Chapter 8
Floodplain Natural Resources and Functions

Chapter Overview
Undeveloped floodplain land provides many natural resources and functions of considerable economic, social, and environmental value. Nevertheless, these and other benefits are often overlooked when local land-use decisions are made. Floodplains often contain wetlands and other important ecological areas as part of a total functioning system that impacts directly on the quality of the local environment. The goal of this chapter is to aid in the understanding of floodplain natural resources and functions. The next chapter examines strategies and tools to preserve and/or restore these resources.

Introduction
Many of the nation's most prominent landscape characteristics, including many of our most valuable natural and cultural resources, are associated with floodplains. These resources include wetlands, fertile soils, rare and endangered plants and animals, and sites of archaeological and historical significance. Floodplains have been shaped, and continue to be shaped, by dynamic physical and biological processes driven by climate, the hydrologic cycle, erosion and deposition, extreme natural events, and other forces. The movement of water through ground and surface systems, floodplains, wetlands and watersheds is perhaps the greatest indicator of the interaction of natural processes in the environment.

These natural processes influence human activities and are, in turn, affected by our activities. They represent important natural functions and beneficial resources and provide both opportunities and limitations for particular uses and activities. *Traditionally, while much attention has been focused on the hazards associated with flooding and floodplains, less attention has been directed toward the natural and cultural resources of floodplains or to evaluation of the full social and economic returns from floodplain use.* In recent decades, the natural resources associated with floodplains – particularly wetlands – have been the subject of increased scientific study and management.

Surface water, ground water, floodplains, wetlands and other features do not function as separate and isolated components of the watershed, but rather as a single, integrated natural system. Disruption of any one part of this system can have long-term and far-reaching consequences on the functioning of the entire system. In the past, lack of understanding of the overall natural system and its component processes contributed to significant alteration of the natural functions of floodplains, and in many cases to the degradation and destruction of these resources.

Floodplain resources, including wetlands and agricultural lands, are experiencing increasing pressure for use and development – for highways, for residential and commercial building sites, and for other urban uses. In response to these development pressures, knowledge and information regarding the natural resources, processes and functions of floodplains can contribute to assessments of the ecological, economic and social impacts on further floodplain development. This knowledge and information can help to protect and better utilize the benefits and values these resources provide. Improved knowledge and information about the natural resources of floodplains can be used to differentiate between lands that should remain in their natural condition, lands that can accommodate certain uses but not others, and lands that are most suitable for development.

The natural and cultural values associated with floodplain resources can be categorized in a variety of ways. Floodplain values can be thought of in terms of environmental quality values such as fish and wildlife habitat and water quality. They can also be thought of in terms of socioeconomic values, which are more easily understood by some because these values provide either dollar savings (related to flood and storm damage protection, for example) or financial profit (related to increased production from floodplain use).

A document initially prepared by the U.S. Water Resources Council in 1979 titled *A Unified National Program for Floodplain Management* divides riverine and coastal floodplain resources into three categories: 1) water resources, 2) living resources (habitat), and 3) cultural resources. Figure 8-1 provides a listing of specific resources associated with each category. The division between these three categories of resources – particularly between water resources and living resources – is somewhat arbitrary. These resources are closely related and interwoven, and are often of a synergistic nature. They are described below.

Water Resources

Natural Flood & Erosion Control
- Provide flood storage and conveyance
- Reduce flood velocities
- Reduce flood peaks
- Reduce sedimentation

Surface Water Quality Maintenance
- Filter nutrients and impurities from runoff
- Process organic wastes
- Moderate temperature of water

Groundwater Recharge
- Promote infiltration and aquifer recharge
- Reduce frequency and duration of low surface flows

Biologic Resources

Biological Productivity
- Support high rate of plant growth
- Maintain biodiversity
- Maintain integrity of ecosystem

Fish and Wildlife Habitats
- Provide breeding and feeding grounds
- Create and enhance waterfowl habitat
- Protect habitats for rare and endangered species

Societal Resources

Harvest of Wild &Cultivated Products
- Enhance agricultural lands
- Provide sites for aquaculture
- Restore and enhance forest lands

Recreational Opportunities
- Provide areas for active and passive uses
- Provide open space
- Provide aesthetic pleasure

Areas for Scientific Study and Outdoor Education
- Contain cultural resources (historic and archaeological sites)
- Provide opportunities for environmental and other studies

A Unified National Program for Floodplain Management, 1994, p. 41

Figure 8-1. Natural Resources of Floodplains

Not all floodplains contain the same natural resources, and efforts to protect the natural functions of floodplains have not always given equal weight and attention to all of the resources. While categories of values, like categories of resources, are useful to keep in mind for discussion purposes, the values of floodplain resources are closely related. Information regarding the extent of these values seldom fits neatly into specific categories.

Natural and Beneficial Floodplain Resources and Functions

Floodplains that are relatively undisturbed (or have been restored to a nearly natural state) provide a wide range of benefits to both human and natural systems. These benefits take many forms: some are static conditions (such as providing aesthetic pleasure) and some are active processes (like filtering nutrients). There is some ambiguity over which of these benefits are properly termed "functions," which are "resources," and where the terms overlap. A fairly well accepted (but not necessarily comprehensive) list and descriptions follows. The resources and functions have been loosely grouped into three categories, and the categories have been labeled according to the primary recipient of the benefit or its relationship to a larger system. "Water resources" include those resources and functions of floodplains that are part of or provide a benefit to the hydrologic cycles on the earth's surface and sub-surface, including natural moderation of floods, water quality maintenance, and groundwater recharge. "Biologic resources" are floodplain resources and functions that benefit large and diverse populations of plants and animals. "Societal resources" are floodplain resources and functions that directly benefit human society, including historical, archeological, scientific, recreational, and esthetic sites, in addition to sites generally highly productive for agriculture, aquaculture, and forestry where these uses are compatible with natural systems.

Photograph of undisturbed watercourse.

Water Resources

Natural Flood Storage and Erosion Control

The characteristics of the floodplain and of flooding are closely interdependent. Floods shape floodplain topography and soils and influence ecology. In turn, the physical characteristics of the floodplain shape flood flows. Except in narrow, steep valleys and areas of coastal bluffs, floodplains provide a broad area to spread out and temporarily store floodwaters. This reduces flood peaks and velocities and the potential for erosion. Flood storage is particularly important in urbanizing areas where even small floods resulting from a 5- or 10-year storm can cause severe flood damage. One acre of floodplain land flooded one foot deep holds 330,000 gallons of water.

In their natural vegetated state, floodplains slow the rate at which the incoming overland flow reaches the main water body. Vegetation also reduces shoreline erosion. In coastal areas, beaches, bars, dunes, and wetlands act as natural barriers to dissipate waves and protect back- lying areas from flooding and erosion.

Water Quality Maintenance

Floodplains serve important functions in protecting the physical, biological, and chemical integrity of water. Water that runs off quickly over the surface, as over a barren floodplain, is capable of carrying with it large amounts of sediment and debris to the main water body. A vegetated floodplain, however, slows the surface runoff, causing it to drop most of its sediment load on the floodplain. Vegetation also filters incoming floodwaters. Much of the sediment originating on the land drops out, as well as some of that scoured from the channel bank and bed. This filtering process may add rich nutrients to the floodplain soil. Another example of water quality maintenance is the beneficial shading effect of riparian (streambank) vegetation, which helps to avoid temperature stress on natural biota. Natural floodplain systems can further serve to reduce or avoid the environmental and economic costs associated with wastewater treatment and water quality maintenance.

Photograph of stream vegetative buffers.

Groundwater Recharge

The natural floodplain has surface conditions favoring local ponding and flood detention, plus subsurface conditions favoring infiltration and storage. The slowing of runoff across the floodplain allows additional time for the runoff to infiltrate and recharge available groundwater aquifers, when there is unused storage capacity. The slowing of runoff provides the additional benefit of natural purification of water as local runoff or overbank floodwater infiltrates through the floodplain alluvium. Natural purification comes from filtration, ion exchange, adsorption, absorption, and aerobic and anaerobic biological action.

This value extends into non-flood periods as groundwater discharge acts to naturally regulate the flow in a river or the level of a lake or pond. In other words, during periods of abundant water, the water can enter the groundwater system whenever there is available capacity rather than contribute to seasonal flood peaks. During low flow periods, the water flows from the higher groundwater system into lower surface waters, so that the frequency and duration of extremely low flows is reduced.

Biological Resources

Biological Productivity

The nation's coastal and riverine floodplains support large and diverse populations of plants and animals. In addition, they provide habitat and critical sources of energy and nutrients for organisms in adjacent and downstream terrestrial and aquatic ecosystems. The wide variety of plants and animals supported directly or indirectly by floodplains constitutes an extremely valuable, renewable resource important to economic welfare, enjoyment, and physical well-being. The variety of floodplains and associated wetlands across the country create habitat for many forms of fish and wildlife. Many spend their entire lives in floodplain wetlands.

Photograph of floodplain flora.

The floodplain is biologically important because it is the place where land and water meet and the elements of both terrestrial and aquatic ecosystems mix. Riparian floodplain ecosystems are distinct associations of soil, flora and fauna occurring along a river, stream, or other body of water and depend for survival upon high water tables and occasional flooding. They are generally more biologically diverse than surrounding uplands. Bottomland hardwood forests are the major types of riparian ecosystems found in the United States, covering large areas of the Southeast, around 30 million acres.

Photograph of biological resources.

The detritus provided by headwater woodlands frequently provides the major source of nutrients and energy that sustain production in woodland streams. Nutrients and energy that enter these upstream areas find their way far downstream into larger rivers and lakes via the aquatic food chain. Shading of the stream by floodplain vegetation moderates water temperatures; roots and fallen trees provide instream habitat, and near stream vegetation filters runoff, removing harmful sediments and buffering pollutants, to further enhance in-stream environments.

Coastal floodplains are widely recognized for their importance to many estuarine and marine fisheries. Here also floodplains, both riverine and coastal, provide much of the nutrients and energy for aquatic estuarine environments. Estuarine wetlands serve as breeding, nursery, and feeding grounds for estuarine and marine fisheries, and coastal floodplains are extremely important to waterfowl, furbearers, and other wildlife species.

Photograph of coastal resources.

Fish and Wildlife Habitats

Due to the abundance of water and vegetation, floodplains provide wetland, riparian and other habitat (including shelter and food sources) for large and diverse populations of fish and wildlife species. Floodplain wetlands, for example, are major sources of food and breeding habitat for both saltwater and freshwater fisheries and for many types of wildlife. Floodplains are especially important and productive sources of energy and nutrients in large part because they contain the elements of both terrestrial and aquatic ecosystems. The fish and wildlife resources supported directly and indirectly by floodplains represent a renewable resource of great economic importance to the states and the nation.

