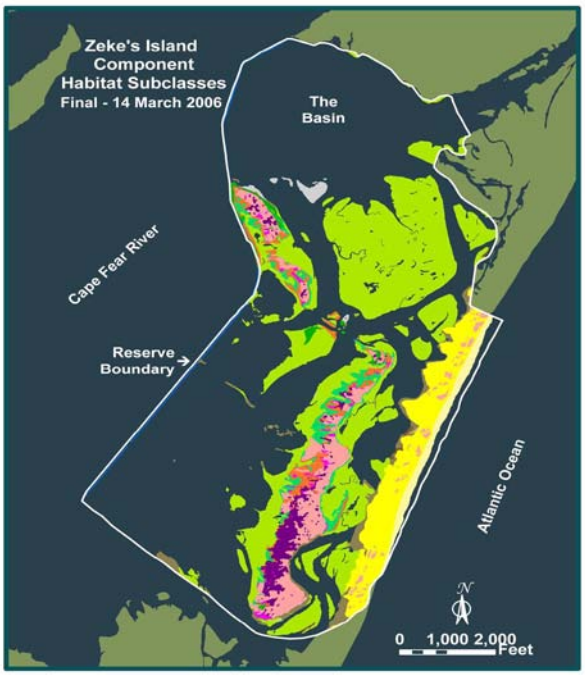
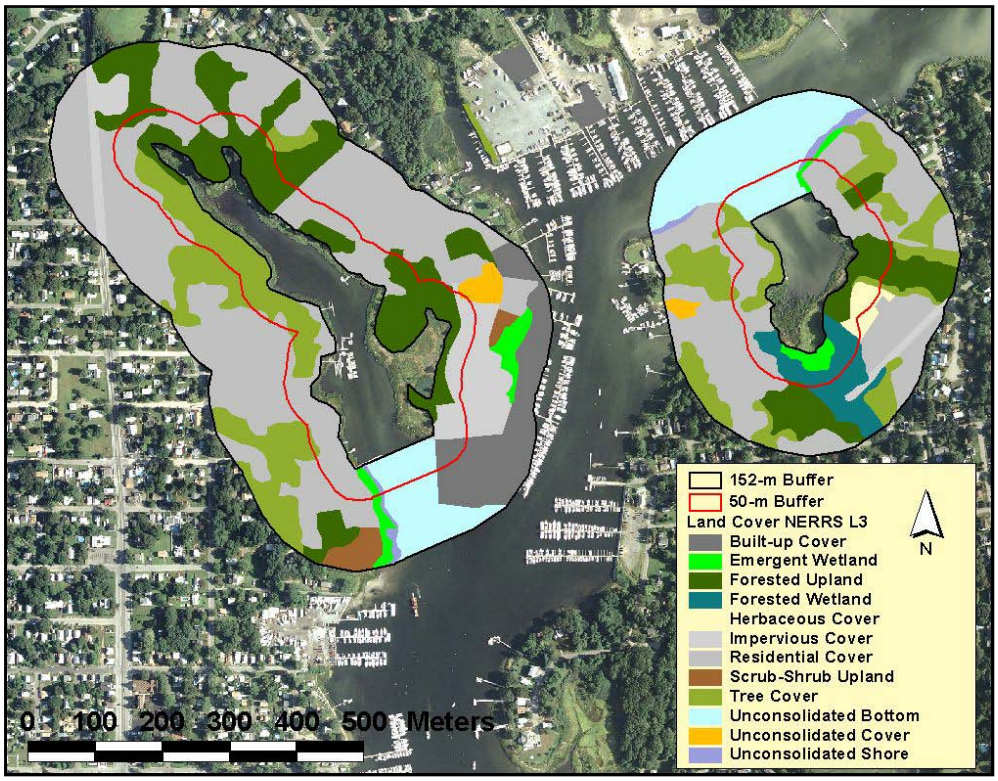
Habitat and Land Cover Classification Scheme for the National Estuarine Research Reserve System





Habitat and Land Cover Classification Scheme for the National Estuarine Research Reserve System

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The National Estuarine Research Reserve System (NERRS) was established by Section 315 of the Coastal Zone Management Act, as amended. Additional information about the system can be obtained from the Estuarine Reserves Division, Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration, US Department of Commerce, 1305 East West Highway - N/ORM5, Silver Spring, MD 20910.

Preface

The NERRS Classification Scheme was developed to standardize the way high-resolution land cover data are classified within the National Estuarine Research Reserve System. Progressive iterations of the classification were developed through a transparent and revolving process of debate, compromise, review, and revision; the final product is presented here. Justifications for various elements of the classification are detailed in a previous report (Kutcher et al. 2005). Minor revisions have since been made to address peer reviewer comments; these include removing the *Artificial* Subclass from the *Reef* Class, removing the *Vegetated* Subclass from the *Unconsolidated Shore* Class, changing the name of the category *Dominance Type* to *Dominant Species,* and designating *Descriptors* and *Dominant Species* as a *Nominal* categories. Some typographic errors within the scheme have also been fixed.

This document is intended to act a user's manual for classifying land cover according to the NERRS Classification Scheme; it is primarily intended be used to classify a new inventory of land cover *in situ*, but it can also be applied to an existing dataset. The document is comprised of two equally important parts: (1) the body of the document and (2) a classification outline attached as Appendix 1. The outline is intended to be used as a key to the text to significantly facilitate classification. This document does not deal with data collection or processing methods, as the classification can be used to classify geospatial data derived from various methods. Field verification may be necessary for some determinations. Walker and Garfield (2005) offer recommendations for implementing a land cover inventory using this scheme.

Certain terms are employed with a particular meaning in the given context. To clarify key technical terms in the context of this document, a glossary is provided as Appendix 2. The first time a key term is used, it is marked with an asterisk and the reader is referred to the glossary in a footnote; subsequent use of the term is not marked.

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Acknowledgements

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Executive Summary

To address goals identified in its System-wide Monitoring Program, the National Estuarine Research Reserve System (NERRS) has developed a comprehensive classification scheme designed to classify all wetland, aquatic, upland, and frozen habitats, as well as all cultural land covers in coastal areas of the United States. The scheme is the result of a multi-year development, piloting, review, and revision process that culminated in its incorporation into NERR System-wide programming. This report outlines and details the structure and content of the resulting NERRS Classification Scheme (NERRSCS) and offers recommendations for its use.

The NERRSCS is an application of the well-accepted and widely applied *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979), which is the National wetland classification standard (hereafter NWCS). For the purpose of mapping and inventorying all land covers in a seamless and compatible manner, the NWCS was expanded for the NERRSCS to include upland and frozen habitat, and cultural cover types, particularly to allow complete baseline inventory and change analysis between natural and cultural covers. All cover types are organized by categories adopted from the NWCS and designed to be analogous in both structure and content.

The structure is comprised of two elements, (1) a four-level hierarchy and (2) a set of non-hierarchical categories. The hierarchy is strictly nested, meaning that each category is subdivided into strictly assigned and dedicated subcategories. Applied in a columnar spreadsheet format, this structure allows data to be queried and analyzed at various levels of interest and in numerous ways. A numeric coding system allows data to be quickly sorted. Non-hierarchical categories add more information to, or further subdivide, the hierarchically-derived categorizations without certain constraints imposed by the hierarchy.

The four levels of the hierarchy are SYSTEM (Level 1), SUBSYSTEM (Level 2), CLASS (Level 3), and SUBCLASS (Level 4); a structure adopted directly from the NWCS. Each level represents an ecologically significant break in land cover ranging, for example, from primary source of water (System); to surface water depth or periodicity (Subsystem); to environmental structure (Class); to leaf type, grain size, or cultural use (Subclass). Each of these levels has a pre-determined, identified, and defined set of attributes that are offered here as a complete and intuitive numbered outline appended to this report. In addition, definitions of all attributes within the four-level hierarchy are offered in the body of this report. Together, the outline and the definitions can be applied as a key to classifying land cover units of interest.

Non-hierarchical categories are comprised of (1) NOMINAL categories and (2) MODIFIERS. Nominal categories are not specified in this report, but are instead taken from scientific naming conventions. Two Nominal categories are described. The first is *Dominant Species*, which is the scientific name (genus and species) of the dominant vegetation or sessile fauna; it may either further describe or subdivide a hierarchically-derived unit. The second is *Descriptor*, which is a commonly used habitat name (e.g. *New*

England salt meadow); a Descriptor further describes a hierarchically-derived unit, but does not subdivide it. Modifiers represent sets of attributes that can be appended to hierarchical and nominal data to further describe or subdivide units. A set of standardized and defined modifiers is offered in the body of this document, but recommendations for applying modifiers from other sources also are offered. Modifiers may be applied in a flexible manner; the types and number of modifiers employed depends on the objectives of the classification effort. However, modifier attributes should be applied as defined to standardize data entry among users.

Although conventional mapping can be utilized, data classified according to the NERRSCS are best entered into a GIS spreadsheet in columnar format, with each hierarchical, nominal, and modifier category occupying a separate column. This adds a great deal of analytical utility to the data with little extra effort. To ensure that utility, all attributes within each level of the NERRSCS hierarchy are intended to be spatially exclusive and completely contiguous. Classification data are intended to be quantified in two dimensions by area; third-dimensional attributes are considered to be beyond the scope of this scheme. Finally, many habitat delineations will be made via interpretation of vegetation. Because natural hydrologic and chemical regimes vary widely in space and time, vegetation is often the best indicator of such physical attributes.

I. Background and Justification

In 2005, a technical workgroup of the National Estuarine Research Reserve System (NERRS) recommended a habitat classification scheme to meet NERRS objectives for standardized habitat and land cover mapping and inventory. The scheme presented herein is the result of a multi-year development and piloting process that produced a peer-reviewed land cover classification tool capable of meeting the various needs of estuarine and coastal stakeholders across the United States.

The original intent of the NERRS workgroup was to research, identify and recommend an existing classification scheme that facilitated the mapping and inventory of all coastal land covers represented in the NERRS for purposes of standardized site characterization and assessment, and local, regional, and national change analyses, as well as other analyses, as a part of the NERRS System-wide Monitoring Program (SWMP, Wenner 2002); however, no appropriate scheme existed. Various national schemes designed to inventory coastal wetlands and waters were available (e.g. Cowardin et al. 1979, Allee et al. 2000) as were several designed to map upland[*] and wetland[*] land cover and land use at a coarse resolution (e.g. Anderson et al. 1976, Dobson et al. 1995), but these were all deficient in either scope or intended resolution.

