BACKGROUND

What is Restoration?

The term *restoration* has a number of definitions, all of which share similar ideas. They often refer to the return of an area to a previous condition by improving the biological structure and function (NOAA 2002).

Some examples of definitions of restoration put forth by various authors and agencies are as follows:

- A putting or bringing back into a former, normal, or unimpaired state or condition (McKechnie 1983).
- A return from a disturbed or totally altered condition to a previously existing natural or altered condition by some action of man (Lewis 1990).
- Returning an ecosystem to a close approximation of its condition prior to disturbance (NRC 1992; Claw et al. 1998).
- Returning a degraded wetland or former wetland to a pre-existing condition or as close to that condition as is possible (NOAA 2002 online).
- The rehabilitation of wetlands that may be degraded or hydrologically altered; often involves reestablishing the vegetation (Mitsch and Gosselink 2000).
- The process of reestablishing a self-sustaining habitat that closely resembles a natural condition in terms of structure and function (NOAA 2002 online).
- The process of assisting the recovery and management of ecological integrity including a critical range of variability in biodiversity, ecological processes and structure, regional and historical context, and sustainable cultural practices (SER 2002).
- An attempt to reset the ecological clock and return a damaged ecosystem to its pre-disturbed state in structure and function (Cunningham et al. 1994).

The Society of Wetland Scientists (2000) defines wetland restoration as actions taken in a converted or degraded natural wetland that result in the reestablishment of ecological processes, functions, and biotic/abiotic linkages and lead to a persistent, resilient system integrated within its landscape. The Society believes that since the science of restoration is young, there is currently ambiguity in the use of the term. In an effort to develop a clear and consistent definition, they suggest five key elements necessary to define the concept effectively:

1. Restoration is the reinstatement of driving ecological processes.
2. Restoration should be integrated with the surrounding landscape.
3. The goal of wetland restoration is a persistent, resilient system.
4. Wetland restoration should result in the historic type of wetland but may not always result in the historic biological community and structure.
5. Restoration planning should include the development of structural and functional objectives and performance standards for measuring achievement of the objectives.

In this manual, restoration is defined as follows:

"*The process of reestablishing a self-sustaining habitat that in time can come to closely resemble a natural condition in terms of structure and function.*" -Turner and Streever 2002.

The definition of restoration used in this volume reinforces the definition of *estuary habitat restoration activity* that is defined in the ERA. Both call for the improvement of degraded habitat with the goal of reestablishing both structure and function integrated into the surrounding landscape.

Figure 2. Metzger Marsh on Lake Erie in 1994 before restoration. Photo courtesy of Doug Wilcox, United States Geological Survey. http://www.glsc.usgs.gov/science/wetlands/WilcoxWeb.htm.

Figure 3. Metzger Marsh on Lake Erie in 1996 after restoration. Photo courtesy of Doug Wilcox, United States Geological Survey. http://www.glsc.usgs.gov/science/wetlands/WilcoxWeb.htm.

Why Coastal Habitat Restoration?

Coastal habitats, including freshwater areas such as those associated with the Great Lakes, are among the most common habitats receiving restoration attention. Two hundred years ago there were 221 million acres (89.5 million hectares) of wetlands in the United States (Dahl 1990). Because of habitat destruction and replacement, only 105.5 million acres (42.7 million hectares) of wetlands remained in 1997 (Dahl 2001). Most destruction and alteration can be linked to population growth in coastal watersheds. Flooding, dredging, filling, construction, surface hardening, dam building, and sewage or other pollutant spilling have severely stressed many coastal habitats (Dahl 1990). Concerted attempts to restore damaged coastal ecosystems to a previous state have been ongoing since pollution became a major social and political issue in the 1960s (Alongi 1998).

Coastal habitats provide ecological, cultural, and economic value. They act as critical habitat for thousands of species by providing shelter, spawning grounds, and food. A high percentage of threatened and endangered species rely on these areas (Mitsch and Gosselink 2000). They act as buffers by filtering sediment and pollution from upland drainage to improve water quality, recharging aquifers, reducing the effects of floodwaters and storm surges, and preventing erosion. Coastal habitats provide cultural value to humans including recreation (boating, fishing, swimming, surfing, and bird watching), tribal subsistence, places of dwelling, scientific knowledge, and aesthetics. Tourism, commercial and recreational fisheries, and transportation are some examples of services coastal habitats provide that benefit the economy and provide goods to humans, both locally and nationally (EPA 1993). Because of their abundant values, coastal habitats should be managed carefully for the mutual benefit of all.