The variety of floodplains and associated wetlands across the country create habitat for many forms of fish and wildlife. Numerous fish and wildlife species depend on marshes and swamps for feeding or feed on organisms produced in wetlands, and many animals visit wetlands for drinking water. Wetlands are also crucial for the survival of numerous endangered species such as the American crocodile, the manatee, and the whooping crane, as well as numerous species of plants.

Photograph of coastal fauna.

Coastal barriers and associated wetlands and near-shore waters are especially important in maintaining the natural productivity of the coastal environment and provide invaluable habitat for fish and wildlife. The estuaries and bays protected by coastal barriers are among the most valuable and productive of all ecosystems.

Freshwater fishes also find wetlands important for survival. Wetland vegetation along rivers is important to fishes in many ways, including providing cover, shade for water temperature regulation, and food for aquatic insects that are eaten by fishes.

Floodplains and wetlands provide important habitat for waterfowl and other birds. Floodplain wetlands are crucial for the existence of many birds, ranging from waterfowl and shorebirds to songbirds. Some spend their entire lives in wetland environments, while others primarily use wetlands for nesting, feeding or resting. In addition to providing year-round habitats for resident birds, coastal and inland wetlands are especially important as breeding grounds, over-wintering areas and feeding grounds for migratory waterfowl and numerous other birds.

Societal Resources

Harvest of Products

Floodplains provide an excellent resource base for agricultural, aquacultural, and forest production. However, the flood risk must be considered for these uses and operations adjusted accordingly. The natural processes of sediment transport and deposition tend to replenish floodplain soils with nutrients. Agricultural operations are made easier by gently rolling terrain, and surface and groundwater supplies are more readily available. Aquacultural operations have grown into a viable industry producing a wide variety of aquatic crops. Bottomland hardwoods and associated species, which flourish in close proximity to water, are important to the timber industry and the overall economy of the country.

Recreational Opportunities
Because of their scenic value and locational and other beneficial characteristics, some of which are unique, floodplains are attractive for recreation. Water-oriented sports, boating, and swimming can be based in a natural floodplain park which also may be suitable for hiking and camping. Floodplain wildlife resources can be managed for observation as well as for recreational hunting and fishing. Natural floodplains are valued as constituents of the "wilderness experience" important in the American culture.

Photograph of river corridor recreation.

Areas for Scientific Study and Outdoor Education
Finally, floodplains contain cultural resources important to the nation and to individual localities. Native American settlements and early cities of European settlers located along the coasts and rivers in order to have access to water supply, waste disposal, water transportation, and transshipment. Consequently, floodplains include most of the nation's earliest archeological and historical sites. In addition to their historical richness, floodplains may contain invaluable resources for scientific research. For example, where floodplains contain unique ecological habitats, they make excellent areas for scientific study. The bedrock geology of the area may also be exposed in the floodplain.

Photograph of historic Fort Pitt at Pittsburgh.

In urban communities, floodplains may provide green belt areas to break urban development monotony, absorb noise, clean the air, and lower temperatures. Floodplain parks can also serve as nature study centers and laboratories for outdoor learning experiences.

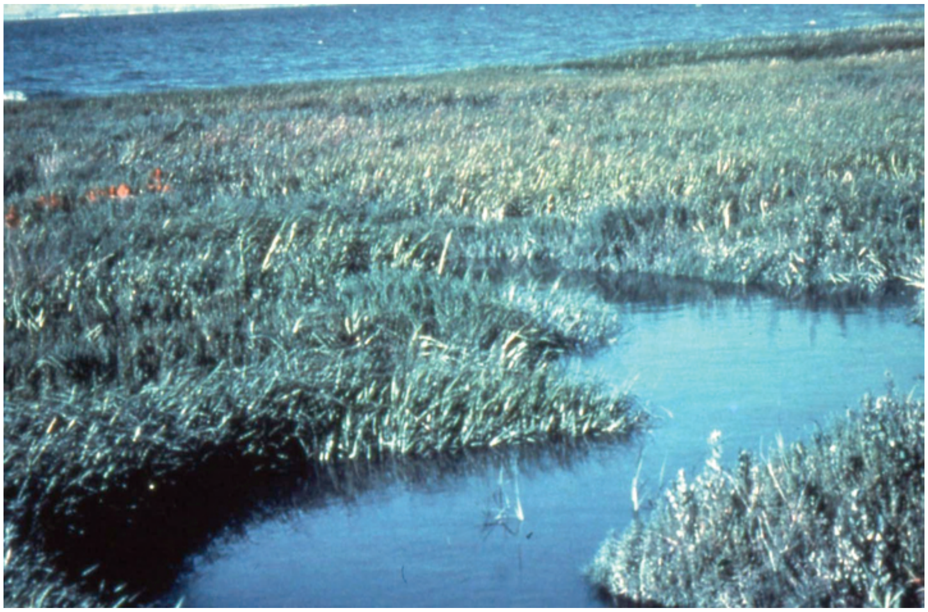
Wetlands

Our nation's wetlands are among our most productive ecosystems. About one-half of our endangered or threatened species require wetland habitat at some point in their life cycle.

Wetlands and floodplains are not synonymous, but wetlands are perhaps the most prominent and familiar of floodplain resources. It has been estimated that wetlands now cover approximately 95 million acres, or about 5 percent of the lower 48 states. Although wetlands represent only a portion of overall floodplain acreage, essentially all coastal wetlands and most inland wetlands occur within floodplains. As a result, functions ascribed to wetlands can be considered, for most practical purposes, as floodplain functions as well. <u>In planning and carrying out programs to protect the natural resources and functions of floodplains, it is therefore important to develop a better overall understanding of wetlands</u>. This is the purpose of the following descriptions.

There is no single, correct, indisputable, ecologically sound definition for wetlands, primarily because of their diversity and because the demarcation between dry and wet environments lies along a continuum. In general terms, wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface.

In general, the wetlands of the United States can be divided into two main groups: tidal wetlands (coastal wetlands) and nontidal wetlands (inland wetlands). Tidal wetlands are largely comprised of coastal marshes, mudflats, and mangrove swamps that are subjected to periodic flooding by ocean-driven tides.



Photograph of coastal wetland.

Nontidal wetlands consist of marshes, swamps, and bogs that are not influenced by ocean-driven tides. They are usually created by a combination of surface-water flooding or ponding and groundwater discharge. Consequently, they form along nontidal rivers, streams, lakes, and ponds; in isolated upland depressions where surface water collects; in association with springs and seeps (points of active groundwater discharge); and where the water table stays near the surface for some time. In these situations, the soil becomes saturated (hydric soils) and plants adapted for life in wet conditions (hydrophytes) become established to form nontidal wetland communities. Nontidal wetlands represent a complex assemblage of inland wet environments. They include freshwater marshes and ponds, shrub swamps, bottomland hardwood forests, wooded swamps, and bogs, as well as inland saline and alkaline marshes and ponds.

Classification of Wetlands and Deepwater Habitats in the United States

Increasing recognition of the important functions provided by wetlands intensified the need for reliable information on the status and extent of wetland resources. To develop comparable information over large areas, a clear definition and classification of wetlands and deepwater habitats is required.

A classification system was developed by wetland ecologists, with the assistance of many private individuals and organizations and local, state and federal agencies. The U.S. Fish and Wildlife Service (Service) officially adopted the classification system contained in the report *Classification of Wetlands and Deepwater Habitats in the United States*, published by the Service in 1979, and in their conduct of a national inventory of wetlands. (This report can be viewed and downloaded from the Service's Internet website at http://wetlands.fws.gov. Click on "Code Definitions" under "Maps Information." On the next screen, click on "National Wetlands Classification Standard.") The system has been widely used throughout the United States and is often cited in the scientific literature. Information on classification contained in this chapter is from the above report.

Marshes, swamps, and bogs have been well-known terms for centuries. Only relatively recently have attempts been made to group these landscape units under the single term "wetlands." This general term has grown out of a need to understand and describe the characteristics and values of all types of land, and to wisely and effectively manage wetland ecosystems.

Wetlands are defined by plants (hydrophytes), soils (hydric soils), and frequency of flooding. The single feature that most wetlands share is soil or substrate (a surface on which a plant or animal grows or is attached) that is at least periodically saturated with or covered by water. The water creates severe physiological problems for all plants and animals except those that are adapted for life in water or in saturated soil.

As defined in the Service's classification document, "**Wetlands** are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification 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."

It is important to note that the Service does not include permanently flooded deepwater areas as wetlands. Instead these water bodies (generally deeper than 6.6 feet) are defined as *deepwater habitats*, since water and not air is the principal medium in which dominant organisms must live. The 6.6 feet (2-meter) lower limit for inland wetlands was selected because it represents the maximum depth to which emergent plants normally grow.

The Classification System

The adopted structure of the classification is hierarchical, progressing from Systems and Subsystems, at the most general levels, to Classes, Subclasses, and Dominance Types. Figure 8-2 is an illustration of the wetland and deepwater habitat system. Figure 8-3 illustrates the classification structure to the class level, the extent of discussion in this chapter. Information on Subclasses and Dominance Types may be found in the Service's document.

