ammodramus caudacutus*).
     Dist:   Tidal marshes along the seacoast and Narragansett Bay.

4. **Salt Panne**.  A poorly drained shallow depression within high or low salt marsh communities.  Pannes in low marshes have substrates of soft, silty mud, drain irregularly and are usually unvegetated.  High marsh pannes are occasionally flooded, the ponded water evaporating and raising salinity to extreme levels.  Characteristic plants include dwarf salt marsh cordgrass (*Spartina alterniflora*), glassworts (*Salicornia* spp.), salt marsh plantain (*Plantago maritima* var. *juncoides*), and sea blites (*Suaeda* spp.).  Within pannes, small ponds may form that are permanently inhabited by fish including mummichog (*Fundulus heteroclitus*) and sheepshead minnow (*Cyprinodon variegatus*).
     Dist:   Tidal marshes along the seacoast and Narragansett Bay.

5. **Brackish Marsh**.  A marsh community that occurs where water salinity ranges from 0.5-18.0 ppt, and water levels are <6 ft (2 m).  This community consists of a combination of salt marsh and fresh marsh plants.  Characteristic species include narrowleaf cattail (*Typha angustifolia*), tall reed (*Phragmites australis*), salt marsh fleabane (*Pluchea odorata*), and rose mallow (*Hibiscus moscheutos*).  The robust bulrush (*Scirpus robustus*), cordgrass (Spartina cynosuroides), and a spike rush (*Eleocharis rostellata*) may also be present.  This community occurs in several environmental situations including the edges of tidal rivers, coastal ponds that maintain breachways to the ocean, and small barrier beach ponds that do not maintain permanent breachways, but exhibit higher salinity levels due to salt spray and occasional overwash.  Additional study is needed to distinguish these types. This community provides nesting habitat for several marsh birds including least bittern (*Ixobrychus exilis*), Virginia rail (*Rallus limicola*), sora (*Porzana carolina*), and marsh wren (*Cistothorus palustris*).
        Dist:   Coastal ponds and tidal rivers along the seacoast and
                Narragansett Bay.

6. **Salt Shrub**.  A shrubland community that develops at the ecotone of salt marsh and upland where the elevation is somewhat higher than the adjacent salt marsh community, and salinity levels are lower.  Characteristic shrubs are salt marsh elder (*Iva frutescens*), groundsel-tree (*Baccharis halimifolia*), and pasture rose (*Rosacarolina*), with salt meadow cordgrass (*Spartina patens*) and switchgrass (*Panicum virgatum*) in the herbaceous understory.  This community usually occurs as a linear feature along the upper edge of salt marshes, or as shrub islands on higher elevations within large marshes.

      Dist:   Tidal marshes along the seacoast and Narragansett Bay.

7. **Freshwater Tidal Marsh**.  A marsh community occurring at the upper limits of tidal flow along streams and rivers.  Salinity levels are <0.5 ppt and water levels are < 6.6 ft (2 m).  This community forms a transition between brackish marsh and nontidal fresh marsh and includes a combination of species typical of both, including narrow-leaved cattail (T*ypha angustifolia*), bulrushes (*Scirpus robustus, S. pungens*, and *S. validus*), pickerelweed (*Pontedaria cordata*), arrowweed (*Sagittaria latifolia*), spatterdock (*Nuphar variegatum*), saltmarsh hemp (*Amaranthus cannabinus*) and water-parsnip (*Sium suave*).  In addition, several indicator species are found exclusively in these restricted habitats, most notable being wild rice (*Zizania aquatica*).

      Dist:   Very rare community type in Rhode Island; best remaining example is Mill Creek system, Warwick.

III. **Riverine System**.  The riverine system consists of the aquatic communities of flowing, non-tidal waters where salinity is <.05 ppt.  This system is composed largely of deepwater habitats (>6.6 ft) where persistent emergent vegetation is generally lacking, but small areas of submerged or floating-leaved aquatic plants can occur locally.  These communities are generally restricted to shallow bottoms and aquatic beds in river channels.

A. **Upper Perennial Stream/River**.  Upper perennial streams have relatively steep gradients with well-defined riffles and pools.  Water flow is constant, fast, and turbulent, and the normal water temperature is cold.  Streambeds are narrow, shallow, and there is little floodplain development.  Bottom substrates are composed of bedrock, boulder, stone, cobble, and occasional patches of sand.  Characteristic fish include brook trout (*Salvelinus fontinalis*), longnose dace (*Rhinichthys cataractae*), blacknose dace (*R. corporalis*), and johnny darter (*Etheostoma nigrum*).  Smaller streams may harbor amphibians including two-lined salamander (*Eurycea bislineata*) and dusky salamander (*Desmognathus fuscus*).  Aquatic macrophytes are limited, but mosses and periphytic algae are often present.

      Dist:   Throughout state.

B. **Lower Perennial Stream/River**.  Lower perennial streams have relatively low gradients and poorly defined pools and riffles.  Water flow is constant but sluggish, and

water temperature fluctuates widely.  Streambeds are wide and there is usually a well-developed floodplain.  Substrates are composed of finer sands and silts.  Characteristic fish include yellow perch (*Perca flavescens*), pumpkinseed (*Lepomis gibbosus*), and chain pickerel (*Esox niger*).  Typical aquatic macrophytes include waterweed (*Elodea canadensis*) and linear-leaved pondweeds, such as sago pondweed (*Potamogeton pectinatus*).

> Dist:    Larger streams/rivers in state, generally lacking in Bristol and Newport counties, and Block Island.

C. **Intermittent Stream**.  Channels of intermittent streams contain flowing water for only part of the year.  When not actively flowing, water may be retained in isolated pools, or surface water may be absent.  Faunal representatives include amphibians and invertebrates that may inhabit the streambed only when water is flowing.  Intermittent streams are widely distributed throughout the Rhode Island landscape, but more inventory is needed to distinguish the plant and animal assemblages unique to this community.

> Dist:    Throughout Rhode Island.

IV. **Lacustrine System**.  The lacustrine system consists of waters situated in topographic depressions or dammed river channels.  Persistent emergent vegetation is lacking, but areas with submerged or floating-leaved aquatic plants may occur locally.  The communities within this system are distinguished by trophic state, annual cycles of thermal stratification, morphometry (size and shape), and water chemistry.

A. **Oligotrophic Lake**.  The aquatic community of a relatively nutrient-poor lake.  These lakes are dimictic - having two periods of mixing or turnover (spring and fall); they are thermally stratified in summer, and they freeze over and become thermally stratified in winter.  Waters are moderately clear with medium transparency (Secchi disk depths of 2-4 m), and are moderately well-oxygenated.  Lake sediments have low - moderate amounts of organic matter.  Characteristic fishes include yellow perch (*Perca flavescens*), smallmouth bass (*Micropterus dolomieui*), Eastern banded sunfish (*Enneacanthus obesus*), bluegill (*Lepomis macrochirus*), and pumpkinseed (*Lepomis gibbosus*).  Pondweeds (*Potamogeton* spp.) are the most common submerged macrophytes.  True oligotrophic lakes of northern New England are likely not represented in Rhode Island, with the closest examples probably being mesotrophic lakes (i.e., intermediate between oligotrophic and eutrophic).

> Dist:    Wallum Lake, Burrillville.

B. **Oligotrophic Pond**.  The aquatic community of a shallow, nutrient-poor pond.  Water is very clear and the bottom is usually sandy or rocky.  These ponds are too shallow to become stratified in the summer; they are winter-stratified, monomictic ponds.  Aquatic vegetation is sparse and species diversity is low.  Characteristic floating-leaved plants include water-shield (*Brasenia shreberi*) and water-lily (*Nymphaea odorata*), and

submerged species include bladderworts (*Utricularia* spp.), pondweeds (*Potamogeton* spp.), and water milfoil (*Myriophyllum* spp.).  In shallower waters, rosette-leaved aquatics may be found including pipewort (*Eriocaulon aquaticum*), water lobelia (*Lobelia dortmanna*) and quillwort (*Isoetes* spp.).  Fish populations are either warm-water or cold-water species, depending on summer temperatures.