The NERRS workgroup decided instead to build the NERRSCS from an existing, widely used wetland classification scheme designed for the U.S. Fish and Wildlife Service National Wetland Inventory (NWI). That scheme is entitled *Classification of Wetlands*

[*] Refer to glossary for definition

and Deepwater Habitats of the United States (Cowardin et al. 1979) and is the Federal Geographic Data Committee's (FGDC) *National Wetlands Classification Standard* (hereafter referred to as NWCS). The NWCS was chosen as a starting point for the following reasons: (1) the concepts and intended scale are consistent with the objectives identified by coastal managers and scientists within the NERRS; (2) the content and hierarchical structure of the scheme, when applied in a GIS, greatly enhance analytical capacity of the data; (3) the categories are based on ecological parameters useful to coastal ecologists; (4) the NWCS has been used effectively to map the Nation's wetlands for nearly thirty years; (5) nomenclature and definitions contained in the NWCS are widely accepted by the scientific community; and (6) historical datasets are available for nearly all coastal U.S. areas. Retaining these attributes for application to a comprehensive land cover scheme will preserve consistency and interoperability for national coastal inventory among NOAA and USFWS agencies. Further justification has been detailed in a previous recommendation to the NERRS (Kutcher et al. 2005).

The NERRS classification scheme (hereafter referred to as the NERRSCS) is a useful tool for comprehensive, high-resolution mapping and inventory of coastal habitat and landscape features. This document describes and defines categories, attributes, and parameters incorporated in the NERRSCS. Included is a detailed description of the structure and functionality of the NERRSCS, as well as nationally recognized definitions, descriptions, and applications of the various categories and their associated parameters. This document also briefly outlines recommendations for implementation of the scheme.

In addressing the requirements identified by the NERRS, this document presents a habitat/land cover classification scheme that:

- is compatible with existing classification efforts and enables crosswalking with existing datasets;
- is fully capable of classifying all cover types, logically organizing all aquatic[*], wetland, upland habitat and cultural land cover data into a seamless dataset;
- is effective over the entire geographic extent of the NERRS and the United States;
- utilizes universally accepted and applied structure and terminology;
- is simple to use, providing the intuitive utility of a multinomial key;
- is useful for communicating data among scientists and non-scientists;
- allows crosswalking between coarse-level and fine-level data;
- allows detailed upland, wetland, and aquatic habitat classification;
- provides a basis for runoff and infiltration modeling;
- is compatible with GIS software and with accepted methods of data collection and classification;
- facilitates data analysis at numerous ecologically significant levels of interest;
- is compatible with remotely-sensed imagery;
- employs parameters that can indicate habitat quality; and
- describes habitats in the transition zone between intertidal and uplands.

[*] Refer to glossary for definition

II. The Classification Structure and Content

Both the structure and content of the NERRSCS are based on the NWCS. Essentially, the NERRSCS is a specific application of the NWCS that has been expanded to include upland and ice-covered habitats, as well as cultural land cover types, in order to facilitate change analyses among these various types and to provide the user with a tool to inventory them in a consistent and seamless manner (Fig 1). Previous to this, no known scheme existed that allowed a user to inventory upland, cultural, wetland, and aquatic high-resolution habitat and land cover types and store the results in a single dataset.

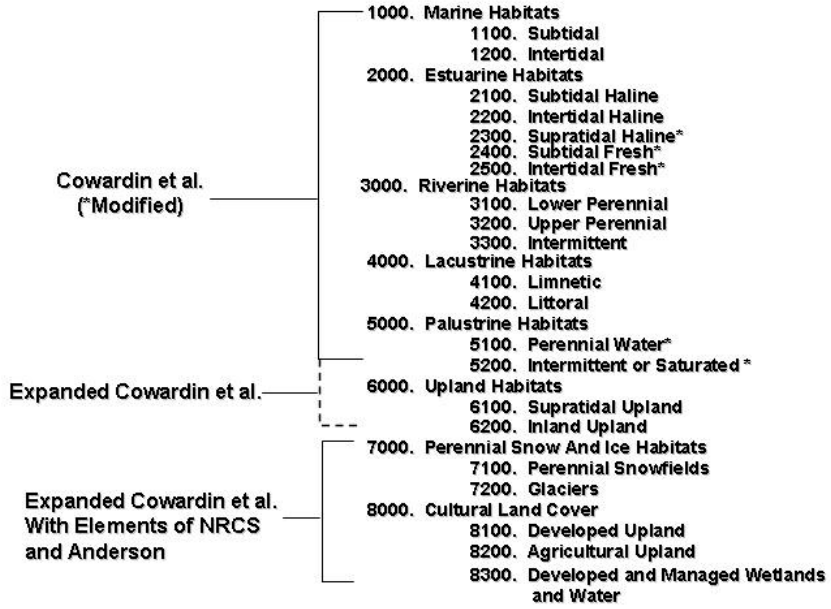

Figure 1. The structure and content of Levels 1 and 2 of the NERRS Classification Scheme.

Generally, the classification structure and all wetland and aquatic habitat categories presented here are adopted directly from the NWCS. However, certain modifications to the order, content, and definitions have been made to allow the user to characterize the environment in a manner frequently preferred by coastal ecologists and managers. Most notably, tidal freshwater habitats have been moved from the Riverine to the Estuarine System. This move allows the discrimination of subtidal and intertidal freshwater habitats within the scheme and is consistent with well-accepted functional definitions of the term *estuarine* (e.g. Fairbridge 1980; Day et al. 1989). Note that haline and fresh habitats within the Estuarine System remain in separate Subsystem categories to allow data to be easily converted to NWCS standards. Other changes to NWCS wetland habitat categories are noted in the descriptions and definitions given in this report. The changes are designed to maintain compatibility between the NERRSCS and the NWCS, and full FGDC compliance can be achieved with a relatively small amount of data manipulation.

Upland, Ice-covered, and Cultural cover types are appended to the NWCS wetland habitat hierarchy in categories that are structurally, conceptually, and spatially analogous with NWCS (Fig. 1). This allows the user to view and analyze classified data consistently across each level.

A. Classification Structure

The NERRSCS utilizes two structural elements, a **four-level hierarchy** and a set of **non-hierarchical categories**. The hierarchy allows the data to be consistently characterized and analyzed by relevant units at various levels of interest, while the non-hierarchical categories allow additional information to be inventoried without the constraints imposed by a hierarchy.

1. Four-Level Hierarchy

The hierarchy utilized is a direct adaptation of the NWCS; it is strictly nested, which allows data to be folded up or expanded to the level of detail desired by the user. A strictly nested hierarchy is structured like a family tree, where each top-level (parent) class is subdivided into dedicated second-level (child) classes and each second level class into dedicated third-level classes and so on (Fig. 2).

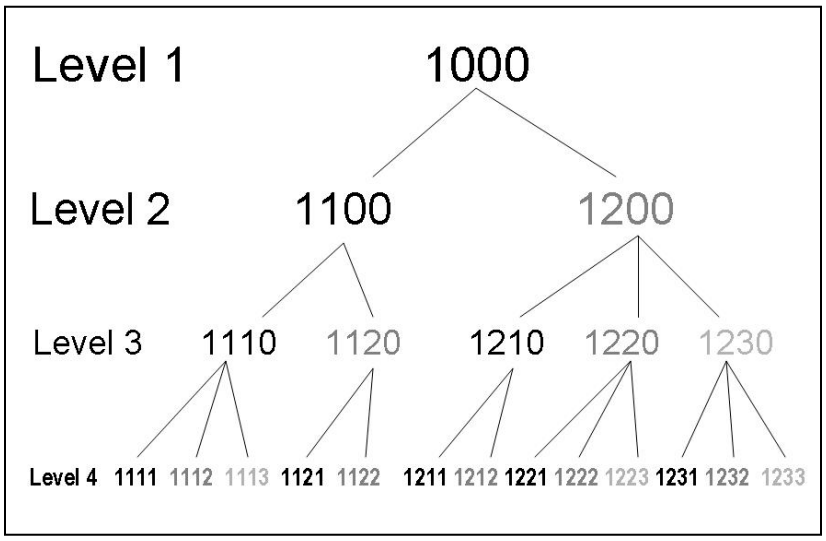

Figure 2. Conceptual diagram illustrating the functionality of a strictly-nested four-level hierarchy; each level represents the same area of interest at different degrees of detail. Turn this diagram 90 degrees to envision its application in columnar format.

Each level represents the same geographic area of interest, with each lower level describing the environment at a higher degree of detail. Thus, data can be viewed and analyzed across each level with no change in total area from any other complete level; this provides the user with a powerful analytical tool when entered into a geographic information system (GIS) in columnar format (Fig. 2, Table 1). To achieve this, attributes within each level are intended to be spatially exclusive[*] and entirely contiguous[*]. Each level represents an ecologically significant, logical break in some aspect of the environment (e.g. hydrologic system, vegetative structure). The NERRSCS requires all users to organize their data identically at each level, which allows for analyses across datasets and standardizes communication at all levels of detail. Standardization is facilitated by the application of a *complete* and *exclusive* list of possible attributes within each level of the hierarchy (App. 1).

[*] Refer to glossary for definitions

The application of a strictly numeric header system to the hierarchy further enhances its utility (Anderson et al. 1976). In GIS and spreadsheet formats, a numeric header system allows the user to organize data into the same logical order as the classification scheme with a single sorting command and provides a meaningful code for data entry (Table 1).

Table 1. Partial GIS data table illustrating attributes of hierarchical categories (levels) of the NERRS Classification Scheme organized in columnar format and sorted by NERRS numeric code (NERRS_COD). Note that each numbered polygon represents a land cover unit characterized by attributes of each of the four levels of the hierarchy from left to right.