Systems form the highest level of the classification hierarchy. The term "System" refers to a complex of wetlands and deepwater habitats that share the influence of similar hydrologic, geomorphologic, chemical, or biological factors. Five Systems are defined:

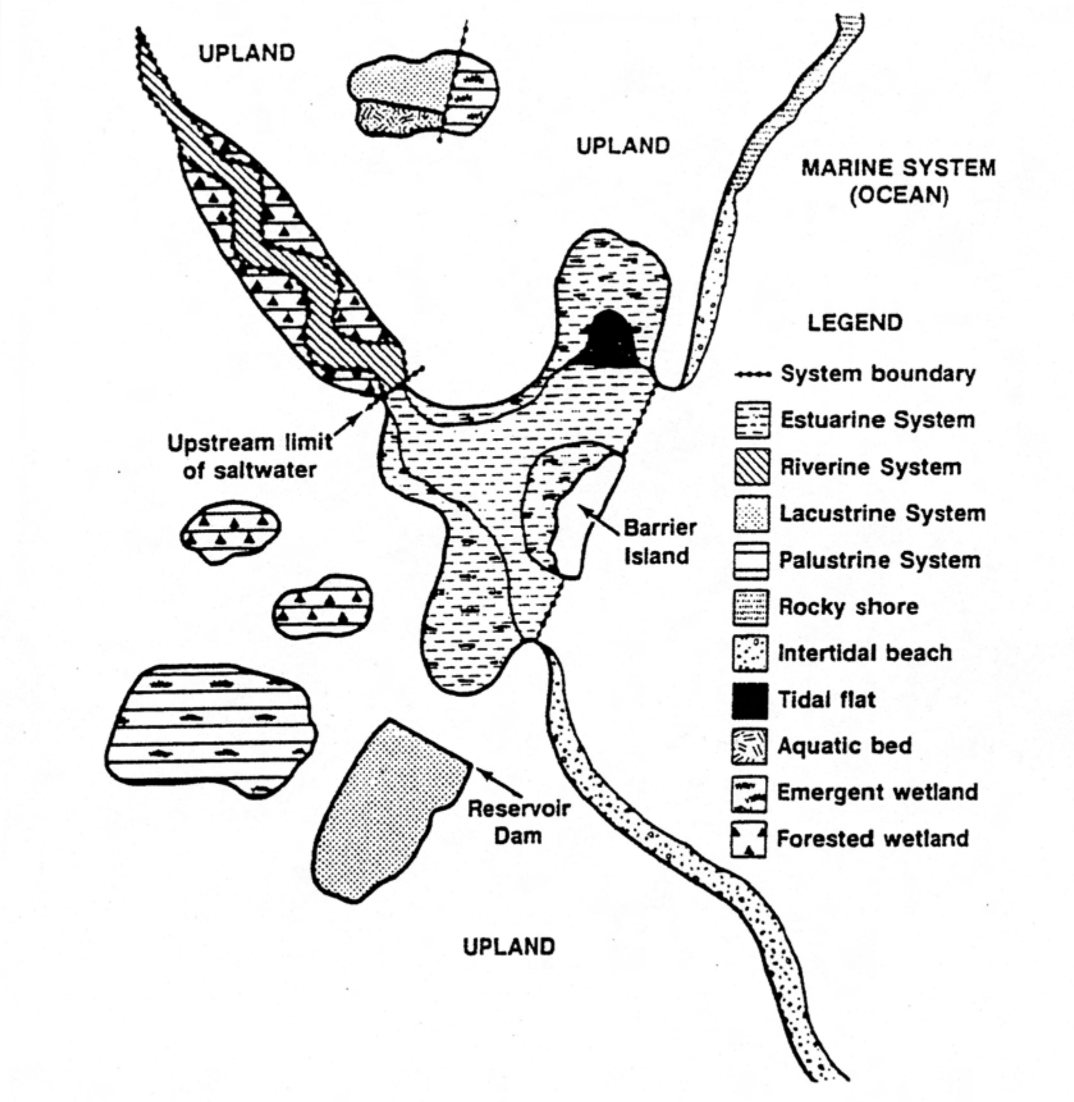
- Marine,
- Estuarine,
- Riverine,
- Lacustrine, and
- Palustrine.

In general terms, the Marine and Estuarine Systems consist of salt and brackish tidal wetlands and the open ocean and estuaries (inlets to the sea, particularly at the mouth of a river). The Riverine System is limited to freshwater river and stream channels. It is mainly a freshwater, deepwater habitat system but has nonpersistent marshes and aquatic beds along its banks. The Lacustrine System is also a deepwater habitat system that includes standing water bodies like lakes, reservoirs, and deep ponds with nonpersistent shoreline marshes and aquatic beds. The Palustrine System encompasses the vast majority (roughly 94 percent) of the country's nontidal wetlands (i.e., marshes, swamps, and bogs) and does not include any deepwater habitats.

Systems are further subdivided into more specific categories called "Subsystems."

Marine and Estuarine Systems each have two **Subsystems**, Subtidal and Intertidal; the Riverine System has four Subsystems, Tidal, Lower Perennial, Upper Perennial, and Intermittent; the Lacustrine has two, Littoral and Limnetic; and the Palustrine has no Subsystems.

Within the Subsystems, **Classes** are based on substrate material and flooding regime, or on vegetative life form. The same Classes may appear under one or more of the Systems or Subsystems.



Source: Tiner, Jr., Ralph W. Wetlands of the United States: Current Status and Recent Trends. Newton Corner, Massachusetts: U.S. Fish and Wildlife Service, Habitat Resources, 1984.

Figure 8-2. Major wetland and deepwater habitat system.

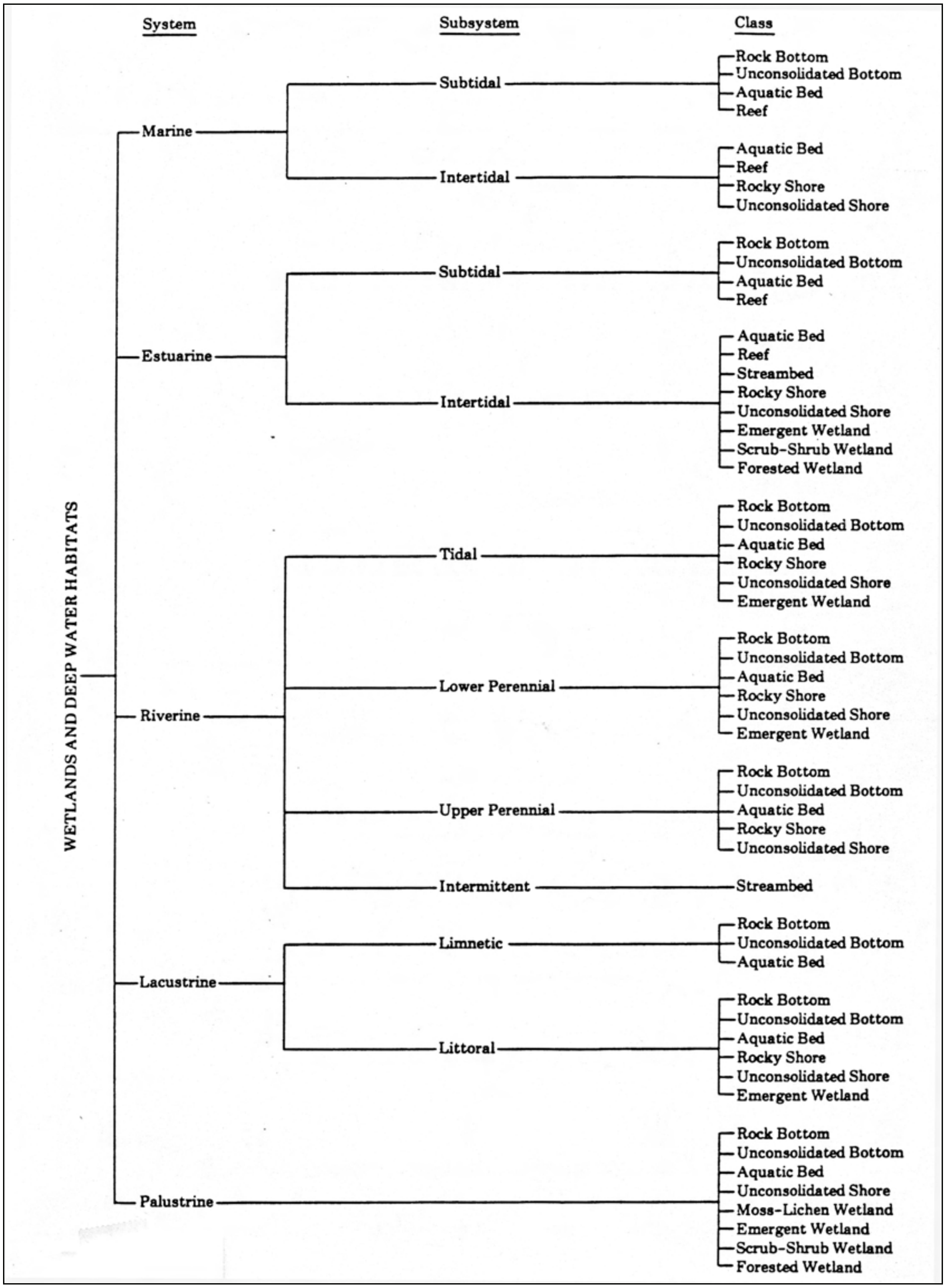


Figure 8-3. Classification hierarchy of wetlands and deepwater habitats, showing systems, subsystems, and classes. The Palustrine System does not include deepwater habitats. (Cowardin et al., 1979). Used with permission from "Protecting Nontidal Wetlands," American Planning Association PAS Report 412/413, 1988, Chicago.

Marine System
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 water regimes are determined primarily by the ebb and flow of oceanic tides. This System extends from the outer edge of the continental shelf 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; or 3) the seaward limit of the Estuarine System, where this limit is determined by factors other than vegetation.

The distribution of plants and animals in the Marine System primarily reflects differences in four factors: 1) degree of exposure of the site to waves; 2) texture and physicochemical nature of the substrate; 3) amplitude of the tides; and 4) latitude, which governs water temperature, the intensity and duration of solar radiation, and the presence or absence of ice.

Subsystems.

Subtidal – The substrate is continuously submerged.
Intertidal – The substrate is exposed and flooded by tides; includes the associated splash zone.

Classes. Rock Bottom, Unconsolidated Bottom, Aquatic Bed, Reef, Rocky Shore, and Unconsolidated Shore.[1]

Distinguishing features and examples of habitats in the Marine System are shown on Figure 8-4.[2]

Estuarine System
The Estuarine System consists of deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed 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. This System extends 1) upstream and landward to where ocean-derived salts measure less than 0.5 parts per thousand during the period of average annual flow; 2) to an imaginary line closing the mouth of a river, bay, or sound; and 3) to the seaward limit of wetland emergents, shrubs, or trees where they are not included in the previous extent. Also included are offshore areas of continuously diluted seawater.

The Estuarine System includes both estuaries and lagoons. It is more strongly influenced by its association with land than is the Marine System. In terms of wave action, estuaries are generally considered to be low-energy systems.

Subsystems.

Subtidal – The substrate is continuously submerged.
Intertidal – The substrate is exposed and flooded by tides; includes the associated splash zone.

[1] These and other Classes are described later in this Chapter.
[2] This and subsequent figures illustrating distinguishing features and examples of habitats in wetland systems are taken from "Classification of Wetlands and Deepwater Habitats of the United States," Cowardin, et al, Dec. 1979.