    C. **Eutrophic Pond**.  The aquatic community of shallow, nutrient-rich ponds.  These ponds are too shallow to become stratified in the summer; they are winter-stratified monomictic ponds.  Water clarity is usually reduced due to accumulations of algae, and bottom substrates are usually mucky.  Aquatic vegetation is abundant with characteristic submersed species including coontail (*Ceratophyllum demersum*), waterweed (*Elodea canadensis*), duckweed (*Lemna* spp.), and pondweeds (*Potamogeton* spp.).  Fish populations are comprised of warm-water species.

V. **Palustrine System**.  The palustrine system includes all non-tidal perennial wetlands characterized by emergent vegetation.  It includes wetlands permanently saturated by seepage, permanently flooded wetlands, and those seasonally or intermittently flooded (these may be seasonally dry).  Vegetative cover is dominated by hydrophytes and the soil types are hydric.  Wetland communities are generally distinguished by their composition, substrate, and hydrologic regime; however, the boundaries between wetlands are not often discrete and several types may occur together in a complex mosaic.

    A. **Open Mineral Soil Wetlands.**  This subsystem includes wetlands with <50% canopy cover of trees; many have no trees.  Dominant vegetation can include shrubs or herbs.  Substrates range from mineral soils or bedrock to well-decomposed organic soils (muck).  Fluctuating water levels allow aeration of the substrate and promote plant litter decomposition, reducing peat accumulation.

        1. **Riverside Sand/Garvel Bar**.  A community that occurs on sand and gravel bars deposited within a river channel.  The community may be sparsely vegetated, depending on rates of deposition and erosion of sand and gravel, and degree of exposure during the growing season.  Characteristic plants include smartweeds (*Polygonum hydropiperoides* and *P. punctatum*), water-starwort (*Callitriche heterophylla*), water-purslane (*Ludwigia palustris*), false pimpernel (*Lindernia dubia*), burreed (*Sparganium chlorocarpon*), and watercress (*Nasturtium officinale*).  Plant species composition differs between upper and lower segments of perennial streams, however more inventory is needed to distinguish these types.  Tiger beetles (*Cicindela* spp.) are also often present on larger bars.

        2. **Coastal Plain Pondshore**.  The gently sloping sandy/gravelly shores of ponds in morainal kettle holes and depressions in glacial outwash plains within the coastal region.  Representative floras include a high percentage of species typical of the Atlantic Coastal Plain.  Two variants are recognized based on the degree of

water level fluctuation.

a. **Seasonally Flooded Coastal Plain Pond**.  Vegetated shores of basin ponds that do not receive above ground inflow.  Water levels fluctuate widely in response to water table change, and pond shores and bottoms may be exposed during the growing season.  In such cases plants germinate from seeds banked in pond substrates producing vigorous populations that develop as concentric zones of vegetation, from shallow open water to upland shrub borders, each with a distinctive assemblage of species.  Characteristic plants include pipewort (*Eriocaulon aquaticum*), golden-pert (*Gratiola aurea*), umbrella-sedge (*Cyperus dentatus*), narrow-leaved goldenrod (*Euthamia tenuifolia*), rush (*Juncus pelocarpus*), and meadow beauty (*Rhexia virginica*).  Notable rare species include rose coreopsis (*Coreopsis rosea*), narrow-leaved arrowhead (*Sagittaria teres*), New England boneset (*Eupatorium leucolepis* var. *novae-angliae*), horned rush (*Rhynchospora macrostachya*), nutrush (*Scleria reticularis*), bald-rush (*Rhychospora scirpoides*), umbrella grass (*Fuirena pumila*), rattlebox (*Crotalaria sagittalis*) and tiny-flowered sedge (*Hemicarpha micrantha*).
Dist:    Matunuck Hills, S. Kingstown and other isolated examples.

b. **Permanently Flooded Coastal Plain Pond.**  Vegetated shores of ponds that maintain relatively constant water levels from perennial stream inflow or recharge from bordering wetlands.  Permanent emergent plant communities develop in the littoral zone in water depths of 0-3.3 ft (1 m).  Characteristic plants include threesquare (*Scirpus pungens*), bayonnet rush (*Juncus militaris*), water lobelia (*Lobelia dortmanna*), pennywort (*Hydrocotyle umbellata*), and yellow-eyed grass (*Xyris difformis*).  Rare species include untuberculated rush (*Scirpus etuberculatus*), creeping St. John's-wort (*Hypericum adpressum*), Plymouth gentian (*Sabatia kennedyana*), redroot (*Lachnanthes caroliniana*), and false loosestrife (*Ludwigia sphaerocarpa*).
Dist:    Tucker Pond and Worden Pond, S. Kingstown and other isolated examples.

3. **Semipermanently Flooded (Deep) Emergent Marsh**.  Marsh community on mineral soils with water depths ranging from 6 in. to 6.6 ft (15 cm to 2 m).  Water levels may fluctuate seasonally but the substrate is rarely dry.  May occur as fringe marshes along rivers, pond margins, or in basins.  Characteristic vegetation

is composed of emergent aquatics including cattails (*Typha latifolia* and *T. angustifolia*), bayonnet rush (*Juncus militaris*), spatterdock (*Nuphar luteum*), water lily (*Nymphaea odorata*), pickerelweed (*Pontedaria cordata*), arrow arum

(*Peltandra virginica*), and burreed (*Sparganium* spp.).  Species composition of each community is highly variable depending on hydrologic regime, topographic position, and substrate.

> Dist: Throughout Rhode Island.

4. **Seasonally Flooded (Shallow) Emergent Marsh**.  Marsh community on mineral or muck soils that are permanently saturated and seasonally flooded. Water depths range from 6 in. to 3.3 ft (15 cm to 1 m) during flood stages, but levels usually drop in mid to late summer exposing the substrate.  Dominant plants include rice cutgrass (*Leersia oryzoides*), cattails (*Typha* spp.), soft rush (*Juncus effusus*), Canada rush (*Juncus canadensis*), reed canary grass (*Phalaris arundinacea*), bluejoint (*Calamagrostis canadensis*), arrow arum (*Peltandra cordata*), manna grass (*Glyceria canadensis*), wool grass (*Scirpus cyperinus*), three-way sedge (*Dulichium arundinaceum*), tussock sedge (*Carex stricta*), and wild iris (*Iris versicolor*).

> Dist: Throughout Rhode Island.

5. **Scrub/Shrub Wetland**.  Wetland communities dominated by shrubs 0.5-5 m tall that occur along the margin of a pond or river, isolated in a wet depression or valley, or as a transition community between a marsh and a terrestrial community. The substrate is usually mineral soil or muck.  This type is  highly variable with the dominant shrub species dictated by local conditions, including water depth, topographic position, and microclimate.  At wetter sites buttonbush (*Cephalanthus occidentalis*) or water willow (*Decodon verticillatus*) may dominate with over 90% cover.  Sites not permanently flooded may support a mix of shrubs with characteristic species including highbush blueberry (*Vaccinium corymbosum*), sweet pepperbush (*Clethra alnifolia*), winterberry (*Ilex verticillata*), alders (*Alnus rugosa* and *serrulata*), silky dogwood (*Cornus amomum*), maleberry (*Lyonia ligustrina*), spicebush (*Lindera benzoin*), meadow-sweet (*Spiraea latifolia*), steeplebush (*Spiraea tomentosa*), and swamp azalea (*Rhododendron viscosum*).  When present, trees form an emergent canopy of < 26% cover.  Examples of more common types, based on the dominant species, include:

> a. Buttonbush *(Cephalanthus occidentalis)*
> b. Water willow *(Decodon verticillatus)*
> c. Shrub-carr.  Occurs along margins of ponds and marshes on muck soils, dominated by red-osier dogwood (*Cornus stolonifera*) and willows (*Salix bebbiana, S. discolor*, etc.).
> d. Alder (*Alnus* spp.) thicket

   B. **Open Peatlands**.  This subsystem includes wetlands with <50% canopy cover of trees,

the dominant vegetation being shrubs, herbs, and mosses.  Substrates consist of accumulated organic deposits consisting of coarse fibrous or woody peat, or mucks. Permanent saturation reduces aeration of the substrate, thereby slowing decomposition of plant litter and allowing accumulation of peat.