POLYGON	SYSTEM	SUBSYSTEM	CLASS	SUBCLASS	NERRS_COD
Polygon 1	Estuarine	Subtidal Haline	Unconsolidated Bottom	Sand	2123
Polygon 2	Estuarine	Intertidal Haline	Unconsolidated Shore	Cobble	2251
Polygon 3	Estuarine	Intertidal Haline	Unconsolidated Shore	Sand	2253
Polygon 4	Estuarine	Intertidal Haline	Emergent Wetland	Persistent	2261
Polygon 5	Estuarine	Intertidal Haline	Emergent Wetland	Persistent	2261
Polygon 6	Estuarine	Intertidal Haline	Scrub-Shrub Wetland	BLD	2271
Polygon 7	Upland	Supratidal Upland	Herbaceous Upland	Broad-leaved Herbs	6132
Polygon 8	Upland	Supratidal Upland	Scrub-Shrub Upland	BLD	6141
Polygon 9	Upland	Inland Upland	Scrub-Shrub Upland	BLD	6241
Polygon 10	Upland	Inland Upland	Scrub-Shrub Upland	BLD	6241
Polygon 11	Upland	Inland Upland	Scrub-Shrub Upland	BLD	6241
Polygon 12	Upland	Inland Upland	Scrub-Shrub Upland	BLD	6241
Polygon 13	Upland	Inland Upland	Scrub-Shrub Upland	BLD	6241
Polygon 14	Upland	Inland Upland	Forested Upland	Mixed	6255
Polygon 15	Upland	Inland Upland	Forested Upland	Mixed	6255
Polygon 16	Upland	Inland Upland	Forested Upland	Mixed	6255
Polygon 17	Upland	Inland Upland	Forested Upland	Mixed	6255
Polygon 18	Upland	Inland Upland	Forested Upland	Mixed	6255
Polygon 19	Cultural Land Cover	Developed Upland	Residential Cover	Low Density	8131
Polygon 20	Cultural Land Cover	Developed Upland	Residential Cover	Medium Density	8132
Polygon 21	Cultural Land Cover	Developed Upland	Residential Cover	Medium Density	8132
Polygon 22	Cultural Land Cover	Developed Upland	Unconsolidated Cover	Dirt/gravel Road	8152
Polygon 23	Cultural Land Cover	Developed and Managed Wetlands and Water	Impervious Cover	Impervious In-water Structure	8312
Polygon 24	Cultural Land Cover	Developed and Managed Wetlands and Water	Built-up Cover	Shellfish Aquiculture	8324
Polygon 25	Cultural Land Cover	Developed and Managed Wetlands and Water	Rocky Cover	Rocky In-water Structure	8342

A complete list of numerically organized categories and attributes comprising the NERRSCS hierarchy are presented in an intuitive outline that can be used as a key for determining hierarchical attributes for any given unit (starting by determining Level 1, narrowing the possibilities for determining Level 2, and so on). The outline is attached as Appendix 1 and is the backbone of the NERRSCS.

2. Non-hierarchical Categories

The non-hierarchical categories include two descriptive *Nominal* categories and several *Modifier* categories. These categories are designed to allow the user to inventory additional information to further describe or subdivide hierarchically derived units. When applied in columnar format, the non-hierarchical structure allows data to be omitted if they are unknown or do not apply to certain habitats or land cover types (e.g. Water Regime does not apply to Upland Habitat data). The two *Nominal* categories represent taxonomic and descriptive data; these are <u>not</u> broken into predetermined classes described or listed here, but are instead based on scientific naming conventions, specifically, plant and animal genus and species names (Dominant Species), and common habitat names (Descriptors). The *Modifier* categories are sets of non-hierarchical data attributes and parameters that can be appended to a dataset as needed to further describe or subdivide hierarchically or nominally-classified geospatial units. Many modifiers are

identified and described in this document, but recommendations are also made for adopting additional *Modifiers*. *Modifiers* need not be entirely contiguous, but attributes within each must be spatially exclusive.

B. Classification Content

The content of the NERRSCS draws heavily from the NWCS. For the most part, wetland habitat categories and their definitions have been adopted directly from NWCS text. NWCS text is presented in italics throughout this section; changes to NWCS definitions are noted or directly inserted (between brackets) in normal font. Additional categories identified and defined below originated as noted.

There are eight Systems (Level 1) in the classification. Five wetland and aquatic *habitat* Systems—each including associated Subsystems (Level 2), Classes (Level 3), and Subclasses (Level 4)—have been adopted directly from the NWCS. An Upland Habitat System, together with its associated levels and attributes, was developed to classify non-wetland undeveloped areas. A Cultural Land Cover System and a Perennial Snow-and-Ice Habitat System have been adapted from Anderson et al. (1976) or based on the NWCS (Fig. 1). For the purposes of differentiation in the NERRSCS, *cultural* cover types are those regularly or irreversibly modified by humans, while *habitat* cover types are those in a sustained, recovering*, or reclaimed natural* state.

1. Hierarchical Categories

Levels 1 and 2: Systems and Subsystems

The SYSTEMS (Level 1) described below have either been adopted directly from the NWCS or have been appended to it to expand its spatial and conceptual range to include upland, permanently frozen, and cultural cover types. Systems are coded to the thousand-level, ascending from marine, through estuarine, riverine, lacustrine, palustrine, upland, frozen, and cultural cover types. Wetland Systems below, coded 1000 to 5000, are taken directly from the NWCS and are defined as … *a complex of wetlands and* [aquatic] *habitats that share the influence of similar hydrologic, geomorphologic, chemical, or biological factors. We further subdivide Systems into more specific categories called SUBSYSTEMS.* The remaining Upland, Perennial Ice and Snow, and Cultural Land Cover Systems, coded 6000 to 8000, are conceptually analogous.

SUBSYSTEMS (Level 2) are assigned to wetland and aquatic habitat Systems to subdivide each based on hydrologic characteristics, such as periodicity of flooding, or surface flow, depth, and area of water. Upland, frozen, and cultural Systems are likewise subdivided by natural or anthropogenic characteristics that can affect the pathways and residence time of water on the landscape. Subsystems are coded to the hundred-level. Note that heading digits for Subsystems are not necessarily exclusive to the Subsystem type, but are applied as necessary to represent the number of Subsystems within each

* Refer to glossary for definition

System (e.g. 1100 represents Marine Subtidal, while 3100 represents Riverine Lower Perennial). CLASSES (Level 3) and SUBCLASSES (Level 4) are assigned to each Subsystem as described in subsequent sections and as outlined in Appendix 1.

1000. Marine Habitats

The Marine Habitats System was adopted directly from the NWCS and is defined below by concept and extent. Note, however, that it is further bounded here by any cultural cover represented in the Cultural System (in bracketed normal text below).

Definition: The Marine System…consists of the open ocean overlying the continental shelf and its associated high-energy coastline. Marine habitats are exposed to the waves and currents of the open ocean and the water regimes are determined primarily by the ebb and flow of oceanic tides. Salinities exceed 30 ‰, with little or no dilution except outside the mouths of estuaries. Shallow coastal indentations or bays without appreciable freshwater inflow, and coasts with exposed rocky islands that provide the mainland with little or no shelter from wind and waves, are also considered part of the Marine System because they generally support typical marine biota.

Limits: The Marine System extends from the outer edge of the continental shelf shoreward to one of three lines: (1) the landward limit of tidal inundation (extreme high water of spring tides), including the splash zone from breaking waves; (2) the seaward limit of wetland emergents, trees, or shrubs; (3) the seaward limit of the Estuarine System, where this limit is determined by factors other than vegetation[, or any cover type in the Cultural System. Aquatic] *habitats lying beyond the seaward limit of the Marine System are outside the scope of this classification system.*

Marine Subsystems:

1100. Subtidal—*the substrate is continuously submerged.*

1200. Intertidal—*the substrate is exposed and flooded by tides; includes the associated* [mean] *splash zone.*

2000. Estuarine Habitats

The Estuarine Habitats System is largely adapted from the NWCS, but differs significantly in definition and spatial limits. Here, tidal freshwater habitats are included in the Estuarine, rather than the Riverine System, as Subtidal Fresh and Intertidal Fresh Subsystems. Also, non-tidal (true) wetlands falling within the upland supratidal zone (refer to 5100 Supratidal Upland for definition), such as dune swales, that are at least seasonally haline, are included in the Supratidal Haline Subsystem. Deviations from the NWCS are inserted in bracketed normal font; text in italics comes directly from the NWCS (Cowardin et al. 1979):

Definition: The Estuarine System…consists of [aquatic] *tidal habitats and adjacent tidal wetlands that are usually semienclosed by land but have open, partly obstructed, or*

sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land [in a significant part of the system. The Estuarine Habitats System also includes freshwater wetland and aquatic habitats influenced by ocean driven tides (including those in and along rivers), and haline non-tidal wetlands in supratidal zones adjacent to Marine and Estuarine water bodies]…*Salinity may be periodically increased above that of the open ocean by evaporation. Along some low-energy coastlines there is appreciable dilution of sea water.*

Limits: The Estuarine System extends (1) upstream and landward to [the head of tide] *during the period of average annual low flow; (2) to an imaginary line closing the mouth of a river, bay, or sound; …(3) to the seaward limit of wetland emergents, shrubs, or trees where they are not included in (2)* [; and includes non-tidal wetlands located within the supratidal zone and containing more than 0.5 ‰ ocean-derived salts at some time during a year of average rainfall. The Estuarine System may be bounded by any cover type represented in the Cultural System; it]… *also includes offshore areas of continuously diluted sea water.*

Estuarine Subsystems:

2100. Subtidal Haline—*the substrate is continuously submerged* [by tidal water and]…*ocean-derived salts measure* [at least] *0.5 ‰ during the period of average annual low flow.*

2200. Intertidal Haline—*the substrate is exposed and flooded by tides; includes the associated splash zone*; *…ocean-derived salts measure* [at least] *0.5 ‰ during the period of average annual low flow.* [This zone extends from the lowest spring tide mark to the highest spring tide mark, but does not include the adjacent zone inundated only by storm surges.]

2300. Supratidal Haline—nontidal wetlands containing at least 0.5 ‰ ocean-derived salts at some point during a year of average rainfall.

2400. Subtidal Fresh—*the substrate is continuously submerged*; *…ocean-derived salts measure less than 0.5 ‰ during the period of average annual low flow.*

2500. Intertidal Fresh—*the substrate is exposed and flooded by tides; includes the associated splash zone*; *…ocean-derived salts measure less than 0.5 ‰ during the period of average annual low flow.*

3000. Riverine Habitats

The Riverine Habitats System is adapted from the NWCS, but differs somewhat in definition and spatial limits. In the NERRSCS, tidal riverine habitats are included in Subsystems of the Estuarine, rather than the Riverine, System and thus are absent below.

Deviations from the NWCS are inserted in bracketed normal text, but otherwise NWCS definitions stand as follows:

Definition: The Riverine System…includes all wetlands and [aquatic] *habitats contained within a channel, with two exceptions: (1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and (2) habitats with* [ocean-driven tides.]