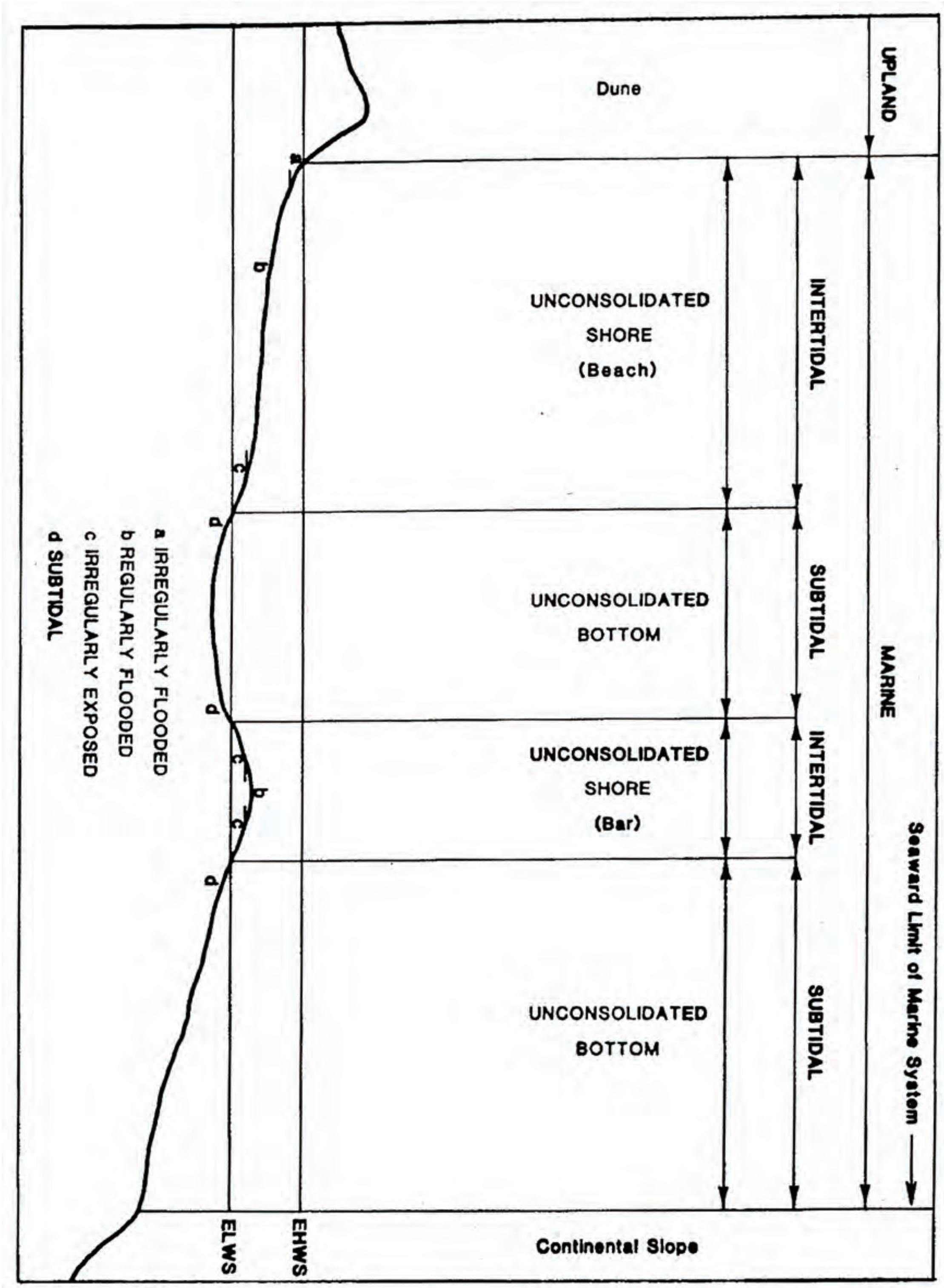


Figure 8-4. Distinguishing features and examples of habitats in the marine system. EHWS – Extreme High Water of Spring tides; ELWS – Extreme Low Water of Spring tides.

Classes. Rock Bottom, Unconsolidated Bottom, Aquatic Bed, Reef, Streambed, Rocky Shore, Unconsolidated Shore, Emergent Wetland, Scrub-Shrub Wetland, and Forested Wetland.

Distinguishing features and examples of habitats in the Estuarine System are illustrated on Figure 8-5.

Riverine System

The Riverine System includes all wetlands and deepwater habitats contained within a channel, with two exceptions: 1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and 2) habitats with water containing ocean-derived salts in excess of 0.5 parts per thousand. This 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.

The Riverine System terminates at the downstream end where the concentration of ocean-derived salts in the water exceeds 0.5 parts per thousand 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. Water is usually, but not always, flowing in this System.

Subsystems.

There are four Subsystems: the Tidal, the Lower Perennial, the Upper Perennial, and the Intermittent. Each is defined in terms of water permanence, gradient, water velocity, substrate, and the extent of floodplain development. The Subsystems have characteristic flora and fauna. All four Subsystems are not necessarily present in all rivers.

Tidal. – The gradient is low and water velocity fluctuates under tidal influence. The streambed is mainly mud with occasional patches of sand. Oxygen deficits may sometimes occur and the fauna is similar to that in the Lower Perennial Subsystem. The floodplain is typically well developed [defined].

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. Oxygen deficits may sometimes occur, the fauna is composed mostly of species that reach their maximum abundance in still water, and true planktonic organisms are common. The gradient is lower that that of the Upper Perennial Subsystem and the floodplain is well developed.

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. The natural dissolved oxygen concentration is normally near saturation. The fauna is characteristic of running water,

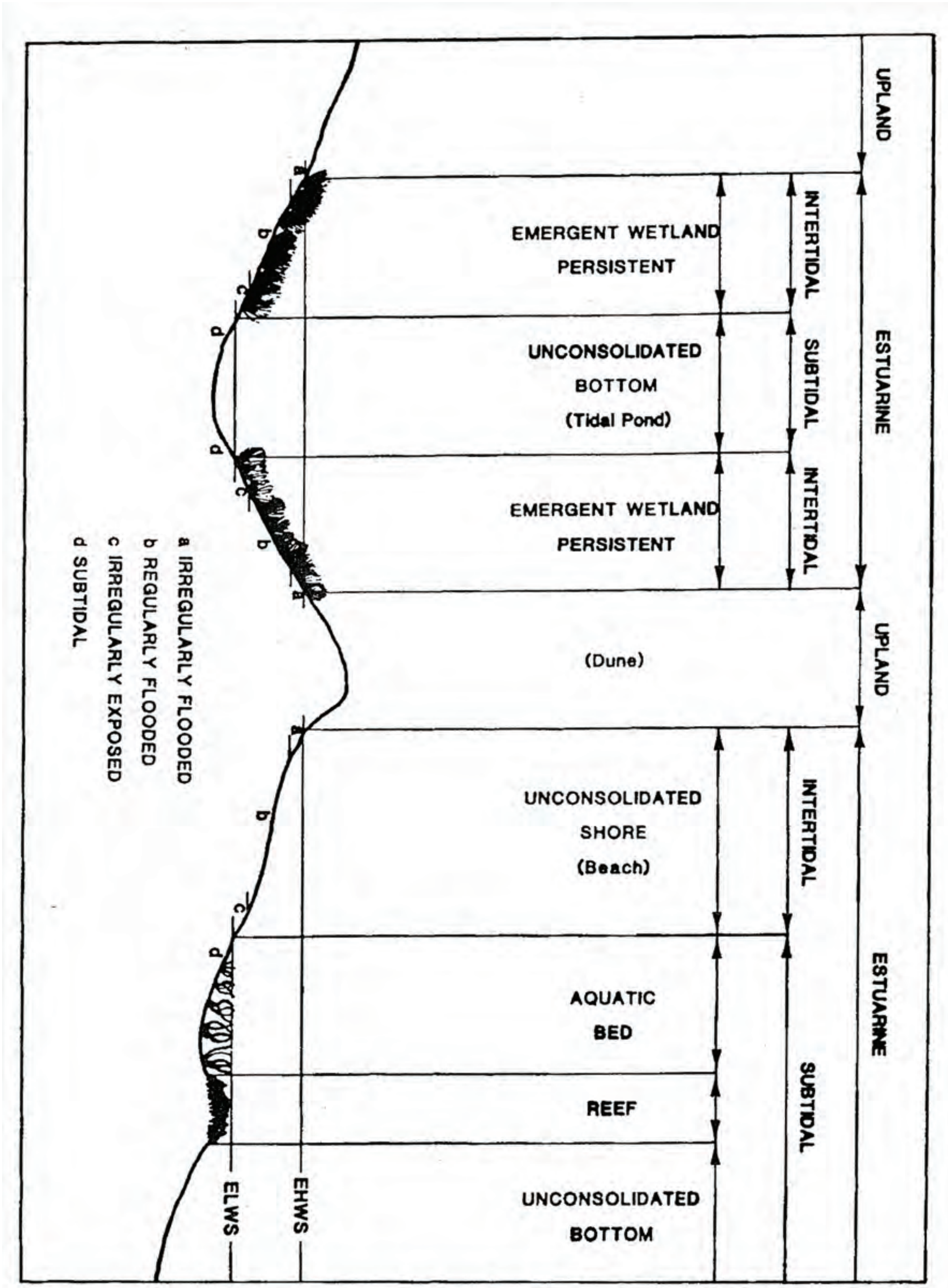


Figure 8-5. Distinguishing features and examples of habitats in the Estuarine System. EHWS – Extreme High Water of Spring tides; ELWS – Extreme Low Water of Spring tides

and there are few or no planktonic forms. The gradient is high compared with that of the Lower Perennial Subsystem, and there is very little floodplain development (physical definition).

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.

<u>Classes.</u> Rock Bottom, Unconsolidated Bottom, Aquatic Bed, Streambed, Rocky Shore, Unconsolidated Shore, and Emergent Wetland (nonpersistent).

Distinguishing features and examples of habitats in the Riverine System are illustrated in Figure 8-6.

Lacustrine System
The Lacustrine System includes wetlands and deepwater 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; and 3) total area exceeds 20 acres. Similar wetland and deepwater habitats totaling less than 20 acres 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 meters (6.6 feet) at low water. Lacustrine waters may be tidal or nontidal, but ocean-derived salinity is always less than 0.5 parts per thousand.

This System is bounded by upland or by wetland dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens. 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.