1. **Acidic Level Fen**.  A weakly minerotrophic peatland fed by groundwater containing minerals obtained during passage through or over mineral soils or aquifers.  The substrate is peat composed primarily of *Sphagnum*.  Three variations are recognized based on plant species composition.

a. **Inland Fen**.   Characterized by sedges (*Carex lasiocarpa* and *exilis*), twig-rush (*Cladium mariscoides*), white beakrush (*Rhynchospora alba*), cottongrass (*Eriophorum virginicum*), round-leaved sundew (*Drosera rotundifolia*), pitcher plant (*Sarracenia purpurea*), rose pogonia (*Pogonia ophioglossoides*), and grass pink (*Calopogon tuberosus*).
Dist:   Rare community type, several examples in Washington County.

b. **Coastal Plain Fen.**   Includes species listed above along with rarer representatives of the southern coastal plain including Walter's sedge (*Carex walteriana*), Long's bulrush (*Scirpus longii*), and dwarf huckleberry (*Gaylussacia dumosa* var. *bigeloviana*).   In both varieties, dwarf shrubs are usually <50% cover and include cranberry (*Vaccinium macrocarpon*), sweet gale (*Myrica gale*), and leatherleaf (*Cassandra calyculata*).  Scattered saplings of white cedar (*Chamaecyparis thyoides*) and red maple (*Acer rubrum*) may be present.
Dist:   One Rhode Island representative in Great Swamp, South Kingstown.

c. **Sea Level Fen.**   A rare community type that develops in the upper border of tidal marshes receiving fresh groundwater seepage.  The best Rhode Island example is found on the inland side of a coastal salt pond that receives freshwater percolating from the adjacent moraine. Characteristic species include twig-rush (*Cladium mariscoides*) and threesquare *(Scirpus pungens)*.
Dist:   Two Rhode Island examples known in Westerly and Narragansett.

2. **Dwarf Shrub Bog**.  An ombrotrophic peatland usually occurring in a basin fed directly by rainfall, with little or no groundwater influence.  Water is nutrient-poor and acidic.  This type is dominated by *Sphagnum* and >50% cover of shrubs <1 m tall, the principal species being leatherleaf (*Chamaedaphne calyculata*). Other shrubs may include sheep laurel (*Kalmia angustifolia*), highbush blueberry (*Vaccinium corymbosum*), cranberry (*Vaccinium macrocarpon*), black

huckleberry (*Gaylussacia baccata*), and dwarf huckleberry (*G. dumosa* var. *bigeloviana*).  Herbs include pitcher plant (*Sarracenia purpurea*), round-leaved sundew (*Drosera rotundifolia*), rose pogonia (*Pogonia ophioglossoides*), cotton grasses (*Eriophorum* spp.), and white beak-rush (*Rhynchospora alba*).  Scattered saplings of white cedar (*Chamaecyparis thyoides*) and red maple (*Acer rubrum*) may be present.  Rare plants are represented by species of northern affinities, including pod-grass (*Scheuchzeria palustris*), pale laurel (*Kalmia polifolia*), and bog rosemary (*Andromeda glaucophylla*).

     Dist:    Throughout Rhode Island.

3. **Black Spruce Bog**.  An ombrotrophic peatland occurring in a basin fed directly by rainfall with little groundwater influence, or as floating islands in man made reservoirs.  The dominant woody plant is black spruce (*Picea mariana*) with most individuals <5 m tall.  A well-developed shrub layer is characterized by leatherleaf (*Chamaedaphne calyculata*) and rhodora (*Rhododendron canadense*), and herbaceous plants generally include species listed for dwarf shrub bog.

     Dist:    Rare community type, several examples in Providence County.

4. **Atlantic White Cedar Bog**.  An ombrotrophic peatland occurring in a basin. The dominant woody plant is Atlantic white cedar (*Chamaecyparis thyoides*) with all individuals growing in a dwarfed form <2 m tall and 10 cm dbh.  Associated shrubs include dwarf huckleberry (*Gaylussacia dumosa* var. *bigeloviana*) leatherleaf (*Chamaedaphne calyculata*) and small cranberry (*Vaccinium oxycoccus*), and predominant herbs include cotton-grass (*Eriophorum* spp.), white beak-rush (*Rhynchospora alba*), yellow-eyed grass (*Xyris torta*), pitcher plant (*Sarracenia purpurea*), and horned bladderwort (*Utricularia cornuta*). . (See related type: Forested peatland - *Chamaecyparis thyoides/Chamaedaphne calyculata* Woodland).

     Dist:    This community is represented by one Rhode Island example at Factory Pond, S. Kingstown.

5. **Coastal Plain Quagmire**.  Community of shallow depressions on permanently flooded muck soils with water depths 16 cm to 0.6 m.  Deeper water sections may be devoid of emergent vegetation, but shallow sections may support dense patches of emergent plants.  Characteristic species include twig rush (*Cladium mariscoides*), white beak-rush (*Rhynchospora alba*), drowned beak-rush (*R. inundata*), yellow-eyed grass (*Xyris smalliana*), horsetail spikerush (*Eleocharis equisetoides*), water lily (*Nymphaea odorata*), threesquare (*Scirpus pungens*), and Canada rush (*Juncus canadensis*).

     Dist:    A rare community type with best examples in Washington County (Grass Pond, Richmond; Phantom Bog and Shumunkanuc Bog, Hopkinton).

**C. Forested Mineral Soil Wetlands.**  This subsystem includes seasonally flooded forests

and permanently flooded or saturated swamps on mineral soils and well-decomposed mucks.  These wetlands are dominated by a >50% canopy cover of woody vegetation, 20+ ft. in height.

1. **Floodplain Forest.**  Hardwood forest on mineral soils on low terraces of river floodplains.  Sites are characterized by a flooding regime in which low areas are flooded annually, usually in the spring; higher areas are flooded irregularly.  Some sites are dry by late summer.  A broadly defined community, floodplain forests are variable based on frequency and duration of flooding, size of river, etc.  Two general variants are identified geographically.

a. **Maple - Sycamore Floodplain Forest.**  Typical of floodplains along major rivers in northern part of state.  Trees include silver maple (*Acer saccharinum*), red maple (*A. rubrum*), box elder (*A. negundo*), sycamore (*Platanus occidentalis*), cottonwood (*Populus deltoides*), and green ash (*Fraxinus pensylvanica*).
> Dist:  Blackstone River, and other sites in Providence County.

b. **Red Maple - Pin Oak Floodplain Forest.**  Typical of floodplains in the

lower Pawcatuck River system.  Dominant trees include red maple (*Acer rubrum*), pin oak (*Quercus palustris*), and green ash (*Fraxinus pensylvanica*).
> Dist:  Lower Pawcatuck River, Washington County.

2. **Red Maple Swamp**.  A deciduous forested wetland that occurs in poorly drained depressions, usually on mineral soils.  This community is broadly defined with many variants described throughout the state.  Red maple (*Acer rubrum*) is either the only canopy dominant, or may be is a codominant with one or more of other trees including black gum (*Nyssa sylvatica*), white pine (*Pinus strobus*), Atlantic white cedar (*Chamaecyparis thyoides*), and hemlock (*Tsuga canadensis*).  Recognized communities based on understory vegetation include the following:

a. *Acer rubrum* - **Deciduous Shrub Swamp**.  Overstory dominated by red maple (*Acer rubrum*) with an understory of mixed deciduous shrubs including highbush blueberry (*Vaccinium corymbosum*), spicebush (*Lindera benzoin*), sweet pepperbush (*Clethra alnifolia*), winterberry (*Ilex verticillata*), elderberry (*Sambucus canadensis*), and swamp azalea (*Rhododendron viscosum*).  Herbs include skunk cabbage (*Symplocarpus foetidus*), cinnamon fern (*Osmunda cinnamomea*), and Turk's-cap lily (*Lilium superbum*).