There are various categories of ecosystem stress, each of which can individually have a profound impact on restoration performance. Based on the recommendations of the Committee on Environment and Natural Resources Report on Ecological Forecasting (CENR 2001), NOAA has categorized environmental stressors under five headings:

Climate change can affect sea level, temperature, currents and water column stratification, precipitation, and storm frequency and intensity. In turn, these will impact freshwater inflows, sediment contribution to estuaries, and pollution.

Extreme natural events such as hurricanes, coastal storms, floods, and droughts produce environmental changes both directly and indirectly that can impact restoration project performance.

Pollution directly affects marine ecosystems and the performance of restoration. Non-point sources from agricultural and suburban runoff, and automobile and industrial air emissions have become stressors. Practitioners should be aware of how these could impact long-term performance of a restoration.

Invasive species can damage or replace native plants and animals. Resulting changes in community structure can impact the services and values that the restored habitat contributes to the coastal ecosystem. Invasive species have been a concern in many restoration projects on the east, west and Gulf coasts of the United States and coastal habitats of the Great Lakes. The common reed

(*Phragmites communis*), now considered native to the United States, is a rapid invader of coastal marshes, particularly where there has been disturbance. Australian pine (*Casuarina equisetifolia*) has invaded many mangrove habitats in Florida. Smooth cordgrass (*Spartina alterniflora*) has invaded shallow coastal areas along the west coast, converting sub-tidal to intertidal elevations and impairing shellfish bed growth. While these invasive species can provide habitat value, their presence at a restoration site should be considered counter to the goals established for a restoration project.

Land and resource changes result from increasing demands for food, fiber, and space. This frequently means loss or damage of natural habitats, increased water pollution, altered natural hydrology, and increased chemical and sediment runoff from land after storms. This is a major concern in restoration projects.

The performance of any restoration project should be placed in the context of interaction with other habitats relative to the landscape mosaic within which it is set (C. Simenstad, Univ. of WA, pers. comm.). While using the recommendations in this document, individuals and organizations should recognize that success of a coastal habitat restoration project or restoration of an entire estuary may largely depend on variables beyond the control of the project or program. This includes the quality of the water flowing into the estuary, which affects nutrient concentrations, light penetration, and sediment quality.

What is Restoration Monitoring?

The science of restoration requires two basic tools: the ability to manipulate ecosystems to recreate a desired community and the ability to evaluate whether the manipulations have produced the desired change (Keddy 2000). The latter is often referred to as restoration monitoring.

For this manual, the definition of restoration monitoring is as follows:

"The systematic collection and analysis of data that provides information useful for measuring project performance at a variety of scales (locally, regionally, and nationally), determining when modification of efforts is necessary, and building long-term public support for habitat protection and restoration."

There are several definitions of ecological monitoring:

- Repetitive measurements or observations recorded over time for the purpose of determining a condition or tracking change (Meeker et al. 1996).
- The systematic observation of parameters related to a specific problem, designed to provide information on the characteristics of the problem and their change with time (Nichols 1979).
- The consistent recording of data collected through standard methods, so that comparison can be made over time and across different sites (Washington et al. 2000).
- The systematic data collection that provides information on changes that can indicate problems and/or progress towards target criteria or performance standards, which, when met, indicated that established ecological goals have been reached (NOAA et al. 2002).

Figure 4. Volunteers transport salt marsh grass for planting along Eastern Neck Island, Maryland. Photo courtesy of NOAA Restoration Center. Publication of the NOAA Central Library. http://www.photolib.noaa.gov/habrest/r0006505.htm

Figure 5. Pam Polmateer prepares to take a secchi disk depth reading in the Puget Sound near Seattle, Washington. Photo courtesy of Felicity Burrows, NOAA National Centers for Coastal and Ocean Science.