The Lacustrine System includes permanently flooded lakes and reservoirs (e.g., the Great Lakes, TVA's Norris Reservoir), intermittent lakes (e.g., playa lakes), and tidal lakes with ocean-derived salinities below 0.5 parts per thousand (e.g., Grand Lake, Louisiana). Typically, there are extensive areas of deep water and there is considerable wave action. Islands of Palustrine wetland may lie within the boundaries of the Lacustrine System.

<u>Subsystems.</u>
Limnetic. – All deepwater habitats within the Lacustrine System. Many small Lacustrine Systems have no Limnetic Subsystem.

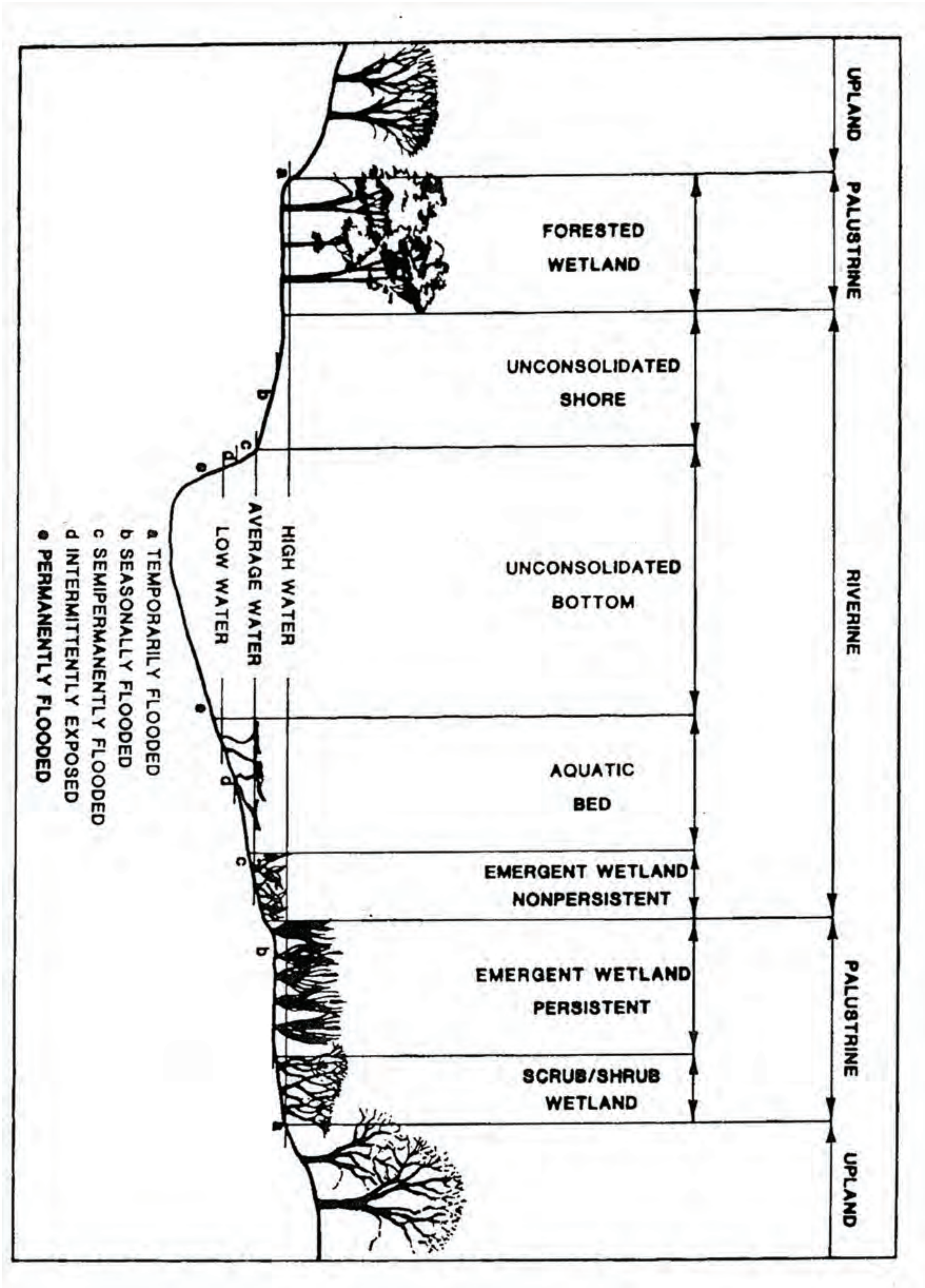


Figure 8-6. Distinguishing features and examples of habitats in the Riverine System.

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

Classes. Rock Bottom, Unconsolidated Bottom, Aquatic Bed, Rocky Shore, Unconsolidated Shore, and Emergent Wetland (nonpersistent).

Distinguishing features and examples of habitats in the Lacustrine System are illustrated on Figure 8-7.

Palustrine System

The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 parts per thousand. It also includes wetlands lacking such vegetation, but with all of the following four characteristics: 1) area less than 20 acres; 2) lacking active wave-formed or bedrock shoreline features; 3) water depth in the deepest part of the basin less than 2 meters at low water; and 4) salinity due to ocean-derived salts less than 0.5 parts per thousand. This System is bounded by upland or by any of the other four Systems.

The Palustrine System was developed to group the vegetated wetlands traditionally called by such names as marsh, swamp, bog, fen, and prairie, which are found throughout the United States. It also includes the small, shallow, permanent or intermittent water bodies often called ponds. Palustrine wetlands may be situated shoreward of lakes, river channels, or estuaries; on river floodplains; in isolated catchments; or on slopes. They may also occur as islands in lakes or rivers. The erosive forces of wind and water are of minor importance except during severe floods. ***This system accounts for over 90% of all wetlands in the United States.***

Subsystems. None

Classes. Rock Bottom, Unconsolidated Bottom, Aquatic Bed, Unconsolidated Shore, Moss-Lichen Wetland, Emergent Wetland, Scrub-Shrub Wetland, and Forested Wetland. The latter three Classes are dominant. They will be described in more detail later in this chapter.

Distinguishing features and examples of habitats in the Palustrine System are illustrated in Figure 8-8.

The **Class** is the next taxonomic unit below the Subsystem level. It is described here to aid in understanding the classification of wetlands and deepwater habitats.

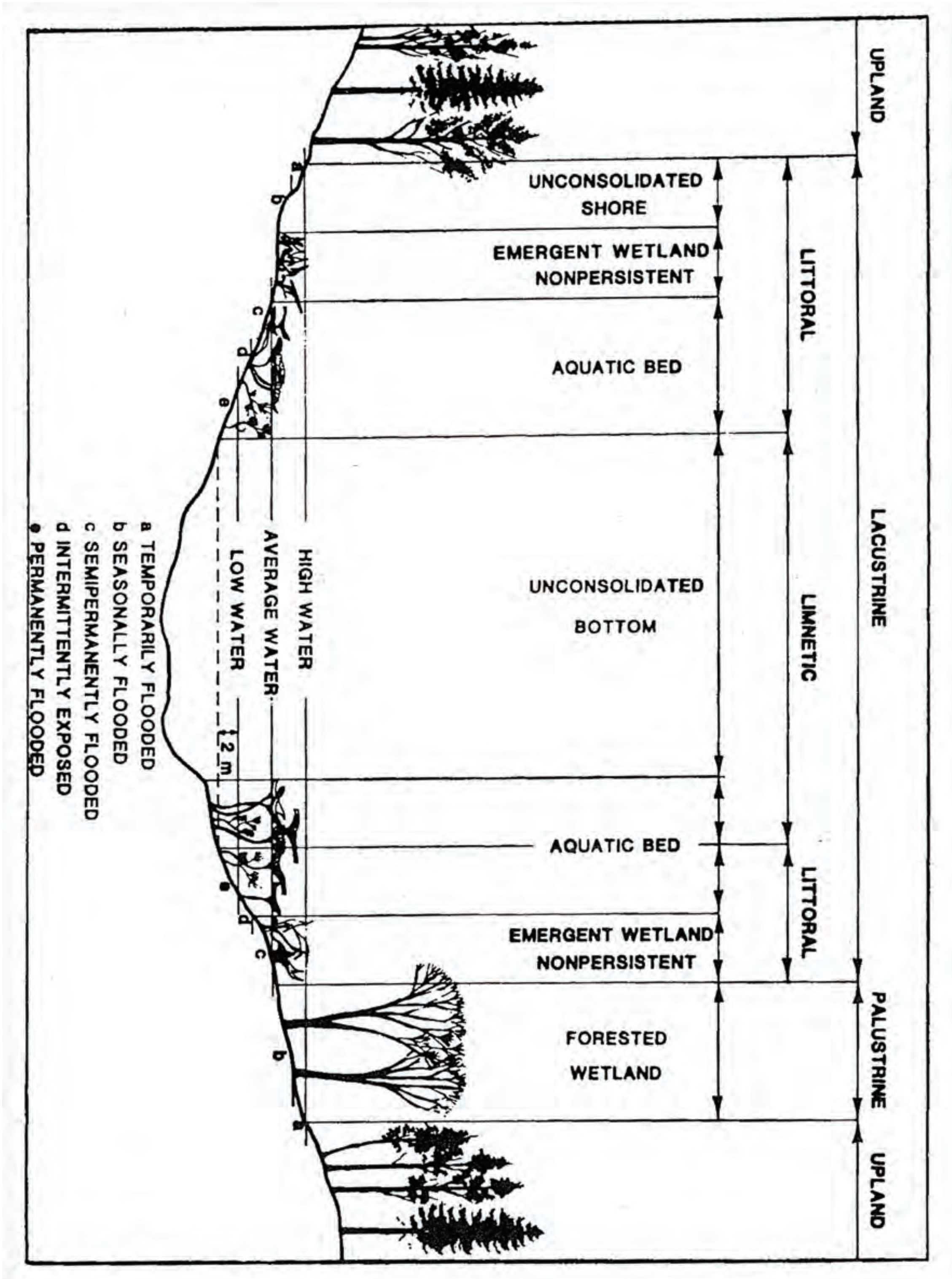


Figure 8-7. Distinguishing features and examples of habitats in the Lacustrine System.