Dist:  Throughout Rhode Island.

b. *Acer rubrum* **- Rhododendron Swamp**.  Overstory dominated by red maple (*Acer rubrum*) with Atlantic white cedar (*Chamaecyparis thyoides*) usually present.  Understory dominated by Great Laurel (*Rhododendron maximum*) with lesser representation by sweet pepperbush (*Clethra alnifolia*) and swamp azalea (*Rhododendron viscosum*).  Herbs are sparse, with most common species being skunk cabbage (*Symplocarpus foetidus*), Jack-in-the-pulpit (*Arisaema triphyllum*), and cinnamon fern (*Osmunda cinnamomea*).

Dist:  Washington County, north of Charlestown recessional moraine.

3. **Hemlock-hardwood Swamp**.  A mixed coniferous/deciduous swamp occurring on mineral soils in depressions receiving groudwater discharge.  Characterized by a closed canopy (70-100% cover), sparse shrub layer, and low species diversity. Canopy is dominated by hemlock (*Tsuga canadensis*), with lesser representation by yellow birch (*Betula alleghaniensis*) and red maple (*Acer rubrum*).  The mostcommon shrub is highbush blueberry (*Vaccinium corymbosum*).  Characteristic herbs include cinnamon fern (*Osmunda cinnamomea*) and sensitive fern (*Onocleasensibilis*).  Water levels fluctuate seasonally.

Dist:    Throughout Rhode Island.

4. **Vernal Pools**.  A wetland in a small, shallow depression within an upland forest.  These pools are usually flooded in the spring or after heavy rainfall, and usually dry during summer.  Some are filled again in autumn.  This community includes invertebrates and amphibians that depend on temporary pools as breeding areas, since these pools do not support fish populations that would prey on eggs or larvae.  Characteristic obligate amphibians include wood frog (*Rana sylvatica*), mole salamanders (*Ambystoma* spp.), and spadefoot *(Scaphiopus holbrookii*), and other species may include green frog (*Rana clamitans*), spring peeper (*Pseudacris crucifer*), and American toad (*Bufo americanus*).  Fairy shrimp (*Eubranchipus* spp.) are characteristic invertebrates, but more data is needed on other invertebrates and characteristic plants.

Dist:    Throughout Rhode Island.

D. **Forested Peatlands**.  This subsystem includes peatlands with >50% canopy cover of trees.  Substrates range from coarse woody or fibrous peat to organic mucks.

1. **Atlantic White Cedar Swamp**.  An evergreen or mixed swamp occurring on organic soils in poorly drained depressions, occasionally along streams.  Atlantic white cedar (*Chamaecyparis thyoides*) comprises >50% of the canopy cover; in mixed stands, red maple (*Acer rubrum*) is the codominant.  A characteristic

invertebrate is Hessel's Hairstreak butterfly (*Mitoura hesseli*), an obligate *Chamaecyparis* feeder.   Recognized community variants include the following:

### a. *Chamaecyparis thyoides/Rhododendron maximum*
Shrub layer dominated by Great Laurel (*Rhododendron maximum*).  Tree canopy is dominated by white cedar, with lesser associates including red maple, yellow birch (*Betula alleghaniensis*), hemlock (*Tsuga canadensis*), and black gum (*Nyssa sylvatica*).  Herbaceous layer depauperate beneath a closed canopy, with mosses (primarily *Sphagnum*) predominant.  Sites supporting this type are seasonally saturated and have potential for considerable water level fluctuation.  Basin swamps overlying stratified drift, glacio-lacustrine deposits, and till with low pH, and a high level of organic decomposition.
     Dist:   Washington County.

### b. *Chamaecyparis thyoides - Acer rubrum - Betula alleghaniensis*
Mixed association of evergreen/deciduous trees with white cedar predominating, but canopy always includes significant amounts of red maple, yellow birch, or hemlock.  White pine (*Pinus strobus*) may also be present.  Shrub layer is diverse with winterberry (*Ilex verticillata*) well represented with sweet pepperbush (*Clethra alnifolia*) and highbush blueberry (*Vaccinium corymbosum*).  Other sporadically occurring shrubs include maleberry (*Lyonia ligustrina*), mountain laurel (*Kalmia latifolia*), smooth winterberry (*Ilex laevigata*), and fetterbush (*Leucothoe racemosa*).  Herbaceous layer variable depending on canopy composition, typical species including cinnamon fern (*Osmunda cinnamomea*), wintergreen (*Gaultheria procumbens*), starflower (*Trientalis borealis*), goldthread (*Coptis groenlandica*), mayflower (*Maianthemum canadense*), sedge (*Carex trisperma*), marsh fern (*Thelypteris palustris*), and skunk cabbage (*Symplocarpus foetidus*).  Habitat variable, typical sites are seasonally saturated basin swamps and seasonally flooded streamsides.
     Dist:   Throughout Rhode Island.

### c. *Chamaecyparis thyoides/Rhododendron viscosum*
Canopy dominated by white cedar with red maple and yellow birch infrequent and sporadic.  Shrub layer primarily swamp azalea (*Rhododendron viscosum*) with mountain holly (*Nemopanthus mucronata*) and highbush blueberry (*Vaccinium corymbosum*).  Other low shrubs may include sweet pepperbush (*Clethra alnifolia*) and dangleberry (*Gaylussacia frondosa*), but winterberry (*Ilex verticillata*) is poorly represented.  Common in the herb layer are starflower (*Trientalis borealis*) and several sedges (*Carex trisperma, C. stricta,* and *C. folliculata*).  Sites supporting this community occur in semipermanently to seasonally flooded streamside or lakeshore habitats where water levels

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remain high into the growing season and fluctuation is lessened.  Organic decomposition is low in wetter sites.


      d. ***Chamaecyparis thyoides/Chamaedaphne calyculata* Woodland**
Open canopy of Atlantic white cedar with a dense understory composed of leatherleaf (*Chamaedaphne calyculata*) or water willow (*Decodon verticillatus*).  Other shrubs may include sweet pepperbush (*Clethra alnifolia*), ighbush blueberry (*Vaccinium corymbosum*), and swamp azalea (*Rhododendron viscosum*).  Sphagnum comprises a nearly continuous ground cover layer with frequently occurring associates including cranberry (*Vaccinium macrocarpon*), sundews (*Drosera rotundifolia* and *D. intermedia*), and pitcher-plant (*Sarracenia purpurea*).  Sites sustaining this type occur in saturated conditions in bog or bog-like situations, with low organic decomposition and low pH.

2. **Black Spruce Bog**.  A conifer swamp of acidic peatlands in cool, poorly-drained depressions.  The dominant tree ( >5 ft tall) is black spruce (*Picea mariana*).  A well-developed shrub layer is characterized by leatherleaf (*Chamaedaphne calyculata*) and rhodora (*Rhododendron canadense*).  (This community differs from the Black Spruce bog under the "Open Peatland" category by the height and density of trees.)  A widespread type of northern New England, this community is represented by only one example in Rhode Island.
      Dist.  Limited to Washington County.


VI. **Terrestrial System**.  This system consists of upland communities, forested and non-forested, which have well-drained soils that are xeric to mesic (never hydric), and a vegetative cover that is never dominated by hydrophytes, even if the soil surface is seasonally flooded or saturated.

A. **Open Uplands**.  This subsystem includes terrestrial communities with less <25% canopy cover of trees.  Dominant plants are shrubs, herbs, mosses and/or lichens.