Restoration Monitoring in Coastal Habitats – Restoration monitoring contributes to the understanding of complex ecological systems (Meeker et al. 1996) and is essential in documenting restoration performance and adapting project and program approaches. For example, monitoring coastal areas can identify opportunities for ecological enhancement (Good 2002), provide indications of ecosystem condition, warn of environmental decline (Washington et al. 2000), establish a record of conditions or trends, track conditions through a storm or unique event (EPA 1993), and identify gaps in existing scientific knowledge (Kusler and Kentula 1990). Additionally, thorough restoration monitoring provides the basis for a rigorous review of the pre-construction project planning and engineering. This allows for design improvement and evaluation of future projects, both of which will eventually lead to more efficient restoration monitoring.

Restoration monitoring can provide important information for future, current, or completed projects. Monitoring restored coastal areas can provide tools for planning management strategies and help improve future restoration practices and projects (Washington et al. 2000). It can be used to determine whether project goals are being met and if mid-course corrections are necessary. Monitoring provides information on whether selected project goals are good measures for future projects and on how to do routine maintenance in a restored area (NOAA et al. 2002).

Currently, there is an abundance of coastal habitat ecological monitoring programs across all coastal states, including the Great Lakes. These programs, primarily ecological monitoring rather than strictly restoration monitoring, vary in size and scope and can often be divided into two categories: basic and extensive monitoring. Basic monitoring involves collection of information such as vegetative cover, water quality, and observations on aquatic life in coastal areas. This sort of monitoring can provide an important connection between restoration ecologists and the community. Basic coastal monitoring projects often rely on trained volunteers for much of the data collection. Volunteer opportunities in monitoring allow citizens and students to learn about the coastal environment in a hands-on manner (Washington et al. 2000). More extensive monitoring often involves the collection of data using more specialized methods and equipment. Examples of data collected from extensive monitoring in coastal areas include sedimentation rates, sediment chemistry, plant biomass, and food and habitat preferences (Good 2002).

What is the Role of Socioeconomics in Restoration?

It is becoming increasingly evident that decisions regarding restoration cannot be made solely by using ecological metrics but should involve social and economic considerations and measurements of success, as well. Local communities have a vested interest in coastal restoration and are directly impacted by the outcome of restoration projects in terms of aesthetics, economics, or culture. Socioeconomic metrics, whether currently available or yet to be developed, should reflect societal uses of the resource to be restored. Establishing these types of metrics will increase the public's understanding of the potential benefits of a restoration project and will increase public support for restoration activities.

Figure 6. Bureau of Commercial Fisheries Research Vessel CISCO returning to port on Great Lakes. Publication of the NOAA Central Library. http://www.photolib.noaa.gov/ships/ship0361.htm

Consideration of socioeconomic issues is not a standard part of the coastal restoration process. Most restoration programs do not integrate social or economic factors into restoration monitoring and few restoration projects have implemented full-scale socioeconomic monitoring. Some restoration plans are developed in an institutional setting that require more deliberate consideration of socioeconomic impacts and goals, although this does not generally extend to the monitoring stage. Linking socioeconomic monitoring metrics with specific habitat types is problematic given the limited use of socioeconomic monitoring and the diversity of habitat types frequently addressed by individual restoration projects.

As with evaluating the ecological effects of a restoration project, several steps should be taken in the restoration process in order to develop appropriate socioeconomic goals and metrics. The process of establishing monitoring metrics should be open to stakeholder involvement and should yield monitoring metrics that stakeholders care about and understand. The structure of stakeholder involvement could take several directions. For small to medium sized projects, restoration managers may want to consider an expert panel approach comprised of, for example, scientists, economists and sociologists as well as local representatives. For larger or more complex efforts, managers should consider a more extensive public involvement process. Monitoring metrics should be selected systematically. Planners should clearly establish the socioeconomic goals of the project through collaborative group discussion. Metrics should be generated that could be used to monitor progress against the stated goals. These metrics should be made an integral part of the restoration project's monitoring plan. Adaptive management strategies should be used and should involve the members of the local community and user groups in interpreting and responding to the results of socioeconomic monitoring.

What is an Estuary?

Estuaries are vital components of coastal regions. Marine, estuarine and Great Lakes coastal systems of the United States directly or indirectly support some of the nation's most profitable recreational and commercial fisheries, as well as providing habitat, food sources, and resting places for numerous endangered and ecologically important species.