Limits: The Riverine System is bounded on the landward side by upland, by the channel bank (including natural and man-made levees), or by wetland dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens. [It is also bounded by any cover type in the Cultural System.] *In braided streams, the system is bounded by the banks forming the outer limits of the depression within which the braiding occurs. The Riverine System terminates at the downstream end* [at the head of ocean-driven tides] *during the period of annual average low flow, or where the channel enters a lake. It terminates at the upstream end where tributary streams originate, or where the channel leaves a lake. Springs discharging into a channel are considered part of the Riverine System… Upland islands or Palustrine wetlands may occur in the channel, but they are not included in the Riverine System.*

Riverine Subsystems:

3100. Lower Perennial—*the gradient is low and water velocity is slow. There is no tidal influence, and some water flows throughout the year. The substrate consists mainly of sand and mud…the floodplain is well developed.*

3200. Upper Perennial—*the gradient is high and velocity of the water fast. There is no tidal influence and some water flows throughout the year. The substrate consists of rock, cobbles, or gravel with occasional patches of sand…there is very little floodplain development.*

3300. Intermittent—*in this Subsystem, the channel contains flowing water for only part of the year. When the water is not flowing, it may remain in isolated pools or surface water may be absent.*

4000. Lacustrine Habitats

The Lacustrine Habitats System is adopted directly from the NWCS and is conceptually and spatially defined below. Note, however, that it is further bounded here by any cover type in the Cultural System (inserted in bracketed normal text below).

Definition: The Lacustrine System…includes wetlands and [aquatic] *habitats with all of the following characteristics: (1) situated in a topographic depression or a dammed river channel; (2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% areal coverage; …(3) total area exceeds 8 ha (20 acres)* [; and (4) is

not influenced by ocean-driven tides]. *Similar wetland and* [aquatic] *habitats totaling less than 8 ha are also included in the Lacustrine System if an active wave-formed or bedrock shoreline feature makes up all or part of the boundary, or if the water depth in the deepest part of the basin exceeds 2 m (6.6 feet) at low water. …Ocean-derived salinity is always less than 0.5 ‰.*

Limits: The Lacustrine System is bounded by upland or by wetland dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens. [It is also bounded by any cover type represented in the Cultural System.] *Lacustrine Systems formed by damming a river channel are bounded by a contour approximating the normal spillway elevation or normal pool elevation, except where Palustrine wetlands extend lakeward of that boundary. Where a river enters a lake, the extension of the Lacustrine shoreline forms the Riverine-Lacustrine boundary.*

Lacustrine Subsystems:

4100. Limnetic—*all* [aquatic] *habitats within the Lacustrine System; many small Lacustrine Systems have no Limnetic Subsystem* [, only a Littoral Subsystem].

4200. Littoral—*all wetland habitats in the Lacustrine System. Extends from the shoreward boundary of the system to a depth of 2 m (6.6 feet) below low water or to the maximum extent of nonpersistent emergents, if these grow at depths greater than 2 m.*

5000. Palustrine Habitats

The Palustrine Habitats System is adapted from the NWCS, but differs in that it is divided into two Subsystems to differentiate between permanently submerged and intermittent or saturated wetland habitats. This allows the user to classify palustrine open water habitats within the system even if the lower categories are unknown. This represents the only structural change; NWCS Classes are assigned to each Subsystem as appropriate. The content of the Palustrine Habitats System differs from the NWCS in that areas inundated by ocean-driven tides are not represented here, but are instead represented within the Estuarine Habitats System. Deviations from the NWCS are presented in normal text, but otherwise definitions stand as follows:

Definition: The Palustrine System…includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens… It also includes wetlands lacking such vegetation, but with all of the following four characteristics: (1) area less than 8 ha (20 acres); (2) active wave-formed or bedrock shoreline features lacking; (3) water depth in the deepest part of basin less than 2 m at low water; and (4) salinity due to ocean-derived salts less than 0.5 ‰.

Limits: The Palustrine System is bounded by upland or by any of the other…Systems.

Palustrine Subsystems:

5100. Perennial Water—the surface is permanently covered with water. Analogous to Lacustrine Littoral, the Perennial Water Subsystem *is bounded by…wetland dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens,* which would be classified under 5200 below. The water regime is Permanently Flooded (Refer to Modifiers section, below).

5200. Intermittent or Saturated—surface water is evident for only part of the year. This Subclass represents all nontidal freshwater wetlands …*dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens*…as well as nonvegetated wetlands not falling within Riverine or Lacustrine Systems. The water regime is Saturated, Seasonally Flooded, Temporarily Flooded, Intermittently Flooded , Intermittently Exposed, or Semipermanently Flooded (Refer to Modifiers section, below).

6000. Upland Habitats

The Upland Habitats System is not a component of the NWCS. This system was developed for the NERRSCS and is designed to be analogous to the above wetland habitat systems in structure and content.

Definition: Upland habitats are those lands that are not defined as wetlands by the NWCS; i.e. they do not at least periodically support mainly hydrophytes, are not dominated by hydric soils, and are not covered with water at some time during the growing season of each year (Cowardin et al 1979). Uplands include the entire range of natural and recovering non-wetland habitats, but are otherwise independent of relations to topographic or geomorphic features.

Limits: The Upland Habitats System is bounded by any wetland, aquatic, or cultural cover type.

Upland Subsystems:

6100. Supratidal Upland—represents any coastal upland area above the highest spring tide mark that is periodically over-washed, covered, or soaked with seawater during storm events to an extent that affects habitat structure or function. Recent literature has incorporated the use of the term *supratidal* to describe the coastal shore zone from spring high water to the storm *log line,* or the highest reach of storm event water (e.g. Howes et al. 2008). Floodplain uplands adjacent to ocean-driven tidal waters are included here. Note that only haline wetlands (≥ 0.5 ‰ ocean-derived salts) within the supratidal zone are classified in the Estuarine Habitats System (2300. Supratidal Haline).

6200. Inland Upland—Any upland habitats inland of the highest reach of seawater during storm events.

7000. Perennial Snow and Ice Habitats

This System is inserted as a placeholder for further development by the user, if necessary. It was derived from Anderson et al. (1976).

Definition: The surface is perennially covered by frozen water.

Limits: This System is bounded by any area not perennially covered by frozen water.

Perennial Snow and Ice Subsystems:

7100. Perennial Snowfields—The surface is perennially covered by snow.

7200. Glaciers—The surface is perennially covered by a thick layer of flowing snow and ice.

8000. Cultural Land Cover

The Cultural Land Cover System was developed to allow the user to classify and inventory areas significantly modified by humans as units that are clearly distinguishable from (and not overlapping with) natural habitats. The Systems and Subsystems are analogous to the habitat systems in concept and scope, but are primarily identified by manmade structures, rather than natural features and processes. Complexes below refer to areas having a diversity of features that (1) separately fall below user-defined minimum mapping units and (2) together have a distinctly identifiable structural signature.

Definition: The Cultural Land Cover System represents any area modified by mechanical or chemical manipulation more than once per growing season, regularly grazed by livestock, modified to a condition that prohibits sustained plant and animal colonization, or dominated by built-up or residential structures (Kutcher et al. 2005). This applies to manipulation in any stratum of the cover; for example, within a developed landscape, an area covered by trees over regularly mowed lawn is classified as Cultural, while a wooded lot untended for over a year is classified as a habitat. Habitats occurring within broad land use types (e.g. shrublands within parks or residential areas) should be classified as habitats. Also, areas that have been extensively modified in the past, but are ecologically functional as habitat (e.g. a dammed mill pond where there once was a stream and flood plain), should be classified according to the current habitat and are not classified as Cultural. Finally, habitats within management areas where ecological features are manipulated specifically to duplicate or enhance natural processes (such as the manipulation of pond water levels) are generally exempt from the Cultural designation and should be classified as habitats; however, such manipulations should be

noted as a *Special* modifier to the data (see *Modifiers* section below). The user will need to use best professional judgment in some cases.

Limits: The Cultural Land Cover System is bounded by any natural or recovering habitat.

Cultural Subsystems:

8100. Developed Upland—Any cultural upland modified or manipulated for reasons other than direct agricultural use. In addition to urban, suburban, and industrial areas, this Subsystem includes large structures and structural complexes within upland agricultural settings or supporting agricultural practices.

8200. Agricultural Upland—Any cultural upland area modified or regularly manipulated to directly support plant or animal agriculture. This does not include large supporting structures and structural complexes, nor does it include wetlands or waters in an agricultural setting, such as wet pastures, cranberry bogs and aquaculture facilities.

8300. Developed and Managed Wetlands and Waters—Any wetlands or waters dominated by cultural structures or practices (i.e. regular manipulation), or constructed, modified, or polluted in a manner that prevents colonization of plants or sessile fauna. This subsystem includes agricultural wetlands and waters. It does not include formerly wet areas that have been filled and converted to developed or natural uplands. However, it does include structures that water can freely pass through, over, or under, such as a rubble breakwater, pier, floating dock, or bridge.

Level 3: Classes

The CLASSES (Level 3) described below have been adopted directly from the NWCS, added within the existing NWCS content to supply further detail, or appended to the NWCS to include upland, permanently frozen, and cultural cover types. Classes are coded in at the tens-level, ascending from 10 to as high as 80 within each Subsystem. Note that numeric heading digits for Classes are not exclusive to Class type, but are applied below each Subsystem as necessary to represent the number of classes within. Wetland Classes have generally been adopted directly from the NWCS. Upland Habitats Classes are analogous to wetland Classes, while Cultural Classes are either derived from Anderson et al. (1976) or adapted from the NWCS. Perennial Snow and Ice Habitat Classes have not been developed here.