1. **Maritime Beach**.  A sparsely-vegetated community that occurs on unstable sand, gravel, or cobble beaches above mean high tide, where the shore is modified by storm waves and wind erosion.  Vegetation may be scarce and ephemeral due to the instability of substrates.  Characteristic plants include sea-rocket (*Cakile edentula*), atriplex Atriplex patula), seabeach sandwort (*Honkenya peploides* var. *robusta*), salsola (*Salsola kali*), and seabeach knotweed (*Polygonum glaucum*).  Tiger beetles (*Cincindela* spp.) are notable invertebrate residents.
      Dist.  This community occurs on unstable sands, gravels, and stones of barrier beaches along the south shore, Narragansett Bay, and Block Island.

2. **Maritime Dune**.  A community dominated by grasses and low shrubs on sand dunes inland of and adjacent to maritime beaches.  Vegetation occurs in patches resulting from past disturbances such as erosion, sand deposition, and dune migration.  The composition and structure of the vegetation is dependent on dune stability, degree of deposition and erosion, and distance from the ocean.

>a. **Beach Grass - Primary Dune Association**.  The active portions of primary dunes where sand shifting is the greatest.  Along with beach grass (*Ammophila breviligulata*), characteristic species include dusty-miller (*Artemisia stellariana*), beach-pea (*Lathyrus japonicus*), seaside goldenrod (*Solidago sempervirens*), and sand rose (*Rosa rugosa*).

>b. **Beach Heather - Secondary Dune Association**.  The more stabilized portions of primary and secondary dunes where sand shifting is reduced.  Open substrates with herbaceous cover.  Characteristic species include beach heather (*Hudsonia tomentosa*), jointweed (*Polygonella articulata*), and beach pinweed (*Lechea maritima*).

>c. **Dune Shrubland**.  Association dominated by medium height woody vegetation in the protected areas of sandy maritime backdunes.  Vegetation includes bayberry (*Myrica pensylvanica*), beach-plum (*Prunus maritima*), and poison ivy (*Toxicodendron radicans*).

3. **Maritime Shrubland**.  A community dominated by woody shrubs that occurs on dry seaside bluffs and headlands exposed to ocean winds and salt spray.  This community is generally low in species diversity, tending to be dominated by a few species of shrubs and scattered small trees.  Characteristic shrubs are bayberry (*Myrica pensylvanica*), sand rose (*Rosa rugosa*), beach plum (*Prunus maritima*), and wild rose (*Rosa virginiana*).  Further inland, where maritime climatic influences are reduced, additional species may include shadbush (*Amelanchier* spp.), arrowwood (*Viburnum dentatum*), poison ivy (*Toxicodendron radicans*), eastern red cedar (*Juniperus virginiana*), and highbush blueberry (*Vaccinium corymbosum*).

>Dist:    Newport and Washington Counties, including Block Island.

4. **Maritime Grassland**.  A sparsely vegetated community on rolling morainal topography of Block Island, generally on areas exposed to periodic maritime wind and salt spray.  Community is dominated by grasses and forbs and is generally found on upper slopes and crests of hills.  Examples are relatively small in area (<1 acre) and tend to be surrounded on downslope sides by the maritime shrubland community type.  Characteristic species include field goldenrods (*Euthamia graminifolia* and *E. tenuifolia*), bitter milkwort (*Polygala polygama*), white-topped Aster (*Aster paternus*), rush (*Juncus greenei*), and several species of grasses, and several rare species including bushy rockrose (*Helianthemum*

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*dumosum*), northern blazing-star (*Liatris scariosa* var. *novae-angliae*), Maryland golden aster (*Chrysopsis mariana*), and purple three awn (*Aristida purpurescens*). [Note: This community type should not be confused with the large acreage grasslands and hayfields on Block Island that are artificially maintained, and tend to be dominated by exotic plants, such as veltvetgrass (*Holcus lanatus*) and sweet vernal grass (*Anthoxanthum odoratum*).]

        Dist:    Block Island

5. **Maritime Cliff Community**.  A community on exposed bedrock outcrops on the shore, receiving direct influence of maritime climate, including salt spray. Plant communities are patchy in areas where freshwater seepage emerges near the crest of cliffs and trickles down following crevices.  Characteristic plants include threesquare rush (*Scirpus americanus*), pearlwort (*Sagina procumbens*), rush (*Juncus marginatus*), and seaside plantain (*Plantago maritima* var. *juncoides*). The exotic scarlet pimpernel (*Anagallis arvensis*) is also commonly found in this community.

        Dist:    Along the rocky shore of Washington and Newport Counties.

6. **Maritime Bluff Community**.  A community on exposed clay and glacial till substrates of bluffs along the immediate coast of Block Island, receiving direct maritime influence including salt spray.  Plant communities are most diverse at sites of freshwater seepage.  Representative plants include common horsetail (*Equisetum arvense*) and atriplex (*Atriplex patula*).  The clay banks tiger beetle (*Cicindela limbalis*) is a characteristic animal of this community.

        Dist:    Block Island

7. **Inland Dune/Sand Barren**.  Sparsely vegetated community on shifting sands within pitch pine forest/woodland types, generally occurring as patches of <2 acres.  Vegetation is patchy, usually on <75% of surface area, consisting of lichens (especially *Cladonia* spp.), heather (*Hudsonia tomentosa*), little bluestem (*Schizachyrium scoparius*), umbrella sedge (*Cyperus filiculmis*), and sand jointweed (*Polygonella articulata*).  The sand star fungus (*Geaster hygrometricus*) is typically present.  Characteristic insects include tiger beetles (*Cicindela* spp.) and parasitic wasps.

        Dist:    Away from the coast in Washington and Kent Counties.

B. **Barrens and Woodlands**.  This subsystem includes upland communities structurally intermediate between forests and open uplands.  Woodlands exhibit a sparse canopy (25-60% cover), or one dominated by stunted trees <16 ft (5 m) tall.  >Barren= is a term often applied to woodlands on sterile soils (e.g., pitch pine barrens), or to wooded communities occurring on shallow soils overlying bedrock.

    1. **Pitch Pine/Scrub Oak Barrens**.  Woodland community typically found on

well-drained sandy soils of outwash plains.  Pitch pine (*Pinus rigida*) is the dominant tree varying from 25-60% cover, and the shrub layer is dominated by scrub oaks (*Quercus ilicifolia* and *Q. prinoides*), often forming dense thickets. The low shrub canopy may include sweetfern (*Comptonia peregrina*), early blueberry (*Vaccinium angustifolium*), and black huckleberry (*Gaylussacia baccata*).  Sandy openings within the woodland may be sparsely vegetated with lichens and mosses, and may also include patches of bearberry (*Arctostaphylos uva-ursi*) and heather (*Hudsonia ericoides* and *H. tomentosa*).  Pennsylvania sedge (*Carex pensylvanica*) is typically found in the understory, and other herbs present may include goat=s-rue (*Tephrosia virginiana*), sickle-leaved golden aster (*Pityopsis falcata*), and wild lupine (*Lupinus perennis*).  Fauna of this community includes several lepidoptera (moths and butterflies) dependent on specific food plants such as buck moth (*Hemileuca maia*), frosted elfin *(Incisalia irus)*, and hoary elfin (*Incisalia polios*).  Sandy openings provide habitat for tiger beetles (*Cicindela* spp.) and parasitic wasps (Hymenoptera).  This community is typically maintained by periodic fire which reduces competing woody species and stimulates reproduction of pitch pine.

       Dist:   Washington and Kent Counties.

2. **Red Cedar Rocky Summit**.  A community occurring on warm, dry, rocky ridges and summits.  Vegetation may be patchy with areas of exposed bedrock. Eastern red cedar (*Juniperus virginiana*) is the characteristic tree, with understory vegetation dependent on site conditions.  At inland sites, herbs may include little blue stem (*Schizachyrium scoparius*), ebony spleenwort (*Asplenium platyneuron*), and a sedge (*Carex eburnea*).  A coastal variation may also be found on the rocky coast.  This community has a very limited occurrence in Rhode Island; more information is needed.