Figure 7. Recreational fishing off the jetty at Panama City Beach. Publication of the NOAA Central Library. http://www.photolib.noaa.gov/fish/fish1196.htm

For this manual, an estuary is operationally defined as follows[1]:

"An estuary is a part of a river, stream, or other body of water that has at least a seasonal connection with the open sea or Great Lakes and where the seawater or Great Lakes water mixes with the surface or subsurface water flow, regardless of the presence of man-made structures or obstructions."

This definition includes both freshwater and estuarine habitats within the following boundaries:

- Marine coastal habitats extending from the head of tide downstream to nearshore terminus structures, such as barrier islands, reefs, sand bars, mudflats, and headlands in close proximity to the connection with the open sea.

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[1] *The definition of the term estuary and the habitat boundaries are taken from the text of the Estuary Restoration Act of 2000 and the ERA Estuary Habitat Restoration Strategy (Federal Register, Volume 67, Number 232, December 3, 2002, pages 71942-71949).*

- Great Lakes habitats: riparian and nearshore areas adjacent to the drowned mouths of streams entering the Lakes. Operationally, the landward boundary reaches to the 100-year flood line of the Great Lakes.

Figure 8. Floodwood Pond in Jefferson County, New York along the Lake Ontario shoreline is a good example of a coastal wetland formed behind a protective barrier beach. Photo courtesy of Doug Wilcox, United States Geological Survey.

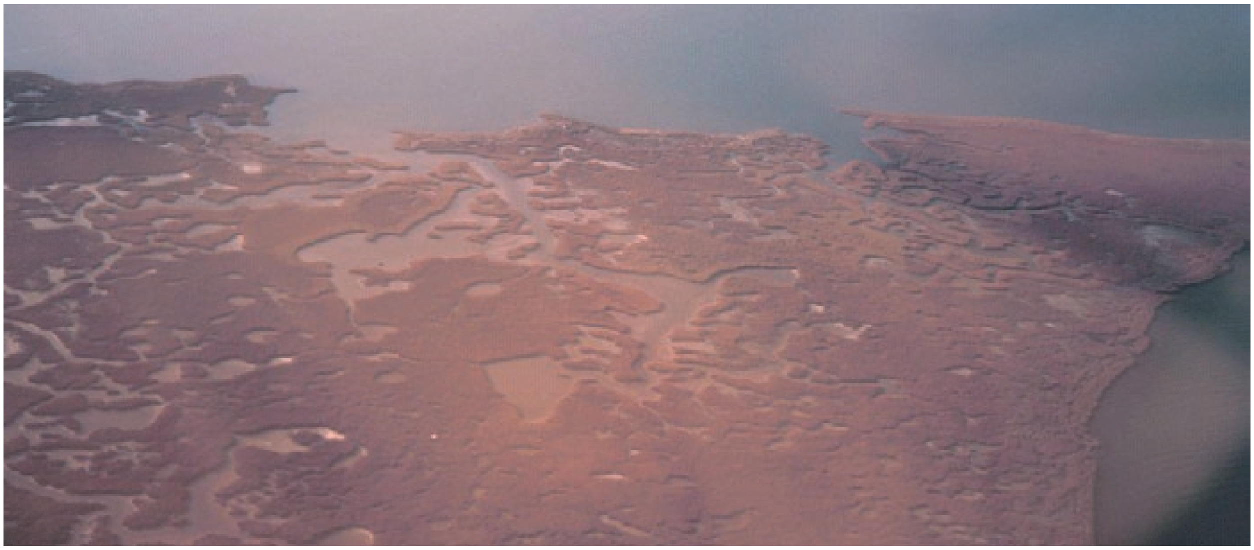

Figure 9. Aerial photograph of marsh land in Barataria Basin, Louisiana. Photo courtesy of Terry McTigue, NOAA Office of Response and Restoration. Publication of the NOAA Central Library. http://www.photolib.noaa.gov/coastline/line1260.htm