The Class level characterizes the often complex structure of the landscape. In order to facilitate consistent inventory, the NWCS established an important description and rule set that applies to all **habitat classes** here. Deviations from the NWCS are inserted in bracketed normal text:

The CLASS is the highest taxonomic unit below the Subsystem level. It describes the general appearance of the habitat in terms of either the dominant life form of the vegetation or the physiography and composition of the substrate—features that can be recognized without the aid of detailed environmental measurements…
…If vegetation (except pioneer species) covers 30% or more of the substrate, we distinguish Classes on the basis of the life form of the plants that constitute the uppermost layer of vegetation and that possess an aerial coverage 30% or greater. For example, an area with 50% areal coverage of trees over a shrub layer with a 60% areal coverage would be classified as Forested Wetland [or Upland]*; an area with 20% areal coverage of trees over the same (60%) shrub layer would be classified as Scrub-Shrub Wetland* [or Upland]*. When trees or shrubs alone cover less than 30% of an area but in combination cover 30% or more, the wetland* [or Upland] *is assigned to the Class Scrub-Shrub. When trees and shrubs cover less than 30% of the area but the total cover of vegetation (except pioneer species) is 30% or greater, the* [cover] *is assigned to the appropriate Class for the predominant life form below the shrub layer. …If vegetation covers less than 30% of the substrate, the physiography and composition of the substrate are the principal characteristics used to distinguish Classes. …Bottoms, Shores, and Streambeds are separated on the basis of duration of inundation. In the Riverine, Lacustrine, and Palustrine Systems, Bottoms are submerged all or most of the time, whereas Streambeds and Shores are exposed all or most of the time. In the Marine and Estuarine Systems, Bottoms are Subtidal, whereas Streambeds and Shores are Intertidal. Bottoms, Shores, and Streambeds are further divided at the Class level on the basis of the important characteristic of rock versus unconsolidated substrate…Reefs are a unique class in which the substrate itself is composed primarily of living and dead animals…*

Cultural Classes are basically to habitat Classes in concept and scope. They are based on NWCS Classes, USDA/NRCS Curve Number Tables (USDA 1986), or Anderson et al. (1976) recommendations for Level III to allow consistent analyses with habitat types while allowing application in landscape models developed around the Curve Numbers and Anderson systems, including those estimating infiltration and runoff. Like habitat Classes, Cultural Classes are often determined by the dominant (tallest) life form covering a significant area of the surface; however, this is extended to the tallest cover in general, manmade structures included.

The context and the size of the structural components of the land cover and the user-defined minimum mapping unit (MMU) will sometimes determine the Class designation. A cultural structure larger than the MMU that falls within a natural matrix (i.e. a habitat) or any area of lower development intensity will be identified as the specific unit it represents, but if it falls within a complex that is defined as comprising such structures, it is considered part of that complex. For example, a large parking lot within a natural or residential setting will be identified as 8110 Impervious Cover, while the same large lot within a commercial or industrial complex will be classified as a continuous part of that complex (8120 Built-up Cover). In contrast, a habitat should always be discriminated if it is larger than the MMU. For example, an unmanaged, treed lot larger than the MMU situated within either a cultural or natural matrix is classified as 6250 Forested Upland,

while a similar treed lot smaller than the MMU within the same matrix will be classified as part of the surrounding matrix.

Habitat Classes

The following **wetland and aquatic** habitat Classes were largely adopted from the NWCS; deviations are inserted in bracketed normal text while definition-altering omissions are represented by an empty set of brackets. Refer to the NERRSCS outline (App.1) for specific Subsystem—Class—Subclass associations.

Rock Bottom

Definition. The Class Rock Bottom includes all wetlands and [aquatic] *habitats with substrates having an areal cover of stones*[1]*, boulders*[2]*, or bedrock 75% or greater and vegetative cover of less than 30%. Water regimes are restricted to subtidal, permanently flooded, intermittently exposed, and semipermanently flooded.*

Unconsolidated Bottom

Definition. The Class Unconsolidated Bottom includes all wetland and [aquatic] *habitats with at least 25% cover of particles smaller than stones, and a vegetative cover less than 30%. Water regimes are restricted to subtidal, permanently flooded, intermittently exposed, and semipermanently flooded.*

Aquatic Bed

Definition. The Class Aquatic Bed includes wetlands and [aquatic] *habitats dominated by plants* [or soft sessile invertebrates] *that grow principally on or below the surface of the water for most of the growing season in most years. Water regimes include subtidal, irregularly exposed, regularly flooded, permanently flooded, intermittently exposed, semipermanently flooded, and seasonally flooded.*

Reef

Definition. The Class Reef includes ridge-like or mound-like structures formed by the colonization and growth of sedentary invertebrates. Water regimes are restricted to subtidal, irregularly exposed, regularly flooded, and irregularly flooded.

Streambed

Definition. The Class Streambed includes all wetlands contained within the Intermittent Subsystem of the Riverine System and all channels of the Estuarine System [] *that are completely dewatered at low tide.*

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[1] Stones: particle size ranges from *25.4 cm (10 in) to 60.4 cm (24 in).*
[2] Boulders: rock fragments are greater than *60.4 cm (24 in).*

Rocky Shore

Definition. The Class Rocky Shore includes wetland environments characterized by bedrock, stones, or boulders which singly or in combination have an areal cover of 75% or more and an areal coverage by vegetation of less than 30%. Water regimes are restricted to irregularly exposed, regularly flooded, irregularly flooded, seasonally flooded, temporarily flooded, and intermittently flooded.

Unconsolidated Shore

Definition. The Class Unconsolidated Shore includes all wetland habitats having three characteristics: (1) unconsolidated substrates with less than 75% areal cover of stones, boulders, or bedrock; (2) less than 30% areal cover of vegetation other than pioneering plants; and (3) any of the following water regimes: irregularly exposed, regularly flooded, irregularly flooded, seasonally flooded, temporarily flooded, intermittently flooded, saturated, or artificially flooded. Intermittent [] *channels of the Riverine System and intertidal channels of the Estuarine System are classified as Streambed.*

Moss-Lichen Wetland

Definition. The Moss-Lichen Wetland Class includes areas where mosses or lichens cover substrates other than rock and where emergents, shrubs, or trees make up less than 30% of the areal cover. The only water regime is saturated.

Emergent Wetland

Definition. The Emergent Wetland Class is characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants. All water regimes are included except subtidal and irregularly exposed.

Scrub-Shrub Wetland

Definition. The Class Scrub-Shrub Wetland includes areas dominated by woody vegetation less than 6 m (20 feet) tall. The species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions. All water regimes except subtidal are included.

Forested Wetland

Definition. The Class Forested Wetland is characterized by woody vegetation that is 6 m tall or taller. All water regimes are included except subtidal.

The following **Upland** Habitats Classes are directly analogous to the NWCS but are associated with upland areas. Analogous NWCS wetland Class definitions have been

modified below through the insertion of bracketed normal text. Associated Subclasses are listed for each.

Rocky Upland

Definition. The Class Rocky [Upland] *includes* [upland] *environments characterized by bedrock, stones, or boulders which singly or in combination have an areal cover of 75% or more and an areal coverage by vegetation of less than 30%.*

Unconsolidated Upland

Definition. The Class Unconsolidated [Upland] *includes all* [upland] *habitats having* [two] *characteristics: (1) unconsolidated substrates with less than 75% areal cover of stones, boulders, or bedrock* [and] *(2) less than 30% areal cover of vegetation.*

Herbaceous Upland

Definition. The [Herbaceous Upland] *Class is characterized by erect, rooted, herbaceous* [upland flora]. *This vegetation is present for most of the growing season in most years.*

Scrub-Shrub Upland

Definition. The Class Scrub-Shrub [Upland] *includes areas dominated by woody vegetation less than 6 m (20 feet) tall. The species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions.*

Forested Upland

Definition. The Class Forested [Upland] *is characterized by woody vegetation that is 6 m tall or taller.*

Cultural Classes

Cultural Land Cover Classes are basically analogous to NWCS Classes but are associated with Cultural areas and are defined as follows:

Impervious Cover

The surface is entirely covered with continuous manmade materials that are impenetrable to water. This may include complexes of impervious surfaces, such as a building surrounded by a large parking lot, where imperviousness is proportionally at or near 1.0.

Built-up Cover

The surface is covered by a commercial, industrial, or service structure or complex generally characterized by large buildings and facilities, and dense transportation systems. Average impervious area generally ranges from 0.70 to 0.85 (USDA 1986).

Residential Cover

The landscape is generally characterized by a complex of residential buildings, lawns, scattered trees and shrubs, and a sparse to moderately dense transportation system. Average impervious area generally ranges from 0.25 to 0.75 (USDA 1986).

Rocky Cover

Analogous to the classes Rocky Shore and Rock Bottom, Rocky Cover represents a surface covered by *bedrock, stones, or boulders which singly or in combination have an areal cover of 75% or more and an areal coverage by vegetation of less than 30%* (Cowardin et al. 1979), and which is the result of human construction or manipulation. Submerged or intertidal rocky structures will generally quickly develop into habitat and then be classified as Rock Bottom or Rocky Shore, respectively.

Unconsolidated Cover

Analogous to Unconsolidated Bottom and Unconsolidated Shore, Unconsolidated Cover represents constructed or manipulated areas characterized by unconsolidated substrates with *less than 75% areal cover of stones, boulders, or bedrock and less than 30% areal cover of vegetation* (Cowardin et al. 1979).

Herbaceous Cover

Any culturally manipulated uplands or wetlands that are dominated by non-woody vegetation. This may include lawns, crops, hay fields, pastures, gardens, etc.

Shrub Cover

Analogous to the Scrub-Shrub habitat Classes, Shrub Cover represents uplands and wetlands *dominated by woody vegetation less than 6 m (20 feet) tall. The species include true shrubs, young trees, and trees or shrubs that are small or stunted* (Cowardin et al. 1979) that are actively culturally manipulated. This includes, but is not limited to, manicured shrubs within developed areas, agricultural nurseries, and agricultural wetlands—such as agricultural cranberry bogs.

Tree Cover

Analogous to the Forested habitat Class, Tree Cover represents uplands and wetlands *characterized by woody vegetation that is 6 m tall or taller* (Cowardin et al. 1979) that are regularly manipulated within any stratum (e.g. mowing, shrub removal, clearing, etc.)

Level 4: Subclasses

SUBCLASSES are subdivisions within Classes based on finer structural or functional characteristics. **Wetland and aquatic** habitats are divided into subclasses according to the NWCS as follows:

Finer differences in life forms are recognized at the SUBCLASS level. For example, Forested Wetland is divided into the Subclasses Broad-leaved Deciduous, Needle-leaved Deciduous, Broad-leaved Evergreen, Needle-leaved Evergreen, and Dead. [Vegetated] *subclasses are named on the basis of the predominant life form.…* [Nonvegetated] s*ubclasses are based on finer distinctions in substrate material unless, as with Streambeds and Shores, the substrate is covered by, or shaded by, an areal coverage of pioneering vascular plants (often nonhydrophytes) of 30% or more; the Subclass is then simply "vegetated." Further detail as to the type of vegetation must be obtained at the level of* [Dominant Species]*… Subclasses of Reefs are designated on the basis of the type of organism that formed the reef.*

Nonvegetated upland habitats and cultural substrate types are likewise distinguished by particle size; vegetated upland habitats and cultural covers are distinguished by structure and density, agricultural type, or habit; Built-up covers are distinguished by imperviousness or complex type; and Residential Cover Subclasses are characterized by the density of residences.