C. **Forested Uplands**.  Upland communities with more than 60% canopy cover of trees, occurring on substrates with less than 50% rock outcrop or shallow soil over bedrock.

1. **Pitch Pine - Oak Forest**.  A mixed coniferous/deciduous forest community that typically occurs on well-drained, sandy soils of glacial outwash plains and moraines, and also on thin, rocky soils of ridgetops.  Dominant trees are pitch pine (*Pinus rigida*) and one or more oaks including scarlet oak (*Quercus coccinea*), white oak (*Q. alba*), and black oak (*Q. velutina*).  The relative proportions of oak and pine is highly variable within this type.  Shrub layer is well-developed with scrub oak (*Quercus ilicifolia*), blueberry (*Vaccinium angustifolium*), and black huckleberry (*Gaylussacia baccata*),  The herb layer is generally sparse,  characteristic plants including bracken fern (*Pteridium aquilinum*), wintergreen (*Gaultheria procumbens*), a sedge (*Carex pensylvanica*), and pink lady's-slipper (*Cypripedium acaule*).  This community usually develops in the absence of fire as a transition type between pitch pine/scrub oak barren and

forest types dominated by oaks.

2. **<u>Oak - Hickory Forest</u>**.  A deciduous forest community on well-drained soils of ridgetops and upper slopes.  Soils are usually loams/sandy loams.  This type is broadly defined with several regional and edaphic variants.  Dominant trees include one or more of the following oaks: white (*Quercus alba*), scarlet (*Q. coccinea*), black (*Q. velutina*), and red (*Q. rubra*).  Represented in lower densities are pignut hickory (*Carya glabra*), shagbark hickory (*C. ovata*), and mockernut hickory (*C. tomentosa*).  Other associated trees include white ash (*Fraxinus americana*), red maple (*Acer rubrum*), and white pine (*Pinus strobus*).  A tall shrub subcanopy is typically present with saplings of the canopy trees along with witch hazel (*Hamamelis virginiana*) and flowering dogwood (*Cornus florida*).  Common low shrubs are blueberries (*Vaccinium pallidum* and *V. angustifolium*), black huckleberry (*Gaylussacia* baccata), and sheep laurel (*Kalmia angustifolia*).  Characteristics plants in the herb layer are wild sarsaparilla (*Aralia nudicaulis*), false Solomon=s seal (*Smilacina racemosa*), and a sedge (*Carex pensylvanica*).  The American chestnut (*Castanea dentata*) was formerly a co-dominant canopy tree species in this community prior to the infestation of chestnut blight;  today chestnut sprouts remain common in the understory.

3. **<u>Chestnut Oak Forest</u>**.  A deciduous forest occurring on well-drained upper slope and ridgetop sites where the dominant canopy tree is chestnut oak (*Quercus prinus*) with lesser representation by other oaks including red oak (*Quercus rubra*), black (*Q. velutina*), and white (*Q. alba*).  Additonal co-dominants may include red maple (*Acer rubrum*) and pitch pine (*Pinus rigida*).  American chestnut (*Castanea dentata*) was a common assiociate prior to the chestnut blight; saplings are still found in the understory.  The shrub layer is ericaceous with characteristic species including black huckleberry (*Gaylussacia baccata*), mountain laurel (*Kalmia latifolia*), and blueberry (*Vaccinium pallidum*).  Plants in the ground layer include a sedge (*Carex pensylvanica*), wild sarsaparilla (*Aralia nudicaulis*), and wintergreen (*Gaultheria procumbens*).

4. **<u>Oak - Pine Forest.</u>**  A mixed coniferous/deciduous forest on sandy soils or on slopes with rocky soils that are well-drained.  The canopy is dominated by a variable mixture of oaks and pines.  Oaks include one or more of the following: black (*Quercus velutina*), chestnut (*Q. prinus*), red (*Q. rubra*), white (*Q. alba*), and scarlet (*Q. coccinea*).  Representation of pine is by white (*Pinus strobus*) or pitch (*P. rigida*), or a combination of both.  Common associated tree species in lower densities include red maple (*Acer rubrum*), hemlock (*Tsuga canadensis*), American beech (*Fagus grandifolia*), and black cherry (*Prunus serotina*).  The shrub layer is predominantly ericaceous with blueberries (*Vaccinium* spp.), and black huckleberry (*Gaylussacia baccata*).  The ground layer is generally sparse and low in species diversity.

5. **<u>Beech - Maple Forest</u>**.  A hardwood forest on generally moist, well-drained acid soils, broadly defined with several regional and edaphic variants.  The canopy is dominated by American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*) with common associates including white ash (*Fraxinus americana*), yellow birch (*Betula alleghaniensis*), hop hornbeam (*Ostrya virginiana*), red maple (*Acer rubrum*), basswood (*Tilia americana*), and American elm (*Ulmus americana*).  Represented in the tall shrub layer are American hornbeam (*Carpinus caroliniana*), witch hazel (*Hamamelis virginiana*), and flowering dogwood (*Cornus florida*).  In the northern part of the state striped maple (*Acer pensylvanicum*) and hobblebush (*Viburnum lantanoides*) occur in the tall shrub layer.  The ground layer is generally high in species diversity with characteristic plants including Christmas fern (*Polystichium acrosticoides*), jack-in-the-pulpit (*Arisaema triphyllum*), white baneberry (*Actaea pachypoda*), and false Solomon=s seal (*Smilacina racemosa*), with rarer representatives being blue cohosh (*Caulophyllum thalictroides*), wild leek (*Allium tricoccum*), and bloodroot (*Sanguinaria canadensis*).  Many herbaceous plants are spring ephemerals that flower before the canopy trees leaf out.

6. **<u>Hemlock - Hardwood Forest</u>**.  A mixed coniferous/deciduous forest that typically occurs on middle to lower slopes of ravines, on cool mid-elevation slopes, and moist uplands on the edge of swamps.  Hemlock (*Tsuga canadensis*) is a co-dominant in the canopy with the following: American beech (*Fagus grandifolia*), sugar maple *(Acer saccharum*), red maple (*Acer rubrum*), black cherry (*Prunus serotina*), yellow birch (*Betula alleghaniensis*), black birch (*B. lenta*), and red oak (*Quercus rubra*).  Tuliptree (*Lireodendron tulipifera*) may also be present.  The relative cover of hemlock is highly variable, ranging from nearly pure stands to as little as 20% of the canopy.  In closed canopy stands the shrub and herb layers are sparsely vegetated.  Characteristic plants in the understory include cucumber root (*Medeola virginiana*), Canada mayflower (*Maianthemum canadense*), shining clubmoss (*Lycopodium lucidulum*), starflower (*Trientalis borealis*), bellwort (*Uvularia sessilifolia*), common wood-sorrel (*Oxalis acetosella*), partridgeberry (*Mitchella repens*), and painted trillium (*Trillium undulatum*).

APPENDIX 4

Definitions of the Habitats of the NBNERR

**DEFINITIONS OF THE HABITATS OF THE NBNERR**

*ESTUARINE SYSTEM*

Estuarine creeks, coves, pools creek beds, beaches, flats, and non-vegetated pannes are defined below.  Each habitat type may have an unconsolidated or rocky shore or bottom type identified at the class and subclass levels.  Definitions 1-7 below facilitate identification of each type by morphology.