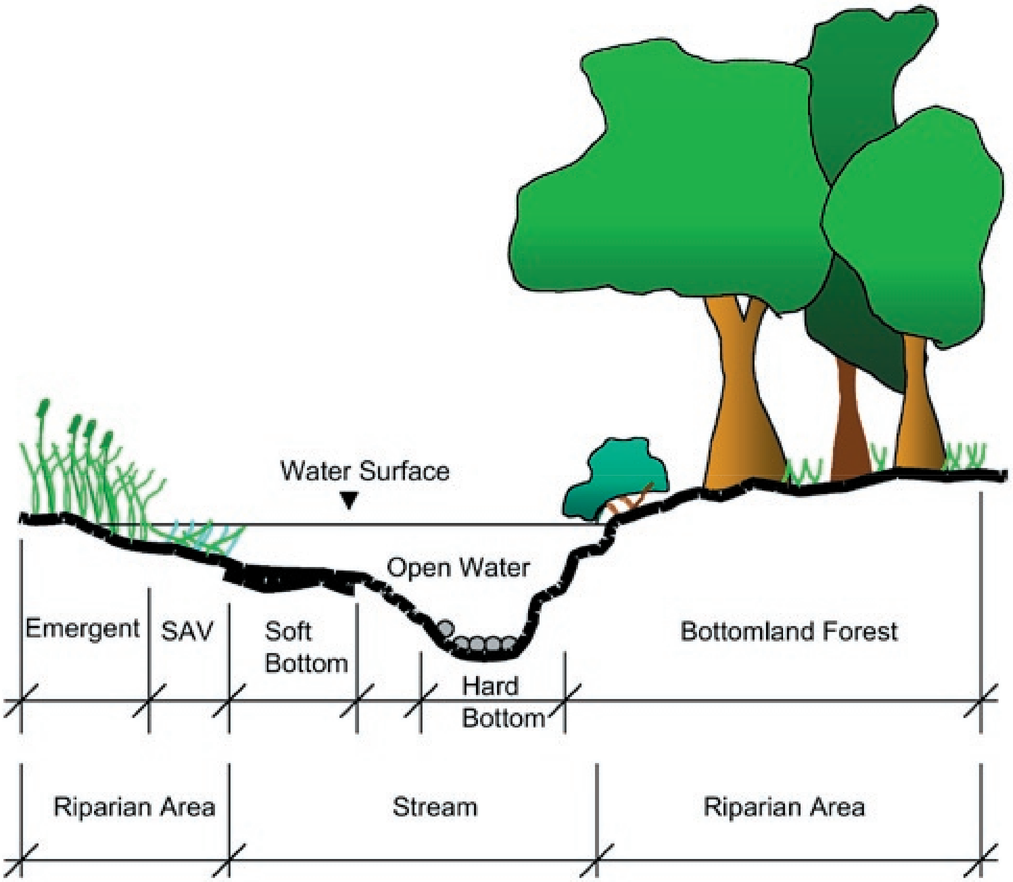

Figure 10. An idealized cross-section of a stream and riparian area, illustrating the diversity of specific habitat types that can occur within those general categories. To use this document for developing a monitoring plan for a stream-side riparian area restoration, the necessary information will be found in the different habitats present in a riparian area. In this example: Riverine Forest, Marsh, and SAV. SAV = submerged aquatic vegetation. Illustration by David Merkey, NOAA Great Lakes Environmental Research Lab.

What are the Habitats?

The number and types of habitats available in any given estuary are a product of a complex mixture of the local physical and hydrological characteristics of the water body and the organisms living there. Some examples include salt and freshwater coastal marshes, coastal forested wetlands, tidal flats, shellfish beds, seagrass meadows, kelp beds, and rocky and soft shorelines. The Cowardin et al. (1979) classification system[2], a national standard for wetland mapping, monitoring, and data reporting, contains 64 different categories of estuarine and tidally-influenced habitats that could be eligible for restoration under the ERA. Add this to local and regional differences in habitat

[2] *The Strategy to implement the ERA states: "the Council will use a classification system based on Cowardin et al. (1979). The Cowardin classification system is the national standard for wetland mapping, monitoring and data reporting as determined by the Federal Geographic Data Committee (http://www.fgdc.gov/). Examples of the relevant classes are: Estuarine subtidal, including open water, bay bottoms, and reefs; estuarine intertidal emergents, such as salt marsh; estuarine intertidal forested/shrub, such as mangroves; estuarine intertidal unconsolidated shore, such as beaches, bars and mudflats; and estuarine aquatic bed, such as submerged or floating estuarine vegetation. Freshwater habitat categories to be included because they are estuarine-associated ecosystems or are found in the Great Lakes include: palustrine forested wetlands, such as forested swamps or riparian zones; palustrine shrub wetlands; and palustrine emergents, including inland marshes and wet meadows."*

definitions and terminology and the list of habitat types continues to grow. It would therefore be impractical to provide a list of specific structural and functional characteristics to monitor during restoration projects for each and every local or regional habitat type.