Habitat Subclasses

The following habitat Subclasses are adopted from or modeled after the NWCS. Direct NWCS text is italicized below and any deviations are inserted in bracketed normal text. Any further information is written in normal text. Subclasses are ordered according to the classification outline; refer to Appendix 1 for strictly-associated parent Classes.

Bedrock: … *bedrock covers 75% or more of the surface.* Rock substrate is nearly continuous.

Rubble: … *less than 75% areal cover of bedrock, but stones and boulders alone, or in combination with bedrock, cover 75% or more of the surface.* Predominant particle size is greater than *25.4 cm (10 in).*

Cobble: …*unconsolidated particles smaller than stones* [constitute at least 25% aerial cover and] *are predominantly cobble.* Cobble ranges from *7.6 cm (3 in) to 25.4 cm (10 in) in diameter.*

Gravel: …*unconsolidated particles smaller than stones* [constitute at least 25% aerial cover and] *are predominantly gravel.* Gravel ranges from *2 mm (0.08 in) to 7.6 cm (3 in) in diameter.*

Sand: …*unconsolidated particles smaller than stones* [constitute at least 25% aerial cover and] *are predominantly sand.* Particle size ranges from *0.074 mm to 2.0 mm* in diameter.

Mud: *The …unconsolidated particles smaller than stones* [constitute at least 25% aerial cover and] *are predominantly* saturated or submerged] *silt and clay.* Particle size is *less than 0.074 mm in diameter.*

Organic: …*unconsolidated particles smaller than stones* [constitute at least 25% aerial cover and] *are predominantly organic.*

Clay (upland): Unconsolidated substrate constitutes at least 25% aerial cover and is dominated by clay or silt. Particle size is less than 0.074 mm.

Loam (upland): Unconsolidated substrate constitutes at least 25% aerial cover and is dominated by bare soil comprised of a mix of sand, silt, and clay.

Rooted Algal: Aquatic beds are comprised of rooted algae.

Drift Algal: Aquatic beds are dominated by non-rooted algae.

Rooted Vascular: Aquatic beds are dominated by rooted vascular, non-woody vegetation.

Floating Vascular: Aquatic beds are dominated by non-rooted vascular vegetation.

Aquatic Moss: Aquatic beds are dominated by aquatic mosses or liverworts.

Faunal: Aquatic beds are dominated by soft, sessile invertebrates.

Mollusk: Surface is dominated by hard-shelled, sessile mollusks.

Worm: *Worm Reefs are constructed by large colonies of Sabellariid worms living in individual tubes constructed from cemented sand grains.*

Moss: The surface is covered with moss, usually peat or sphagnum.

Lichen: The surface is dominated by lichens.

Persistent: *Persistent Emergent Wetlands are dominated by* [herbaceous plant] *species that normally remain standing at least until the beginning of the next growing season.*

Nonpersistent: *Wetlands in this Subclass are dominated by* [emergent] *plants which fall to the surface of the substrate or below the surface of the water at the end of the growing season so that, at certain seasons of the year, there is no obvious sign of emergent vegetation.*

Grassland: Herbaceous upland habitat that is dominated by graminoids.

Broad-leaved Herbs: Herbaceous upland habitat that is dominated by forbs.

BLD: Broad-leaved deciduous vegetation constitutes > 75% of the dominating woody vegetation crown cover.

NLD: Needle-leaved deciduous vegetation constitutes > 75% of the dominating woody vegetation crown cover.

BLE: Broad-leaved evergreen vegetation constitutes > 75% of the dominating woody vegetation crown cover.

NLE: Needle-leaved evergreen vegetation constitutes > 75% of the dominating woody vegetation crown cover.

Mixed: No single leaf type constitutes > 75% of the dominating woody vegetation crown cover. This diverges from the NWCS which does not contain a Mixed subclass, instead classifying mixed crown cover strictly by the dominant (> 50%) leaf type. Because actual leaf types are not identified by this subclass designation, the use of the Dominant Species nominal category is recommended when employing the Mixed subclass.

Dead: Standing deadwood constitutes > 30% aerial cover and total living vegetation comprises < 30% cover.

Cultural Subclasses

Cultural Subclasses are defined as follows:

Paved Lot: Continuous paved surface; may include parking lots, airport runways, etc., not adjacent to or contained within a Commercial, Service, or Industrial Complex.

Paved Roadway: Linear paved surfaces, including roads, highways, overpasses, and paved railways not adjacent to or contained within a Commercial, Service, or Industrial, Complex. Paved roads wider than two lanes within residential complexes should be classified here, while roads two lanes or less should be classified as part of the residential complex.

Large Building: Any building larger than a user-defined minimum mapping unit and not adjacent to or contained within a Commercial, Service, or Industrial Complex.

Impervious Complex: Any contiguous area of completely impervious cover not adjacent to or contained within a Commercial, Service, or Industrial Complex.

Commercial or Service Complex: This land cover is generally characterized by large commercial buildings and facilities, and dense transportation systems, but extends to

retail and service development within any landscape, including those within wetlands and waters and within agricultural settings. Examples include retail shopping areas, religious or government facilities, marina facilities and docks, penned aquaculture sites etc. Imperviousness generally averages approximately 0.85 (USDA 1986).

Industrial Complex: This Subclass is characterized by industrial facilities of any sort, including those within an agricultural setting. Imperviousness generally averages approximately 0.72 (USDA 1986).

Semi-pervious Cover: The surface is entirely covered with continuous manmade materials or structures that are partly penetrable by water. This does not include commercial, service, or industrial complexes. Examples include semi-pervious asphalt lots and large wooden piers.

Low Density: Residential complex containing less than two units per acre. Imperviousness generally averages approximately 0.25 (USDA 1986).

Medium Density: Residential complex containing two to eight units per acre. Imperviousness generally averages approximately 0.38 (USDA 1986).

High Density: Residential complex containing greater than eight units per acre. Imperviousness generally averages approximately 0.65 (USDA 1986).

Rocky Revetment: Any large exposed rock structure within uplands, including retaining walls, rock piles, etc.

Open Quarry: Any excavated area covered with rock.

Dirt/gravel Lot: Non-linear area covered with compacted unconsolidated substrate including gravel, sand, shell, pea-stone etc.

Dirt/gravel Road: Linear area covered with compacted unconsolidated substrate including gravel, sand, shell, pea-stone etc.

Railway Corridor: Railway corridor having a gravel or similar base.

Mining Operation: Any current or recent excavated area covered with unconsolidated substrate.

Landfill Operation: An area covered in unconsolidated materials, where refuse is dumped and buried.

Cleared Land: Any area recently cleared of vegetation; for example, construction sites or clear-cuts.

Managed Turf: Any non-agricultural area dominated by mown grasses; includes parks, ball fields, large lawns, etc.

Managed Garden: Any upland area covered by planted and managed herbaceous vegetation not for harvest.

Managed Old Field: Any upland area covered by managed natural herbaceous vegetation not for harvest.

Managed Shrubs: Any area covered by planted and managed shrub vegetation not for harvest, including extensive hedges, etc.

Managed Trees: Any managed area dominated by trees not for harvest or fruit; includes parks, large treed yards, etc.

Unvegetated Farmland: Any fallow agricultural land.

Turf: Farmland growing lawn grass for harvest.

Pasture: Regularly grazed agricultural grassland.

Hay Meadow: Farmland growing feed hay for harvest.

Crops/Cover Crops: Farmland growing conventional herbaceous crops and/or cover crops in rotation, including grains.

Shrub Nursery: Farmland growing shrubbery for harvest.

Grazed Shrub Upland: Regularly grazed upland dominated by shrubs.

Tree Farm: Any regularly maintained agricultural area dominated by trees grown for harvest.

Orchard: Any regularly maintained agricultural area dominated by trees grown to bear fruit for harvest.

Grazed Wooded Upland: Any regularly grazed area dominated by trees.

Impervious Bottom/shore: Any submerged or periodically flooded area covered by a continuous, submerged, impervious cultural substrate; e.g. boat ramps, lined waterways.

Impervious In-water Structure: Any submerged or periodically flooded area covered by a continuous, impervious, emerged cultural substrate or structure; e.g. bridges.

Pervious In-water Structure: Any submerged or periodically flooded area covered by a continuous, pervious or semi-pervious, emerged cultural structure; e.g. wooden piers.

In-water Commercial or Service Complex: A commercial or service complex dominates the land cover within any submerged or periodically flooded area; e.g. marinas, commercial wharfs, etc.

In-water Industrial Complex: An industrial complex dominates the land cover within any submerged or periodically flooded area; e.g. oil rigs, major ports, etc.

Shellfish Aquaculture: Any submerged or periodically flooded area dominated with gear or structurally/functionally modified in support of shellfish aquaculture.

Finfish Aquaculture: Any submerged or periodically flooded area dominated with gear or structurally/functionally modified in support of finfish aquaculture.

In-water Residential Complex: Residential complex built within or over any submerged or periodically flooded area; generally stilted housing.

Rocky Shoreline Structure: Any rock structure built at or across the interface of two of the following: waters, periodically flooded areas, upland areas; e.g. a breakwater.

Rocky In-water Structure: Any periodically emerged or emerged cultural in-water rock structure; e.g. a rock pier.

Managed Unconsolidated Bottom: Any regularly manipulated submerged area with unconsolidated substrate; e.g. a regularly dredged channel.

Managed Unconsolidated Shore: Any regularly manipulated periodically flooded area with unconsolidated substrate; e.g. a groomed beach.

Managed Herbaceous Wetland: Any non-agricultural, regularly manipulated herbaceous wetland.

Agricultural Herbaceous Wetland: Any cultivated herbaceous wetland.

Grazed Herbaceous Wetland: Any regularly grazed herbaceous wetland.

Managed Shrub Wetland: Any non-agricultural, regularly manipulated shrub wetland.

Agricultural Shrub Wetland: Any cultivated shrub wetland.

Grazed Shrub Wetland: Any regularly grazed shrub wetland.

Managed Wetland Trees: Any non-agricultural, regularly manipulated wetland dominated by trees.

Agricultural Wetland Trees: Any cultivated wetland dominated by trees.

Grazed Wooded Wetland: Any regularly grazed wetland dominated by trees.

2. Non-hierarchical Categories

Nominal Categories

Dominant Species

DOMINANT SPECIES is intended to be appended to the hierarchical data as a descriptive category*; specifically, it consists of the genus and species name(s) of the dominant plant(s) (or sedentary animal(s) for nonvegetated classes) within the characterizing Class. This category may further subdivide or simply add additional information to hierarchically derived geospatial units and may not be applicable to all classified units (i.e. some nonvegetated areas). Dominant Species may be an ecologically important category and should be included, if possible, in any dataset characterizing vegetated or reef habitats. It may be especially useful for identifying the vegetation composition of Mixed Subclasses. Dominant Species was adapted from the NWCS *Dominance Type* and is defined as below.