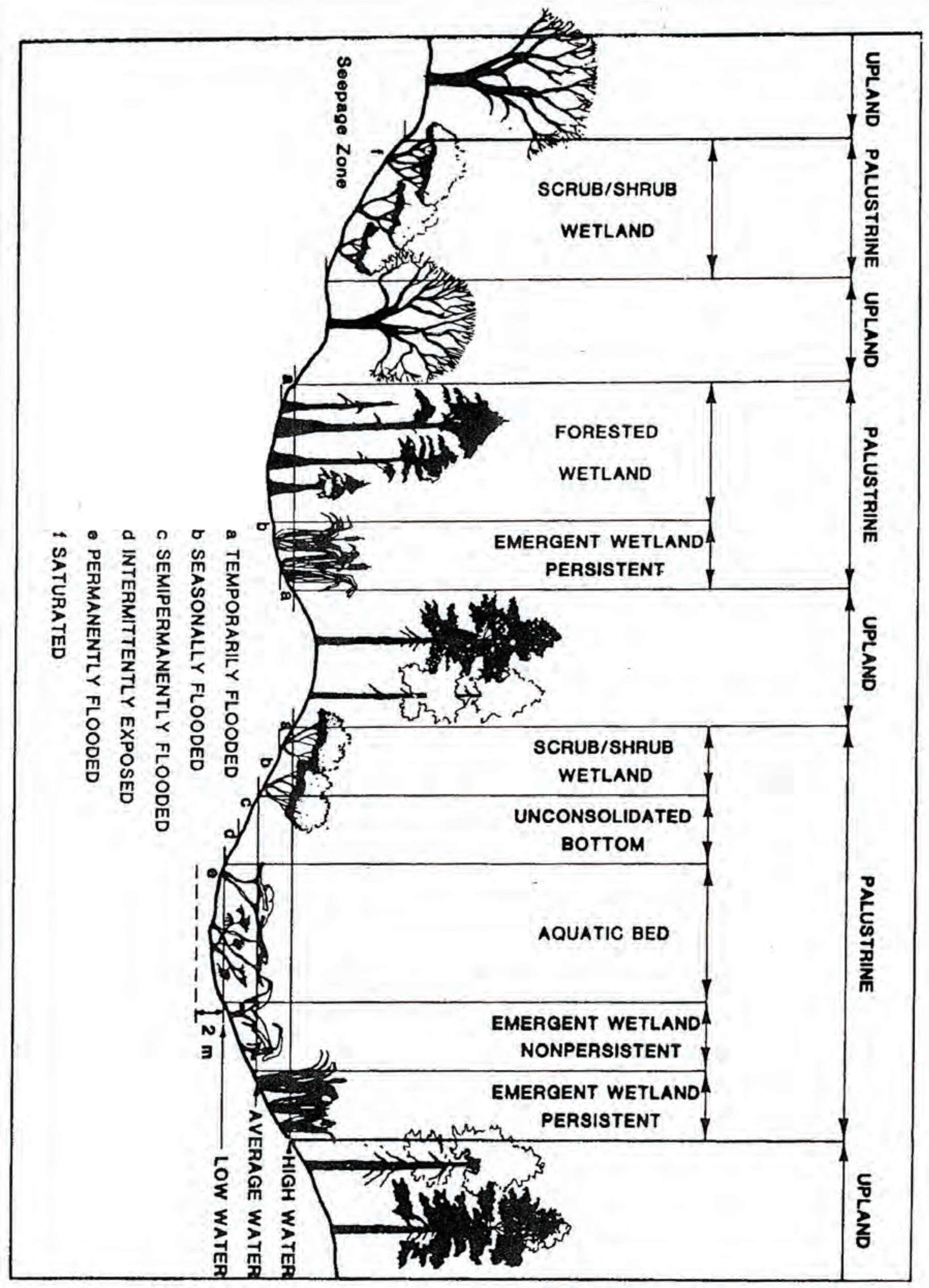


Figure 8-8. Distinguishing features and examples of habitats in the Palustrine Svstem.

Classes are used to describe the general appearances 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.

Vegetation is used at two different levels in the classification. The life forms – trees, shrubs, emergents, emergent mosses, and lichens – are used to define Classes because they are relatively easy to distinguish, do not change distribution rapidly, and have traditionally been used as criteria for classification of wetlands. Other forms of vegetation, such as submerged or floating-leaved rooted vascular plants, free-floating vascular plants, submerged mosses, and algae, though frequently more difficult to detect, are used to define the Class Aquatic Bed.

Use of life forms at the Class level has two major advantages: 1) extensive biological knowledge is not required to distinguish between various life forms, and 2) it has been established that various life forms are easily recognizable on a great variety of remote sensing products. *If vegetation covers 30% or more of the substrate, Classes are distinguished on the basis on the life form of the plants that constitute the uppermost layer of vegetation and that possess an area coverage 30% or greater*. For example, an area with 50% coverage of trees over a shrub layer with 60% coverage would be classified a Forested Wetland; an area with 20% coverage of trees over the same (60%) shrub layer would be classified as Scrub-Shrub Wetland. When trees or shrubs alone cover less than 30% of an area but in combination cover 30% or more, the wetland is assigned to the Class Scrub-Shrub. When trees and shrubs cover less than 30% of the area but the total cover of vegetation is 30% or greater, the wetland is assigned to the appropriate Class for the predominant life form below the shrub level. Finer differences in life forms are recognized at the **Subclass** level. Subclasses are named on the basis of the predominant life form.

If vegetation covers less than 30% of the substrate, the physiography and composition of the substrate are the principal characteristics used to distinguish Classes. The nature of the substrate reflects regional and local variation in geology and influence of wind, waves, and currents on erosion and deposition of substrate materials. Bottoms, Shores, and Streambeds (found in Classes) 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.

Definitions of Classes

Rock Bottom

The Class Rock Bottom includes all wetlands and deepwater habitats with substrates having an area cover of stones, boulders, or bedrock 75% or greater and vegetative cover of less than 30%. Water regimes are restricted to subtidal, permanently flooded, intermittently exposed, and semi-permanently flooded.

Unconsolidated Bottom

The Class Unconsolidated Bottom includes all wetland and deepwater 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 semi-permanently flooded.

Aquatic Bed

The Class Aquatic Bed includes wetlands and deepwater habitats dominated by plants 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 exposed, regularly flooded, permanently flooded, intermittently exposed, semi-permanently flooded, and seasonally flooded.

Reef

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

The Class Streambed includes all wetland contained within the Intermittent Subsystem of the Riverine System and all channels of the Estuarine System or of the Tidal Subsystem of the Riverine System that are completely dewatered at low tide. Water regimes are restricted to irregularly exposed, regularly flooded, irregularly flooded, seasonally flooded, temporarily flooded, and intermittently flooded.

Rocky Shore

The Class Rocky Shore includes wetland environments characterized by bedrock, stones, or boulders which singly or in combination have an area cover of 75% or more and an area 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

The Class Unconsolidated Shore includes all wetland habitats having three characteristics: 1) unconsolidated substrates with less than 75% area cover of stones, boulders, or bedrock; 2) less than 30% area 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 or intertidal channels of the Riverine System and intertidal channels of the Estuarine System are classified as Streambed.

Moss-Lichen Wetland

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 area cover. The only water regime is saturated.

Emergent Wetland

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

Scrub-Shrub Wetland
The Class Scrub-Shrub Wetland includes areas dominated by woody vegetation less than 6 meters (20 feet) tall. The species include tree 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
The Class Forested Wetland is characterized by woody vegetation that is 6 meters tall or taller. All water regimes are included except subtidal.

Dominant Classes
Because of their dominance, the following three classes within the Palustrine System are described here in more detail. Table 8-1 lists the kinds of vegetation common to each.

Emergent wetlands are dominated by herbaceous (non-woody) vegetation, including certain grasses, cattails, rushes, and sedges. These wetlands are commonly referred to by a variety of terms, including "marsh," "wet meadow," "fen," and "inland salt marsh," depending on the region of the country and individual characteristics. Emergent wetlands may be flooded for variable periods from as little as a couple of weeks early in the growing season to as much as permanently flooded throughout the year.

Emergent wetlands occur in a variety of situations, including along the margins of rivers and lakes, in isolated depressions surrounded by upland (as in the Prairie Pothole Region of the Dakotas), in seepage areas on gentle slopes, and in saturated permafrost areas of Alaska.

Freshwater wetlands dominated by woody vegetation less than 20 feet tall are called scrub-shrub wetlands. Although not as abundant as nontidal emergent and forested wetlands, they occur throughout the nation. These scrub-shrub wetlands are commonly called "bogs," "pocosins," "shrub-carrs," or "shrub swamps" in different parts of the country.

Northern and southern peat bogs are particularly interesting types of scrub-shrub wetlands. Both types are rarely flooded and are generally characterized by a saturated organic soil with the water table at or near the surface for most of the year. Northern bogs are prevalent in the glaciated region of the country in isolated depressions, along river courses, and along the margins of lakes in some states, including Alaska, Maine, Michigan, Minnesota, New York, and Wisconsin. Southern bogs, locally called "pocosins," occur along the southeastern coastal plain and are most abundant in North Carolina. They are found in broad flat plateaus usually apart from large streams. The term "pocosin" is an Indian term meaning swamp on a hill.

Forested wetlands dominated by trees occur mostly in Alaska and the eastern half of the United States. In the East, they are the most abundant nontidal wetland type. As in other nontidal wetlands, flooding is extremely variable depending on regional climate, topographic position, and local hydrology.

Table 8-1. Vegetation Common to Nontidal Wetlands*

Type of Wetland	Vegetation
Emergent Wetlands:	
Freshwater	Cattails, wild rice, sedges, rushes, bulrushes, spikerushes, burreeds, rice cutgrass, maidencane, reed, arrowheads, pickerelweed, smartweeds, bluejoint, whitetop, reed canary grass, manna grass, asters, goldenrods, marsh fern.
Saline	Glassworts, saltgrass, cattails, alkali grass, dropseed, alkali bulrush, harstem bulrush, arrow grass, barley grass.
Shrub Wetlands:	
Northern Bogs	Leatherleaf, sweet gale, cottongrass, peat moss, bog rosemary, Labrador tea, cranberry, bog laurel, sedges, black spruce, larch, lodgepole pine, balsam fir, water willow, sheep laurel, highbush blueberry.
Pocosins	Pond pine, sweet bay, inkberry, fetterbush, titi, red bay, wax myrtle.
Others	Buttonbush, alders, willows, dogwoods, red maple saplings, cottonwood saplings.
Forested Wetlands:	
Northern	Red maple, ashes, northern white cedar, black spruce, larch.
Southern	Bald cypress, red maple, Atlantic white cedar, overcup oak, water tupelo, black gum, black willow, pumpkin ash.
Northwestern	Western hemlock, red alder, willows.
Alaskan	Black spruce, larch, lodgepole pine, balsam poplar.
Bottomland Hardwood Forests:	
Southern	Sweet gum, beech, loblolly pine, slash pine, sycamore, water hickory, black walnut, pignut hickory, various oaks.
Northern	Silver maple, pin oak, sycamore.
Riparian Forested Wetlands:	
Western	Cottonwoods, green ash, box elder, elms, willows.