1. *Estuarine…Creek*—a small stream that serves as a conduit for the transport of material and energy transfer between salt marshes and adjacent bodies if water (Mitsch and Gosselink 2000).
2. *Estuarine…Cove*—a small tidal bay or inlet continuously connected to estuarine-marine open water by subtidal water, excluding ditched pools.
3. *Estuarine… Pool*—a depression in a salt marsh which is filled with brackish or haline water at least semipermanently and is irregularly exposed to tidal waters, and is not (naturally) continuously connected to estuarine-marine open water by subtidal water.  Note: many pools have been ditched to connect them to open waters.
4. *Estuarine Bedrock Shore*—an estuarine intertidal zone with a substrate cover of >75% bedrock.
5. *Estuarine…Beach*—an unconsolidated estuarine shoreline open to wave action.
6. *Estuarine…Flat*—an unconsolidated estuarine intertidal shoreline that is nearly flat due to restriction of wave action.
7. *Estuarine (unconsolidated) Panne*—a shallow depression in a salt marsh which is less than semipermanently flooded with water, is irregularly exposed to tidal waters, is discontinuous in elevation and vegetation with fringing *Smooth Cordgrass Salt Marsh*, and has <30% vegetative cover.
8. *Smooth Cordgrass Salt Marsh*—a regularly and/or irregularly flooded, intertidal, halophitic grassland bordering estuarine waters (Mitsch and Gosselink 2000), that is dominated by *Spartina alterniflora* that exists as a continuous vegetative cline extending landward from a regularly flooded low marsh.
9. *Fringe Marsh*—a small or narrow salt marsh that is dominated by *Spartina alterniflora*, is characterized by exposure to open estuarine waters, and is discontinuous with any salt marsh *proper*.  Fringe marshes may include up to 50% cover of *Salt Meadow* or *Cobble Beach* species such as *Salicornia sp* and *Limonium carolinianum*.
10. *Salt Meadow*—an irregularly flooded, intertidal, halophytic grassland bordering estuarine waters (Mitsch and Gosselink 2000), that is dominated by *Spartina patens, Distichlis spicata, and Juncus gerardii.*
11. *Stunted Smooth Cordgrass Panne*— a shallow depression in a salt marsh which is less than semipermanently flooded with water, is irregularly exposed to tidal waters, is discontinuous in elevation and vegetation with fringing

*Smooth Cordgrass Salt Marsh*, and has >30% vegetative cover dominated by stunted *Spartina alterniflora.*

12. *Glasswart Panne*—a shallow depression in a salt marsh which is less than semipermanently flooded with water, is irregularly exposed to tidal waters, is discontinuous in elevation and vegetation with fringing *Smooth Cordgrass Salt Marsh*, and has >30% vegetative cover dominated by *Salicornia sp.*

13. *Common Reed Brackish Marsh*—a brackish marsh dominated by *Phragmites australis.*

14. *Cattail Brackish Marsh*—a brackish marsh dominated by *Typha sp*, usually represented by *T. angustifolia.*

15. *Three-square Brackish Marsh*—a brackish marsh dominated by *Scirpus sp.*

16. *Rose Mallow Brackish Marsh*—a brackish marsh dominated by *Hibiscus moscheutos.*

17. *Sea Blight Community*—a cobble beach community dominated by *Sueda sp.*

18. *Hightide Bush Shrubland*—a brackish shrub wetland (or closely fringing upland) dominated by *Iva frutescens.*

*PALUSTRINE SYSTEM*

1. *Fern Wet Meadow*—a wet meadow dominated by ferns. Often dominated by *Thelypteris sp.*

2. *Wet Meadow*—an emergent wetland that is seasonally saturated, or temporarily-seasonally flooded and is usually dominated by persistent herbaceous vegetation (Golet, 2003).

3. *Emergent Fen*—a palustrine peatland characterized by persistent emergent vegetation growing in hemic or fibric organic soil, with a seasonally flooded or permanently saturated water regime (Golet, 2003). Soils may exist as a floating mat.

4. *Cattail Fresh Marsh*—a palustrine wetland dominated by *Typha sp.* growing in mineral or sapric organic soil, with a seasonally flooded or wetter water regime (Golet, 2003). Soils do not exist as a floating mat.

5. *Common Reed Fresh Marsh*—a palustrine wetland dominated by *Phragmites australis* growing in mineral or sapric organic soil, with a seasonally flooded or wetter water regime (Golet, 2003). Soils do not exist as a floating mat.

6. *Low BLD Shrub Swamp*—a palustrine wetland dominated by immature or stunted broad-leaved deciduous true shrubs, <1m tall, growing in mineral or sapric to hemic organic soil, with a seasonally saturated to semi-permanently flooded water regime (Golet, 2003). Soils do not exist as a floating mat. Typical dominant species may include *Vaccinium corymbosum*, *Viburnum dentatum* and *Lyonia ligustrina.*

7. *Shrub Fen*—a palustrine wetland dominated by compact shrubs, <1m tall, growing in hemic to fibric, non-sphagnum organic soil, with a seasonally flooded or permanently saturated water regime (Golet, 2003). Soils may exist as a floating mat. Typical dominant species include *Myrica gale, Gaylussacia sp*, and *Vaccinium macrocarpon.*

8. *Tall mixed BLD Shrub Swamp*—a palustrine wetland dominated by a mix (no one species dominates by more than 75% cover) of broad-leaved deciduous true shrubs, >1m tall, growing in mineral or sapric to hemic organic soil, with a seasonally saturated to semi-permanently flooded water regime (Golet, 2003). Soils do not exist as a floating mat. Typical species may include *Clethra alnifolia, Vaccinium corymbosum*, *Viburnum dentatum, Cephalanthus occidentalis, and Rosa palustris.*

9. *Willow Swamp*—a palustrine wetland dominated by *Salix sp*., <6m-tall, growing in mineral or sapric to hemic organic soil, with a seasonally saturated to semi-permanently flooded water regime (Golet, 2003). Typical species are *Salix bebbiana* and *Salix nigra*.

10. *Alder Swamp*—a palustrine wetland dominated by *Alnus sp*., <6m-tall, growing in mineral or sapric to hemic organic soil, with a seasonally saturated to semi-permanently flooded water regime (Golet, 2003). Typical local species are *Alnus rugosa* and *Alnus serrulata.*

11. *BLD Sapling Swamp*—a palustrine wetland dominated by immature trees, <6m-tall, growing in mineral or sapric to hemic organic soil, with a seasonally saturated to semi-permanently flooded water regime (Golet, 2003). Soils do not exist as a floating mat. Typical species are *Acer rubrum* and *Betula populifolia*.

12. *Leatherleaf Bog*—a palustrine peatland dominated by *Chamaedaphne calyculata* growing fibric sphagnum organic soil, with a permanently saturated water regime (Golet, 2003). Soils most often exist as a floating mat.

13. *Red Maple Swamp*—a palustrine forested wetland dominated by *Acer rubrum*, >6m-tall, growing in mineral or sapric to hemic organic soil, with a seasonally saturated to semi-permanently flooded water regime (Golet, 2003). Subordinate species include tall shrubs such as *Clethra alnifolia, Vaccinium corymbosum*, and *Viburnum dentatum*, and emergent hydrophytes, including *Osmonda cinamomea*.

14. *Pin Oak Swamp*—a palustrine forested wetland dominated by *Quercus palustris*, >6m-tall, growing in mineral or sapric to hemic organic soil, with a seasonally saturated to seasonally flooded water regime (Golet, 2003). Subordinate species include tall shrubs such as *Clethra alnifolia, Vaccinium corymbosum*, and *Viburnum dentatum*, and emergent hydrophytes, including *Osmonda cinamomea*.

*UPLAND SYSTEM*

1. *Coastal Dune Sparse Grassland*—a grassland with <30% total vegetative cover on sand dunes inland of and adjacent to marine and estuarine beaches (Enser and Lundgren 2003). Typical dominant species is *Ammophila breviligulata*, but other species such as *Elytrigia repens* may dominate.

2. *Coastal Dune Beach Heather Barren*—a low sparse shrubland with <30% total vegetative cover on sand dunes inland of and adjacent to marine and estuarine beaches (Enser and Lundgren 2003). Typical dominant species is

*Hudsonia tomentosa*, but other species such as *Lechia maritima* may dominate.

3. *Inland Dune*—an inland dune area, never affected by tidal waters, with <30% vegetative cover.

4. *Inland Sand Barren*—an inland area, never affected by tidal waters, with <30% vegetative cover and unconsolidated substrates consisting predominantly of sand sized particles, with consolidated substrates covering <75% (Cowardin etal. 1979).