In light of this, the habitat types presented in this document should be numerically small, broad in scope, and flexible in definition. Restoration practitioners should consider local conditions and pick and choose which general habitat types are present and which monitoring measures might apply. A restoration project may focus on one particular habitat type or may contain a number of habitat types. For example, a project may attempt to restore an area of emergent marsh only or it may attempt a more complex restoration of a tidal stream and its associated riparian zones. These areas may be made up of emergent marsh, submerged aquatic vegetation (SAV), soft bottom, rock bottom, open water, and riverine forest habitats. Figure 1 shows this complex habitat combination. If one were considering restoring the stream area itself, open water, soft bottom, and hard bottom habitats would need to be considered. For riparian areas, riverine forest, emergent marsh, and SAV should be included in consideration for monitoring in this example. Project areas can be diverse. Restoration practitioners should expect to regularly work in areas containing multiple habitat types.

The classification of habitats used in this document is generally based on that of Cowardin et al. (1979) in their *Classification of Wetlands and Deepwater Habitats of the United States*, as called for in the ERA Estuary Habitat Restoration Strategy[3]. The terms "riparian" and "stream" are geographic designations that can include multiple habitats. As illustrated in Figure 1, a riparian area may include SAV, marsh, and riverine forest habitats. Additionally, "palustrine forested wetlands" are included in the ERA Strategy as a freshwater category. Similarly, forested wetlands are actually a group of related habitats and will be treated as several separate habitats.

What is the Habitat Decision Tree?

A habitat decision tree has been constructed to assist in the easy differentiation among the habitats included in this framework. The tree allows readers to overcome the restraints of varying habitat related terminology in deciding which habitat definitions best describe the habitats within their project area.

In many cases, a project area will contain more than one habitat type. To appropriately determine the habitats within a project area, the practitioner should gather surveys and aerial photographs of the project area. From this information, he or she will be able to break down the project area into a number of smaller areas that share basic structural characteristics. The practitioner should then work through the habitat decision tree for each of these smaller areas. For example, a practitioner working in a riparian area may find a project area contains riverine forest, rocky shoreline, and rock bottom. Similarly, someone working to restore an area associated with a tidal creek or stream may find the project area contains water column, marshes, soft shoreline, soft bottom, and oyster reefs.

Once determination of habitat types within the project area has been made, the practitioner should address the appropriate monitoring of each of those habitats. Brief habitat definitions

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[3] The ERA Estuary Habitat Restoration Strategy (Federal Register, Volume 67, Number 232, December 3, 2002, pages 71942 - 71949) states: "The Council will use a classification based on Cowardin et al., 1979. The Cowardin classification system is a national standard for wetland mapping, monitoring, and data reporting…"

are provided after the habitat decision tree and a general description for each can be found in Appendix I. Identification of structural and functional characteristics of the habitats, identification of parameters that determine the status of those habitat characteristics, and determination of the potential parameters for use in each habitat are presented in three matrices in Appendix II. Detailed descriptions and explanations of the importance of each of the structural/functional characteristics and suggested restoration monitoring measures are presented in *Volume Two: Tools for Monitoring Coastal Habitats*.