*Used with permission from "Protecting Nontidal Wetlands," American Planning Association PAS Report 412/413, 1988, Chicago.

Obtaining Wetland Data

The U.S. Fish and Wildlife Service's (Service) National Wetlands Inventory has produced a series of large-scale (1:24,000) maps that show the general locations and types of wetlands and deepwater habitats for about 90% of the nation. Standard-sized 7.5' paper wetland maps (blue-line polygons shown on U.S. Geological Survey blue-line topographic base, size 2 feet by 3 feet) can be purchased through Cooperator-Run Distribution Centers. Each Center establishes its own pricing structure, product types and order procedures. A list of the Centers may be found at the Service's Internet website at http://wetlands.fws.gov. Under "Maps Information" click on Hard-Copy Maps." On the next screen click on "View List of Cooperator-Run Distribution Centers."

Custom maps can be viewed, printed in color, or saved as a file starting at the "Wetlands Mapper" located on the "Wetland Hard-copy Maps" screen. Clicking on a number of sites on the screens can launch available maps. These letter-sized hard-copy maps can be printed for the 42% of the nation that is available in digital format. The website also contains a status map showing available digital data. Very little digital data exist for Tennessee.

Interpreting Wetland Data

A representative sample of a wetland map available in digital format and downloaded and saved as a file from the Service's Internet website, identified above, is illustrated in Figure 8-9. It shows mapped wetlands in portions of Blount and Knox Counties, Tennessee.

Utilizing the Wetlands and Deepwater Habitats Classification codes, Figures 8-10 and 8-11, obtained from the Service's website under "Maps Information," clicking on "Code Definitions," and then on "Wetlands and Deepwater Habitats Classification Map Legend," wetlands shown on maps can be interpreted according to System, Subsystem, Class and Subclass.

As examples, the wetland shown near the center of Figure 8-9 has the following designation: PFO1A. Utilizing the classification system illustrated on Figures 8-10 and 8-11, this wetland's System is Palustrine (P), Class is Forested (FO), Subclass is Broad-Leaved Deciduous (1), and is Temporarily Flooded (A). The wetland shown in the upper right corner has the following designation: L2UBFh. Its System is Lacustrine (L), Subsystem is Littoral (2), Class is Unconsolidated Bottom, Semipermanently Flooded (F), and Diked/Impounded (h).

On the website at "Wetland Codes and Definitions," the user can utilize the "NWI Map Codes Search Form" and type the wetlands code from the map into the form to get the Service description and definition.

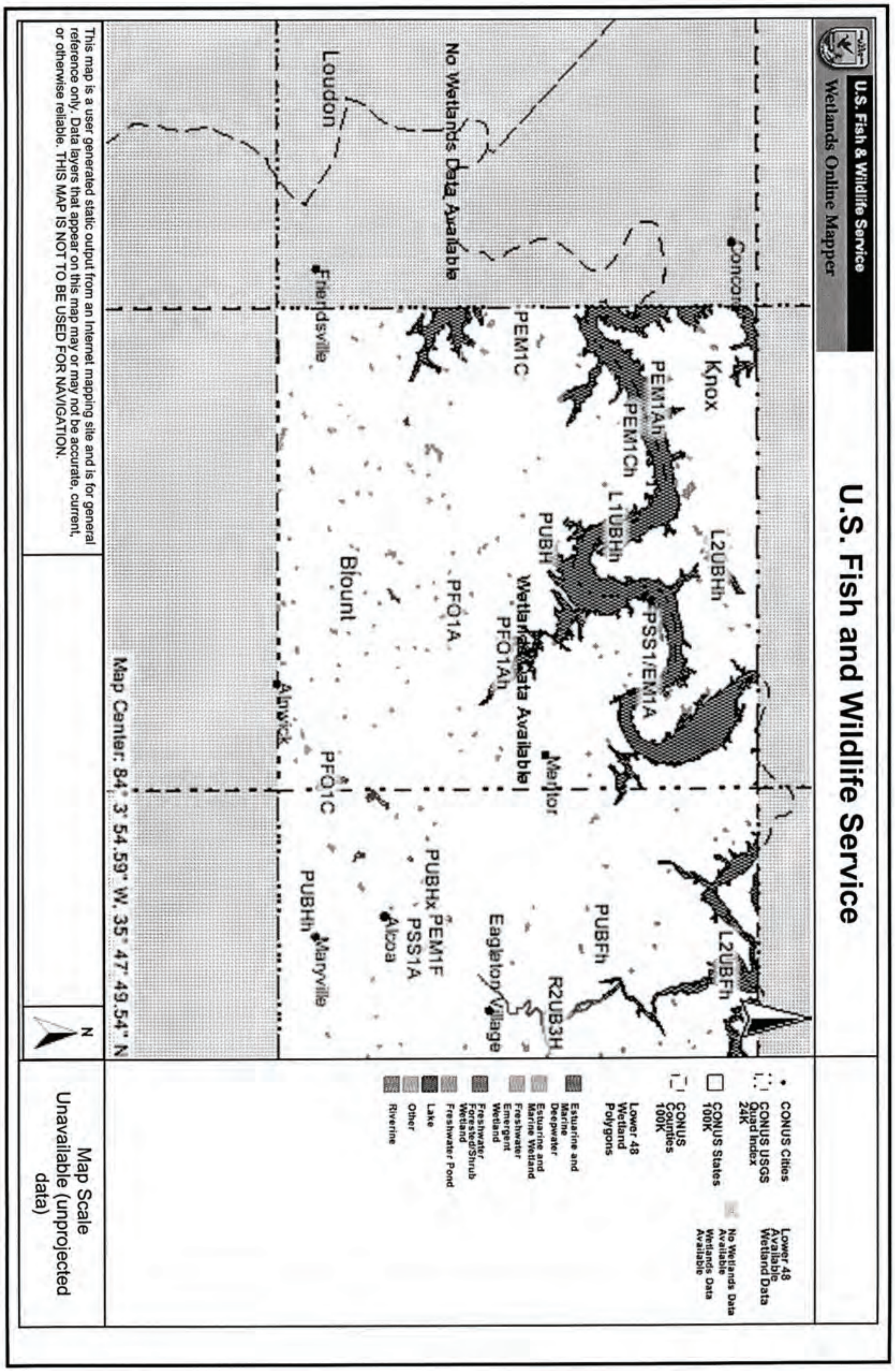


Figure 8-9. Typical U.S. Fish and Wildlife Service wetlands map.

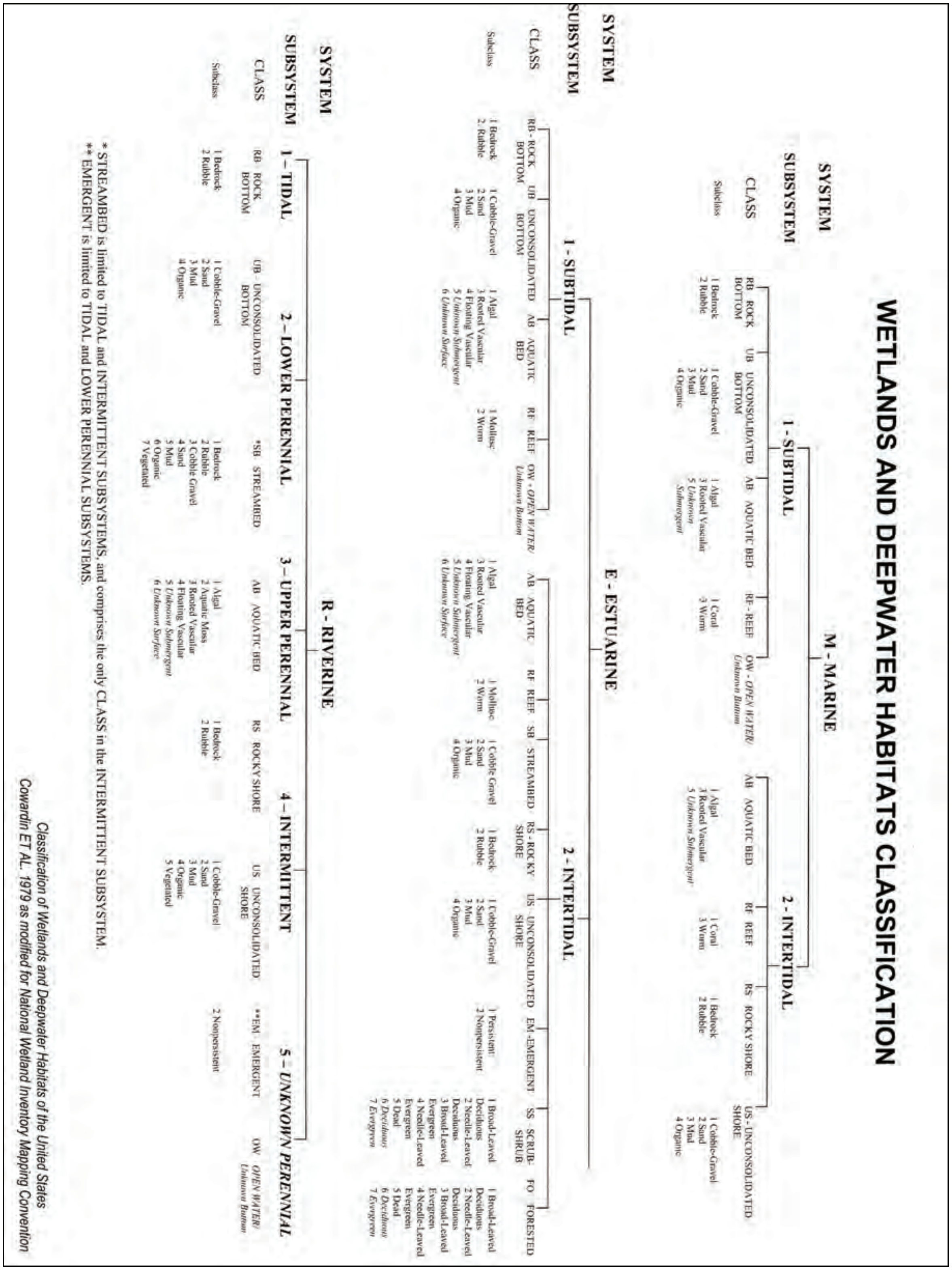


Figure 8-10. Wetlands and deepwater habitats classification.