When the Subclass is based on life form, we name the [Dominant Species] *for the dominant species or combination of species (codominants) in the same layer of vegetation used to determine the Subclass. For example, a Needle-leaved Evergreen Forested Wetland with 70% areal cover of black spruce (Picea mariana) and 30% areal cover of tamarack (Larix laricina) would be designated as a Picea mariana* [Dominant Species]. *When the relative abundance of codominant species is nearly equal* [or the subclass is classified as Mixed], *the* [Dominant Species] *consists of a combination of species names. For example, an Emergent Wetland with about equal areal cover of common cattail (Typha latifolia) and hardstem bulrush (Scirpus acutus) would be designated a Typha latifolia-Scirpus acutus* [Dominant Species]. *When the Subclass is based on substrate material, the* [Dominant Species] *is named for the* [most abundant] *plant or sedentary or sessile macroinvertebrate species,* [even though the life form may not technically dominate the habitat (by at least 30% areal cover as needed for Class designation)].

Descriptors

DESCRIPTORS are attributes comprising a non-hierarchical, descriptive category (single column) that is appended beyond the hierarchy to provide a single common name for each habitat and cover type. Descriptors consist of or land use names commonly used in national or regional scientific literature. Descriptors represent each geospatial unit within the dataset by the association of its hierarchical attributes (System, Subsystem, Class, and Subclass), the Dominant Species, and possibly certain modifiers, and thus should not subdivide the data. However, a single Descriptor may represent a plant community

* Refer to glossary for definition

comprised of more than one Dominant Species units; for example, the Descriptor *Salt Meadow* may contain polygons classified as separate *Spartina patens* and *Distichlis spicata* Dominant Species units. A Descriptor may characterize a habitat dominated by a single species (e.g. *Atlantic White Cedar Swamp*), by multiple species (e.g. *Pitch Pine-Oak Forest*), or by substrate (e.g. *Inland Sand Barren*). For certain cultural land covers, Descriptors may simply be reiterations of the subclass or class or they may describe the cover more specifically (e.g. *Cement Parking Lot*). Each Descriptor should be spatially distinct and exclusive, as well as entirely contiguous.

The use of Descriptors will primarily serve to facilitate communication between data providers and users. Descriptors may also allow crosswalking between classification systems, since they represent a concept that is commonly utilized in the different classification systems of the various Reserves, states, and agencies. Over time, a set of Descriptors and definitions will be developed, filed, and maintained on the NERRS intranet to avoid name overlap within the Reserve System. However, descriptors also may be developed and applied outside of the NERRS to meet specific project needs.

Modifier Categories

MODIFIERS beyond the classification hierarchy may be added as fields (columns) to a dataset attribute table to add greater descriptive and analytical detail or to facilitate crosswalking with different classification systems that use other criteria or codes. Recommended Modifiers include those employed by the NWCS, which further describe or subdivide each habitat type by water regime, water chemistry (e.g. by salinity classes in ‰) and certain cultural modifications. Water or soil water chemistry modifiers enhance differentiation between *salt* and *brackish* estuarine wetland types, while cultural modifiers enable users to identify human activities affecting habitats, with terms such as *Impounded, Diked,* or *Excavated*. Nominal-numeric invasive species modifiers are also recommended here to identify the presence and percent cover of invasive species within each habitat. Modifier use may vary on a project-specific basis. Recommended Modifiers are listed below. Ideally, an evolving list of recommended Modifiers will be posted on the NERRS Intranet Site. Any user may present proposals for additions to this system-wide list of modifier categories or attributes.

The suite of modifiers listed and defined below is intended to be expandable. Any relevant geospatial variable can be appended as columnar data and incorporated into a dataset to meet the intended goals of the inventory. These will ideally draw from existing, established, or well-accepted classification schemes. For example, the Coastal and Marine Ecological Classification Standard (CMECS, Madden et al. 2005) is a national effort that has assembled a large set of attributes intended to classify marine and estuarine habitats by nationally standardized and accepted parameters. CMECS can be applied in this context as an extensive list of marine/estuarine modifiers capable of being appended to the NERRS data. In addition to providing the NERRSCS user with additional capabilities, the use of CMECS data will allow NERRS data to be linked to the expected nationally consistent body of CMECS data through the use of one or more columns of attributes.

Modifiers may be used to further describe or subdivide the hierarchical and nominal data described above. In the case of subdivision, data parameters may be delineated over existing data in "cookie-cutter" fashion—delineated as they exist in space and subdividing existing geospatial units as modifier parameters are delineated across them—or data may be subdivided in a hierarchical fashion; this will depend on the intent of the user, the inventory methods, and the modifier type.

Many Modifier categories are relevant only to a subset of units within the landscape and thus, complete contiguity is not possible or necessary; spatial exclusivity, however, must be retained within each category.

Recommended Modifiers

Modifiers adapted from the NWCS are listed directly below. These include water regime, water chemistry, soil, and special modifiers. Partial definitions and other text adapted directly from the NWCS are italicized. Deviations or expansions of definitions and terms are inserted in brackets or appended in normal font.

Water Regime: For wetland and aquatic cover types only. * Denotes tidal; all others are nontidal.

- Subtidal*
- Irregularly Exposed*
- Regularly Flooded*
- Irregularly Flooded*
- Permanently Flooded
- Intermittently Exposed
- Semipermanently Flooded
- Seasonally Flooded
- Saturated
- Temporarily Flooded
- Intermittently Flooded
- Artificially Flooded

Definitions for Water Regime Modifiers are as follows:

(Tidal: The water regimes are largely determined by oceanic tides.)

- *Subtidal: The substrate is permanently flooded with tidal water.*
- *Irregularly Exposed: The land surface is exposed by tides less often than daily.*
- *Regularly Flooded: Tidal water alternately floods and exposes the land surface at least once daily.*
- *Irregularly Flooded: Tidal water floods the land surface less often than daily.*

(Nontidal: Though not influenced by oceanic tides, nontidal water regimes may be affected by wind or seiches in lakes.)

- *Permanently Flooded: Water covers the land surface throughout the year in all years.*

- *Intermittently Exposed: Surface water is present throughout the year except in years of extreme drought.*
- *Semipermanently Flooded: Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land surface.*
- *Seasonally Flooded: Surface water is present for extended periods especially early in the growing season, but is absent by the end of the season in most years. When surface water is absent, the water table is often near the land surface.*
- *Saturated: The substrate is saturated to the surface for extended periods during the growing season, but surface water is seldom present.*
- *Temporarily Flooded: Surface water is present for brief periods during the growing season, but the water table usually lies well below the soil surface for most of the season.*
- *Intermittently Flooded: The substrate is usually exposed, but surface water is present for variable periods without detectable seasonal periodicity. Weeks, months, or even years may intervene between periods of inundation.*
- *Artificially Flooded: The amount and duration of flooding is controlled by means of pumps or siphons in combination with dikes or dams.*

Salinity: Surface and wetland soil water salinity. * The suffix "haline" denotes ocean-derived salts; modifiers with the suffix "saline" are used inland. Units are in parts per thousand (‰).

- Hyperhaline (>40‰*)
- Euhaline (30.0-40‰*)
- Polyhaline (18.0-30‰*)
- Mesohaline (5.0-18‰*)
- Oligohaline (0.5-5‰*)
- Hypersaline (>40‰)
- Eusaline (30.0-40‰)
- Polysaline (18.0-30‰)
- Mesosaline (5.0-18‰)
- Oligosaline (0.5-5‰)
- Fresh (<0.5‰)

Special: Historical or ongoing modifications influencing the character of wetland habitats.

- Excavated
- Impounded
- Diked
- Partly drained
- Artificial
- Farmed
- Dredged

Definitions for Special Modifiers:

- *Excavated: Lies within a basin or channel excavated by man.*
- *Impounded: Created or modified by a barrier or dam which purposefully or unintentionally obstructs the outflow of water. Both manmade dams and beaver dams are included.*
- *Diked: Created or modified by a man-made barrier or dike designed to obstruct the inflow of water.*
- *Partly Drained: The water level has been artificially lowered, but the area is still classified as wetland because soil moisture is sufficient to support hydrophytes. Drained areas are not considered wetland if they can no longer support hydrophytes.*
- *Artificial: Refers to substrates classified as Rock Bottom, Unconsolidated Bottom, Rocky Shore, and Unconsolidated Shore that were emplaced by man, using either natural materials such as dredge spoil or synthetic materials such as discarded automobiles, tires, or concrete. Jetties and breakwaters are examples of Artificial Rocky Shores. Man-made reefs are an example of Artificial Rock Bottoms.*
- *Farmed: The soil surface has been mechanically or physically altered for production of crops, but hydrophytes will become reestablished if farming is discontinued.*
- Dredged: The channel or bottom has been lowered, through the removal of sediment, by man.

Recommended Modifiers developed within the NERRS are listed below.

Tidal Geoform: Meso-topographic features of tidal coastal habitats. Tidal Geoforms are applied as relevant within specific tidal zones as defined below.

- Bay
- Cove
- Lagoon
- Pool
- Subtidal Creek
- Intertidal Creek
- Intertidal Flat
- Beach
- Panne
- Low Marsh
- High Marsh Surface

Definitions for Tidal Geoforms are as follows:

Subtidal Geoforms: apply to subtidal units.

- Bay: A coastal embayment with an area ≥260 ha (1.0 mi^2) and ≥50% enclosure*.
- Cove: A coastal embayment with an area <260 ha (1.0 mi^2) and 25% to 75% enclosure.
- Lagoon: A shallow coastal embayment with an area <260 ha (1.0 mi^2) and >75% enclosure that is at least seasonally directly connected to a larger water body.
- Pool: A small water body, usually within an intertidal zone (e.g. within a high marsh, intertidal flat, etc.), that is indirectly connected (via overland flow or a

* Refer to glossary for definition

tidal creek) to the sea by tidal flooding. Many pools are also fed by groundwater or fresh surface runoff that helps maintain flooding during neap tides. Pools differ from *Pannes* in that they are submerged throughout most lunar cycles during the entire season in most years (*subtidal* or *irregularly exposed*).

- Subtidal Creek: Subtidal channel running through an intertidal feature such as a high marsh, low marsh, tidal flat, or beach.

Intertidal Geoforms: apply to intertidal units.