5. *Coastal Dune Grassland*—a grassland with >30% total vegetative cover on sand dunes inland of and adjacent to marine and estuarine beaches (Enser and Lundgren 2003). Typical dominant species is *Ammophila breviligulata*, but other species such as *Elytrigia repens* may dominate.

6. *Maritime Grassland*—a grassland with >30% total vegetative cover directly exposed to periodic disturbances by coastal winds and salt spray (Enser and Lundgren 2003). Dominant species include mixed grasses (*Poaceae*) and goldenrods (*Euthamea sp*).

7. *Switchgrass Grassland*—any upland grassland dominated by *Panicum virgatum*. No taller plants may cover >30%.

8. *Little Bluestem Grassland*—any upland grassland dominated by *Schizacharyum scoparium.* No taller plants may cover >30%.

9. *Mixed Grassland*—any upland grassland not dominated by any single species by 75% or more. No taller plants may cover >30%.

10. *Coastal Dune Forbs*—an herbaceous upland with >30% total vegetative cover on sand dunes inland of and adjacent to marine and estuarine beaches (Enser and Lundgren 2003). Typical dominant species are *Atriplex sp*, *Chenopodium sp,* and *Vincetoxicum nigra.*

11. *Goldenrod Meadow*—an herbaceous upland with >30% cover, dominated by *Solidago sp* or *Euthamia sp*.

12. *Milkweed Meadow*—an herbaceous upland with >30% cover, dominated by *Asclepias sp.*

13. *Coastal Shrubland*—an upland area, dominated by a mix of shrubs or stunted saplings, that occurs on dry seaside areas directly exposed to periodic disturbances by coastal winds and salt spray (Enser and Lundgren 2003). Characteristic species include *Rhus sp., Myrica pensylvanica, Prunus serotina, P. maritima, Juniperus virginiana, Vitus labrusca, Smilax sp,* and *Toxicodendron radicans.* This habitat type is often invaded by *Celastrus orbiculatus and Rosa multiflora.*

14. *Coastal Sumac Thicket*—an upland area, with ≥75% cover of *Rhus sp.*, that occurs on dry seaside areas directly exposed to periodic disturbances by coastal winds and salt spray (Enser and Lundgren 2003).

15. *Coastal Dune Shrubland*—an upland, with >30% total vegetative cover of true shrubs, on sand dunes inland of and adjacent to marine and estuarine beaches (Enser and Lundgren 2003). Typical dominant species are *Rosa rugosa, Myrica pensylvanica, Prunus maritima*, and *Toxicodendron radicans.*

16. *Blueberry Shrubland*—any upland dominated by *Vaccinium corymbosum, V. alba,* or *Gaylussacia baccata.*

17. *Bayberry Shrubland*—an inland upland, dominated by *Myrica pensylvanica,* that is not directly exposed to periodic disturbances by coastal winds and salt spray.
18. *Steeplebush shrubland*—any upland dominated by *Spiraea sp.*
19. *Coastal Greenbrier Shrubland*—an upland area, co-dominated by a thick bramble of *Smilax sp* and a mix of shrubs or stunted saplings, that occurs on dry seaside areas directly exposed to periodic disturbances by coastal winds and salt spray (Enser and Lundgren 2003). Characteristic species include *Smilax rotundifolia, Rhus sp, Myrica pensylvanica, Prunus serotina, Juniperus virginiana, Vitus labrusca,* and *Toxicodendron radicans..*
20. *Greenbrier Shrubland*—an upland area dominated by a thick bramble of *Smilax sp.* Often exists as a near monoculture.
21. *Blackberry Shrubland*—any upland dominated by blackberries (*Rubus sp*).
22. *Mixed BLD Saplings*—any upland dominated by broad-leaved deciduous immature trees (<6m).
23. *Pitch Pine Sapling Shrubland*—an upland dominated by *Pinus rigida* immature trees (<6m).
24. *Pitch Pine Sapling Shrubland*—an upland dominated by *Pinus rigida* immature trees (<6m) with total sapling cover of 60-100%.
25. *Pitch Pine Sapling Open Shrubland*—an upland dominated by *Pinus rigida* immature trees (<6m) with total sapling cover of 30-60%.
26. *Oak-Red Maple Forest*—a secondary growth forested upland co-dominated by *Quercus sp* and *Acer rubrum.* Typical oaks include *Q. velutina, Q. alba*, and *Q. coccinia.* Other commonly associated trees include *Sassifrass albidum, Prunus serotina,* and *Acer sp.*
27. *Naturalized Maple Forest*—a secondary growth forested upland dominated by naturalized maples. Typical species include *Acer platanoides* and *Acer pseudoplatanus.*
28. *Black Locust Woodland*—a forested upland, with total tree cover of 30-60%, dominated by *Robinia pseudoacacia.*
29. *Mixed BLD Woodland*—a forested upland, with total tree cover of 30-60%, dominated by mixed (no single species represented by more than 75%) broad-leaved deciduous trees.
30. *Larch Forest*—a naturalized upland forest dominated by *Larix sp.*
31. *Coastal Eastern Red Cedar Forest*—an upland area, dominated by *Juniperus virginiana* with >75% species representation, that occurs on dry seaside areas directly exposed to periodic disturbances by coastal winds and salt spray (Enser and Lundgren 2003).
32. *Pitch Pine Forest*—a needle-leaved evergreen forested upland, dominated by *Pinus rigida*, with a total tree cover of >60%.
33. *Pitch Pine Woodland*—a needle-leaved evergreen forested upland, dominated by *Pinus rigida*, with a total tree cover of 30-60%.
34. *White Pine Forest*—a needle-leaved evergreen forested upland, dominated by *Pinus strobus.*
35. *Coastal Black Cherry-Eastern Red Cedar Forest*—a mixed upland forest or woodland, co-dominated by *Prunus serotina* and *Juniperus virginiana*, that

occurs on dry seaside areas directly exposed to periodic disturbances by coastal winds and salt spray (Enser and Lundgren 2003). It likely represents a retarded successional stage between *Coastal Shruland* and forested upland.

36. *PitchPine-Oak Forest*—a mixed upland forest, co-dominated by *Pinus rigida* and one or more of the following full size oaks: *Quercus velutina, Q. coccinea,* or *Q. alba.* Usually occurs on sandy, well drained outwash and moraines. Ratio of pine to oak may be highly variable (Enser and Lundgren 2003).

37. *Oak-Pine Forest*—a mixed upland forest, co-dominated by one or more of the following full size oaks *Quercus velutina, Q. prinus, Q. rubra, Q. coccinea,* and *Q. alba*; and pines including *Pinus rigida* and *P. strobus.* Usually occurs on sandy soils or on slopes (Enser and Lundgren 2003).

38. *Paved Road*—any paved or cement or oiled road (>10m in width for this dataset).

39. *Dirt Road*—any dirt or gravel road (>10m in width for this dataset).

40. *Earthen Bridge*—any impounding or semi-impounding roadway made of raw earth materials such as rip rap or gravel (>10m in width for this dataset).

41. *Boat Ramp*—any area modified for the purpose of launching boats by trailer.

42. *Stone Pier*—any man-made stone or rip-rap pier, sea wall or jetty.

43. *Wooden Pier*—any permanent wooden dock, pier etc.

44. *Mowed Lawn*—any area with regularly mowed grass and no trees or buildings.

45. *Mowed Lawn with Buildings*—any area with regularly mowed grass and buildings.

46. *Mowed Lawn with Trees*—any area with regularly mowed grass and 10-30% cover of trees.


*DEFINITION OF TERMS USED IN THIS DOCUMENT*

1. Dominant species: most abundant species within the tallest life form (class) covering ≥30% of the ground when viewed from directly above (Cowardin et al. 1979).
2. Representation: species composition within a dominant class.
3. Woodland: forested area with 30-60% total tree cover.

For water regimes definitions and soil type definitions refer to Cowardin et al. (1979).