Habitat Decision Tree

1. a. Habitat consists of open water and does not include substrate (Water Column)
   b. Habitat includes substrate (go to 2)
2. a. Habitat is continually submerged under most conditions (go to 3)
   b. Habitat substrate is exposed to air as a regular part of its hydroperiod (go to 8)
3. a. Habitat is largely unvegetated (go to 4)
   b. Habitat is dominated by vegetation (go to 7)
4. a. Substrate is composed primarily of hard materials, either of biological or geological origin (go to 5)
   b. Substrate is composed primarily of soft materials, such as mud, silt, sand, or clay (Soft Bottom)
5. a. Substrate is composed of geologic material, such as boulders, bedrock outcrops, gravel, or cobble (Rock Bottom)
   b. Substrate is biological in origin (go to 6)
6. a. Substrate was build primarily by oysters, such as *Crassostrea virginica* (Oyster Reefs)
   b. Substrate was build primarily by corals (Coral Reefs)
7. a. Habitat is dominated by macroalgae (Kelp and Other Macroalgae)
   b. Habitat is dominated by rooted vascular plants (SAV)
8. a. Habitat is not predominantly vegetated (go to 9).
   b. Habitat is dominated by vegetation (go to 10)
9. a. Substrate is hard, made up materials such as bedrock outcrops, boulders, and cobble (Rocky Shoreline)
   b. Substrate is soft, made up of materials such as sand or mud (Soft Shoreline)
10. a. Habitat is dominated by herbaceous, emergent, vascular plants. The water table is at or near the surface or the area is shallowly flooded (Marshes)
    b. Habitat is dominated by woody plants (go to 11)
11. a. The dominant woody plants present are mangroves, including the genera *Avicennia*, *Rhizophora*, and *Laguncularia* (Mangrove Swamps)
    b. The dominant woody plants are other than mangroves (go to 12)
12. a. Forested habitat experiencing prolonged flooding, such as in areas along lakes, rivers, and in large coastal wetland complexes. Typical dominant vegetation includes bald cypress (*Taxodium distichum*), black gum (*Nyssa sylvatica*), and water tupelo (*Nyssa aquatica*). (Deepwater Swamps)
    b. Forested habitat along streams and in floodplains that do not experience prolonged flooding (Riverine Forests)

Habitat Definitions

Water column – A conceptual volume of water extending from the water surface down to, but not including the substrate. It is found in marine, estuarine, river, and lacustrine systems.

Rock bottom - Includes all wetlands and deepwater habitats with substrates having an areal cover of stones, boulders, or bedrock 75% or greater and vegetative cover of less than 30% (Cowardin et al. 1979). Water regimes are restricted to subtidal, permanently flooded, intermittently exposed, and semi-permanently flooded. The rock bottom habitats addressed include bedrock and rubble.

Coral reefs – Highly diverse ecosystems, found in warm, clear, shallow waters of tropical oceans worldwide. They are composed of marine polyps that secrete a hard calcium carbonate skeleton, which serves as a base or substrate for the colony.

Oyster reefs – Dense, highly structured communities of individual oysters growing on the shells of dead oysters.

Soft bottom – Loose, unconsolidated substrate characterized by fine to coarse-grained sediment.

Kelp and other macroalgae – Relatively shallow (less than 50 m deep) subtidal algal communities dominated by very large brown algae. Kelp and other macroalgae grow on hard or consolidated substrates forming extensive three-dimensional structures that support numerous flora and fauna assemblages.

Rocky shoreline – Extensive littoral habitats on high energy coasts (i.e. waves or ice).

Soft shoreline – 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 (Cowardin et al. 1979). This definition includes cobble-gravel, sand and mud. However for the purpose of this document, cobble-gravel will not be addressed.

Submerged aquatic vegetation (SAV; marine/brackish and freshwater) – Seagrasses and other rooted aquatic plants growing on soft sediments in sheltered shallow waters of estuaries, bays, lagoons, and lakes. Freshwater species are adapted to the short- and long-term water level fluctuations typical of freshwater ecosystems.

Marshes (marine/brackish and freshwater) – Transitional habitats between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is covered by shallow water tidally or seasonally. Freshwater species are adapted to the short- and long-term water level fluctuations typical of freshwater ecosystems.

Mangrove swamps – Swamps dominated by shrubs that live between the sea and the land in areas that are inundated by tides. Mangroves thrive along protected shores with fine-grained sediments where the mean temperature during the coldest month is greater than 20º C, which limits their northern distribution.

Deepwater swamps – Forested wetlands that develop along edges of lakes, alluvial river swamps, in slow-flowing strands, and in large coastal-wetland complexes. They can be found along the Atlantic and Gulf Coasts and throughout the Mississippi River valley. They are distinguished from other forested habitats by the tolerance of the dominant vegetation to prolonged flooding.

Riverine forests – Forests found along sluggish streams, drainage depressions, and in large alluvial floodplains. Although associated with deepwater swamps in the southeastern United States, riverine forests are found throughout the United States in areas that do not have prolonged flooding.

References

Alongi, D. M. 1998. Coastal Ecosystem Processes, CRC Press, Boca Raton, Florida.