- Intertidal Creek: Intertidal channel running through an intertidal feature such as a high marsh, low marsh, tidal flat, or beach.
- Panne: A small depression, usually within a high marsh, that is indirectly connected (via overland flow or an intertidal creek) to the sea by irregular tidal flooding (e.g. spring tides only). Pannes differ from *Pools* in that they do not retain water throughout most lunar cycles (*irregularly flooded*).
- Low Marsh: Regularly flooded tidal wetland dominated by emergent vegetation.
- High Marsh: Irregularly flooded tidal wetland dominated by emergent or scrub-shrub vegetation.
- Intertidal Flat: Low-energy, unvegetated feature formed primarily by tides and generally having a fine sand or mud substrate with little or no slope.
- Beach: Moderate- to high-energy unvegetated feature formed primarily by waves and generally having a sand or coarser unconsolidated substrate with mild to moderate slope.

Managed: Reflect management actions affecting the habitats, and the number of full growing seasons between the action and the inventory (examples below). A list of management actions will be developed by users over time.

- Burned 0
- Burned 1
- Burned 2
- Mowed 0
- Mowed 1
- Mowed 2
- Tidally Restored 0
- Tidally Restored 1
- Tidally Restored 2

Prehistoric Modification: Sites with ecologically significant prehistoric substrate or landscape modifications existing beneath or within contemporary habitat types (examples below). A list of prehistoric attributes will be developed by users over time.

- Ceremonial Mounds
- Middens
- Scatter Sites

Natural Disturbance: Identifies natural disturbances that have had an effect on the habitat, and number of growing seasons since the disturbance (examples below). A list of natural disturbance attributes will be developed by users over time.

- Fire 4
- Flooding 2
- Tornado 3

Important Species: Nominal/numeric modifier that identifies species within a habitat that may be important ecologically, but perhaps not numerically or physically dominant, in e.g. individuals per area or volume (examples below).

- *Littorina littorea* 20 m^{-2}
- *Fundulus heteroclitis* 15 m^{-2}
- *Lumbricus* sp. 50 m^{-2}

III. Recommendations

Applying the Scheme

The body of this document is intended to be used in concert with the classification outline (App. 1) to determine the classification of each area of interest. I recommend the following approach to applying this classification:

1. Determine the level of detail appropriate for the project and the source data; for example, all four levels of the hierarchy plus Dominant Species, Descriptors, and the Tidal Geoform Modifier may be an appropriate level of detail for characterizing your coastal property with data derived from 1:12,000 aerial photography.
2. Discriminate units of interest to their smallest subdivisions (e.g. Dominant Species or Tidal Geoform above, since Descriptors do not subdivide units). For each distinct unit of interest (polygon), use the classification outline (App. 1) as a key and the body of this document as a set of definitions to determine its classification at each level in ascending order, starting with System (L1).
3. Work through Subsystem (L2), Class (L3), and Subclass (L4) within the outline, followed by Dominant Species, Descriptor, and Modifiers for each unit. In the classification outline, under each level of the hierarchy (L1 to L4), and in certain modifiers, all possible sublevels are listed; choose from among those only. If a subcategory characterizing your unit of interest is not listed, check prior determinations at the higher levels for user error; otherwise, the most appropriate subcategory should be selected.

The Use of GIS and Columnar Formatting

The NERRSCS is intended to be stored, displayed, analyzed, and organized in a geographic information system (GIS). Although other formats of inventory (including hard-copy maps) are capable of organizing in a way that allows presentation and analysis of data, a GIS allows the data to be geo-referenced against other geo-rectified data for overlay and other analysis. When applied in a GIS, the hierarchical structure of the

NERRSCS and recommended columnar inventory format will allow a carefully-collected NERRSCS-derived inventory to act as a robust analytical tool for numerous aspects of ecological management, planning, and scientific investigation.

Application of the recommended columnar format is perhaps the most important aspect in unlocking the analytical utility of this classification scheme. While geospatial land cover inventory conventionally utilizes a coding system in a single data column to represent the levels of the classification scheme being applied, this convention was originally developed to allow coding in small polygons displayed on a hard-copy map. This practice is no longer necessary with the advent of computer systems that allow the user to view and analyze the data at any level of interest and in any number of conceptual combinations of attributes and categories, and represent those data in an array of colors and textures that can be referred to in an automatically-generated key.

In essence, a columnar dataset functions like a two-way dictionary; not only can a unit be defined through an ordered query, but any part of the definition can be used to identify associated units. For example, all shrub-dominated areas can be identified by querying Class; all estuarine areas can be identified (and quantified) by querying System; all shrub-dominated estuarine areas can be identified by querying Class and System; all shrub-dominated, haline, estuarine areas can be identified by querying Class, Subsystem, and System, etc; the combinations are nearly endless.

A columnar dataset is also expandable to the capacity of the software. Any number columns can be added, representing additional information about the unit (row). This facilitates compatibility with any number of other classification schemes, since the coding system for another scheme can be manually or automatically appended to the NERRSCS dataset in the form of additional columns representing each unit as appropriate. Database software may enhance or expand these capabilities.

Exclusivity and Contiguity

Complete spatial exclusivity and contiguity of hierarchical data are essential to achieve robust analytical utility within a columnar format (above). **Exclusivity** refers to each attribute within each category being conceptually and spatially distinct from all other attributes in that category. This prevents overlap and thus ensures accurate quantification in relative analyses. Complete **contiguity**, referring to a lack of gaps between spatial units and their attributes, works to the same end. Together, they ensure that data are complete for any given area across all levels of the hierarchy. In columnar format, unit attributes within the hierarchy that are unknown should be replaced with the closest known parent level inserted as a placeholder; for example, if the particle size of an area with an unconsolidated bottom is not known, insert *Unconsolidated Bottom* into the Subclass column to reflect the (known) Class column designation.

Although the real world is comprised of three dimensions, geospatial data are conventionally measured by only two of those dimensions, *x* and *y* coordinates, to retain analytical utility. Recent efforts have focused on inventorying the natural world in three

dimensions, and this adds a comprehensive quality to the data. But, it introduces complexities in conceptualizing, quantifying, analyzing, and displaying the data. Most specifically, the addition of third-dimensional data results in area overlap which complicates relative and actual quantification of the land cover, which is the primary intent of this effort. For these reasons, third dimensional data are considered to be beyond the scope of the NERRSCS.

Hydrologic and Chemical Delineations

Many habitat delineations are best made according to the boundaries of indicative vegetation. Specifically, water regimes, water chemistry, and soil-water chemistry vary greatly over space and time on regular and seasonal intervals. Vegetation is exposed to these fluctuations continuously and is therefore often the best indicator of "average" condition. For example, in New England, the boundary between regularly and irregularly flooded salt marsh (often referred to as low marsh and high marsh, respectively) can often easily be identified at the interface between tall *Spartina alterniflora* and one of the salt meadow forms (e.g. *Spartina patens* or *Distichlis spicata*). Often, vegetation also best represents the ecological response to changes in water regime and chemistry, since it interacts so closely with both the physical environment and the rest of the living world. Finally, because vegetation is an actual and measurable component of the landscape, it is a most useful and intuitive parameter to delineate.

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Appendix 2: Glossary of Key Terms

category A set of attributes comprising any single hierarchical, nominal, or modifier class applied in this classification.

aquatic Replacing the term *deepwater* from the NWCS, aquatic, here, refers to all subtidal waters of the Estuarine System, subtidal nearshore (>30 m) waters of the Marine System, and any nontidal waters deeper than 2 m (6.6 feet) or the extent of vegetation at low water (Cowardin et al. 1979).

enclosure % enclosure of an embayment can be estimated with the equation:

$$\% \text{ enclosure} = 1.00 - L_m / L_s$$

Where: L_m = the length across the mouth and
L_s = the length of the surrounding shoreline

entirely contiguous Completely lacking gaps or voids between spatial units classified to any category.

natural Produced or existing without direct influence of humans.

recovering For habitats following a disturbance, any state in which plant or sessile animal colonization is progressing toward natural conditions

spatially exclusive Each attribute within a category is conceptually and spatially distinct from all other attributes in that category—thus, no overlaps in spatial data occur within the category.

uplands Terrestrial dry (non-wetland) lands, i.e. that do not at least periodically support mainly hydrophytes, are not dominated by hydric soils, and are not covered with water at some time during the growing season of each year (Cowardin et al 1979).

wetlands The Cowardin et al. (1979) definition applies in this classification as follows: *Wetlands are transitional lands between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water…wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.*

Appendix 3: NERRSCS-NWI Crosswalk

System	NERRSCS Subsystem	NERRSCS Code	NWI Code
Marine	Subtidal	1100	M1
	Intertidal	1200	M2
Estuarine	Subtidal Haline	2100	E1
	Intertidal Haline	2200	E2
	Supratidal Haline	2300	E2*
	Subtidal Fresh	2400	R1
	Intertidal Fresh	2500	P*
Riverine	Lower Perennial	3100	R2
	Upper Perennial	3200	R3
	Intermittent	3300	R4
Lacustrine	Limnetic	4100	L1
	Littoral	4200	L2
Palustrine	Perennial Water	5100	P
	Intermittent or Saturated	5200	P
Upland	All	6000	UP
Class	**Subclass**	**NERRSCS Code**	**NWI Code**
Rock Bottom	Bedrock	0011	RB1
	Rubble	0012	RB2
Unconsolidated Bottom	Cobble	varies	UB1
	Gravel	varies	UB1
	Sand	varies	UB2
	Mud	varies	UB3
	Organic	varies	UB4
Aquatic Bed	Rooted Algal	varies	AB1
	Drift Algal	varies	AB1
	Rooted Vascular	varies	AB3
	Floating Vascular	varies	AB4
	Aquatic Moss	varies	AB2
Rocky Shore	Bedrock	varies	RS1
	Rubble	varies	RS2
Unconsolidated Shore	Cobble	varies	US1
	Gravel	varies	US1
	Sand	varies	US2
	Mud	varies	US3
	Vegetated	varies	US4
	Organic	varies	US5
Moss-lichen	Moss	varies	ML1
	Lichen	varies	ML2
Emergent	Persistent	varies	EM1
	Nonpersistent	varies	EM2
Scrub-shrub	BLD	varies	SS1
	NLD	varies	SS2
	BLE	varies	SS3
	NLE	varies	SS4
	Dead	varies	SS5
Forested	BLD	varies	FO1
	NLD	varies	FO2
	BLE	varies	FO3
	NLE	varies	FO4
	Mixed	varies	varies
	Dead	varies	FO5

*likely designation