Claw, P., D. A. Falk, J. Grace, P. D. Moore, B. Shorrocks, and S. C. Stearns. 1998. The Encyclopedia of Ecology and Environmental Management. Blackwell Science, Ltd., Malden, Massachusetts.

Committee on Environment and Natural Resources (CENR). 2001. Ecological Forcasting. Washington, D.C. 12 pp.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. FWS/OBS-79/31, US Fish and Wildlife Service, Washington, D.C.

Cunningham, W. P., T. Ball, T. H. Cooper, E. Gorham, M. T. Hepworth, and A. A. Marcus. 1994. Environmental Encyclopedia. Gale Research, Inc., Detroit, Michigan.

Dahl, T. E. 1990. Wetland loss in the United States 1780's to 1980's. United States Department of Interior, Fish and Wildlife Service, Washington, D.C.

Dahl, T. E. 2001. Status and Trends of Wetlands in the Conterminous United States 1986 to 1997. United States Department of Interior, Fish and Wildlife Service, Washington, D.C.

Environmental Protection Agency Publication (EPA). 1993. Volunteer Estuary Monitoring: a Methods Manual. United States Environmental Protection Agency, Office of Water (4504F), Washington, D.C. EPA 842-B-93-004.

Good, J. 2002. Watershed planning, pp. 85-108. In S. Ridlington and T. Welch (eds.), National Coastal Ecosystem Restoration Manual. Oregon Sea Grant, Corvallis, Oregon. A/ECO-1-NS1.

Keddy, P. A. 2000. Wetland Ecology: Principles and Conservation, Cambridge University Press, Cambridge, United Kingdom.

Kusler, J. A. and M. E. Kentula. 1990. Executive summary, pp. xvii-xxv. In J. A. Kusler and M. E. Kentula (eds.), Wetland Creation and Restoration: the Status of the Science. Island Press, Washington, D.C.

Lewis, R. R. 1990. Wetlands restoration/creation/enhancement terminology: suggestions for standardization, pp. 417-419. In J. A. Kusler and M. E. Kentula (eds.), Wetland Creation and Restoration. Island Press, Inc., Washington, D.C.

McKechnie, J. L. 1983. Webster's New Universal Unabridged Dictionary. Simon and Schuster, Cleveland, Ohio.

Meeker, S., A. Reid, J. Schloss, and A. Hayden. 1996. Great Bay Watch: A Citizen Water Monitoring Program. University of New Hampshire/University of Maine Sea Grant College Program. UNMP-AR-SG96-7.

Mitsch, W. J. and J. G. Gosselink. 2000. Wetlands, 3rd Edition. Van Nostrand Reinhold, N.Y.

National Oceanic and Atmospheric Administration (NOAA), Environmental Protection Agency, Army Corps of Engineers, United States Fish and Wildlife Service, and Natural Resources Conservation Service. 2002. An Introduction and User's Guide to Wetland Restoration, Creation, and Enhancement (pre-print copy). Silver Spring, Maryland.

National Oceanic and Atmospheric Administration (NOAA). 2002 online. What is Restoration? National Oceanic and Atmospheric Administration, Restoration Center, 1315 East-West Highway, Silver Spring, Maryland 20910. URL: http://www.nmfs.noaa.gov/habitat/restoration/whatisrestoration.html

National Research Council (NRC). 1992. Restoration of Aquatic Ecosystems: Science, Technology, and Public Policy. National Academy Press, Washington, D.C.

Nichols, D. 1979. Marine monitoring: an introduction, pp. xi-xiv. In D. Nichols (ed.). Monitoring the Marine Environment. Praeger Publishers, New York, New York.

Society for Ecological Restoration (SER) Science and Policy Working Group. 2002. The SER Primer on Ecological Restoration.

Society of Wetland Scientists (SWS). 2000. Position Paper on the Definition of Wetland Restoration. URL: http:/www.sws.org/wetlandconcerns/restoration.html

Turner, R. E. and B. Streever. 2002. Approaches to Coastal Wetland Restoration: Northern Gulf of Mexico. SPB Academic Publishing, The Hague, The Netherlands.

Washington, H., J. Malloy, R. Lonie, D. Love, J. Dumbrell, P. Bennett, and S. Baldwin. 2000. Aspects of Catchment Health: A Community Environmental Assessment and Monitoring Manual. Hawkesbury-Nepean Catchment Management Trust, Windsor, Australia.