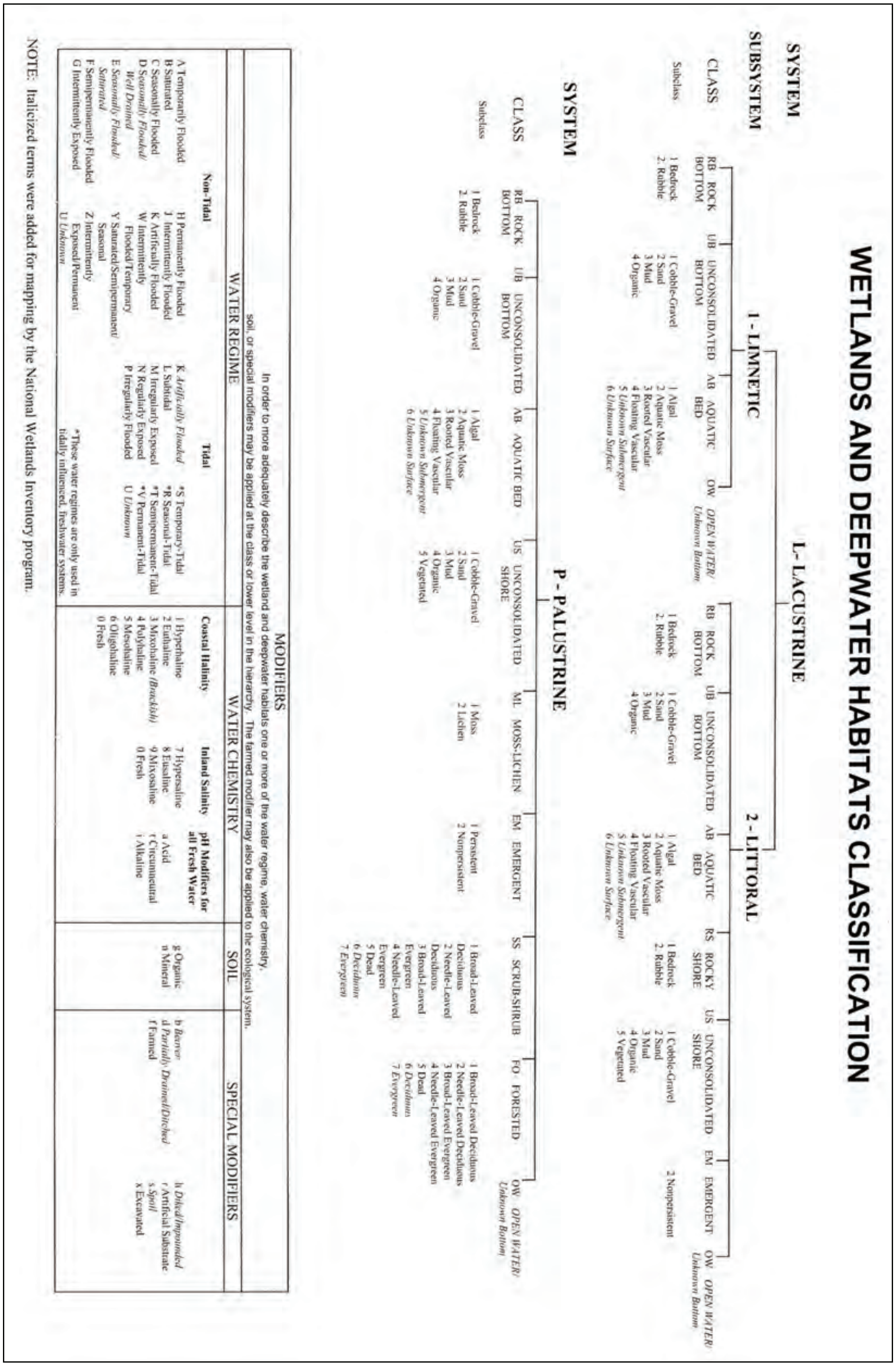


Figure 8-11. Wetlands and deepwater habitats classification.

Forces Changing Wetlands

Wetlands represent a dynamic natural environment that is subject to both human and natural forces. These forces directly result in wetland gains and losses and affect wetland quality. Major causes of wetland loss and degradation are listed in Figure 8-12.

Major Causes of Wetland Loss and Degradation

Human Threats: Direct

- Drainage for crop production, timber production, and mosquito control
- Dredging and stream channelization for navigation channels, flood protection, coastal housing developments, and reservoir maintenance
- Filling for dredged spoil and other solid waste disposal, roads and highways, and commercial, residential, and industrial development
- Construction of dikes, dams, levees, and seawalls for flood control, water supply, irrigation, and storm protection
- Discharge of materials (e.g., pesticides, other pollutants, nutrient loading from domestic sewage and agricultural runoff, and sediments from dredging and filling, agricultural, and other land development) into waters and wetlands
- Mining of wetland soils for peat, coal, sand, gravel, phosphate, and other materials

Human Threats: Indirect

- Sediment diversion by dams, deep channels, and other structures
- Hydrologic alterations by canals, spoil banks, roads, and other structures, and groundwater withdrawals
- Subsidence due to extraction of groundwater, oil, gas, sulphur, and other minerals

Natural Threats

- Subsidence (including natural rise of sea level)
- Droughts
- Hurricanes and other storms
- Erosion and accretion
- Biotic effects, e.g., muskrat, nutria, and goose "eat-outs"

Source: Tiner, 1984.

Used with permission from "Protecting Nontidal Wetlands," ibid., American Planning Association PAS Report 412/413, 1988, Chicago.

Figure 8-12. Major causes of wetland loss and degradation.

Natural events influencing wetlands include rising sea level, natural succession, the hydrologic cycle, sedimentation, erosion, beaver dam construction, and fire. The rise in sea level, for example, both increases and decreases wetland acreage, depending on local factors. Natural succession and fire typically change the vegetation of a wetland, usually with no net loss or gain in wetland acreage. However, fire in Alaska's permafrost wetlands may convert the area to non-wetland. Disturbance of the vegetative cover can cause the frostline to recede, and dry-site plants may become established.

The hydrologic cycle also plays an important role in the dynamics of wetlands. Great Lakes water levels, for example, fluctuate drastically, roughly on a 20-year cycle. This adds an important dimension to wetlands, making them vulnerable to drainage during dry periods. Similar conditions have resulted in wetland drainage in the Prairie Pothole Region of the Dakotas. The activities of beavers create or alter wetlands by damming stream channels. Thus, natural forces act in a variety of ways to create, destroy, and modify wetlands.

Human activities are particularly significant in determining the fate of wetlands. Unfortunately, many human activities are destructive to wetlands, either converting them to agricultural or other land uses or degrading their quality. Key human impacts include drainage for agriculture; channelization for flood control; filling for housing, highway, industry, and sanitary landfills; dredging for navigation channels, harbors, and marinas; reservoir construction; timber harvest; peat mining; oil and gas extraction; strip mining; groundwater extraction; and various forms of water pollution and waste disposal. A few activities, however, create wetlands. Construction of farm ponds and, in some cases, reservoirs and irrigation projects may increase wetland acreage, although valuable natural wetlands may also be destroyed in the process. Marsh creation and the restoration of previously altered wetlands can also be beneficial. Federal and state fish and wildlife agencies traditionally manage wetlands to improve their value to waterfowl.

Coastal Dunes and Barrier Islands

Most coastal areas contain beaches, backed by vegetated sand ridges called **dunes**. Coastal beaches and dunes begin with the accumulation of marine sand that is transported to the coast by waves and currents. In the case of dunes, sand is subsequently reworked by strong onshore winds and then deposited behind the beach, principally being trapped in vegetation and by other obstructions. As sand accumulates, the dunes become higher and wider.

Primary dunes act as a reservoir of sand which can buffer inland areas from the effects of storm waves and, in the process, act as natural levees against coastal flooding. Ocean dune fields are relatively continuous features exposed to the open ocean. During high energy conditions, such as the tropical storms which frequent the Southeast and Gulf areas and the Northeast storms which frequent the Eastern Seaboard, primary dunes may be subject to attack by wind-driven waves aided by storm surges. The dune may be eroded, and the sand deposited in an offshore bar. Then, under low-energy conditions, the sand may move back to the beach. Factors in the **natural** renourishment of beaches and dunes over periods of time after the occurrence of coastal storms are complex and include the locations of sand fields, beach profiles, onshore winds, waves, and currents.

Sand deposited on the beach during periods of relatively low wave energy is moved landward by onshore winds. The deposition of material above the intertidal zone allows vegetation to take root along the wrack line (a line that runs the length of the beach and marks the place where the tide reaches its highest point.) which then acts as a baffle, slowing wind speed and causing wind-borne sand to settle and be trapped in the vegetation, thereby resulting in further accretion of the dune. Therefore, the size and location of a primary dune is determined by the amount of sand available and the ability of wind and waves to move it as well as the degree to which any existing vegetation can act to trap it. Just as the intensity, direction, and duration of winds and waves constantly change through the seasons, so too, do coastal dunes. They exist in a state of flux.
Dunes in the estuarine system involving bays and inlets are mobile features. These dunes form across a temporal and spatial geomorphic matrix driven by sand volume, varying wave climate, and shoreline geology. The coastal geology, in large part, determines whether shoreline erosion acts upon the upland (high bank) or marsh (low bank). Sand supply and the long-term local wave

climate are significant factors in the location of dunes. The stability or ability of a dune/beach system to accrete over time is necessary for the formation of secondary dunes.
Natural dunes in the estuarine system vary in size and nature, but all require an accreted feature, such as a beach washover or a spit to become vegetated above the intertidal zone. Vegetation and a continuous beach/dune profile are required to create the jurisdictional primary dune. When the dune/beach forms across a low marsh shoreline, the system may move landward in response to storms, and only a low primary dune will exist. If sand can accrete bayward due to shoals, spits, or man-made features such as jetties and groins, then a secondary dune may develop from the original primary dune.

Federal involvement in **artificially** renourishing eroded beaches resulting from coastal storms will be discussed later in this course. Economic issues affecting coastal communities are principal factors.

Barrier islands are long, narrow, offshore deposits of sand or sediments that parallel the coast line. The current theory is that they were formed about 18,000 years ago when the last Ice Age ended. In the United States they are principally found along the eastern coast where they extend from New England down the Atlantic Coast, around the Gulf of Mexico and south to Mexico. Some barrier islands can extend for 100 miles or more. The islands are separated from the main land by a shallow sound, bay, or lagoon. Barrier islands are often found in chains along the coast line and are separated from each other by narrow tidal inlets, such as the Outer Banks of North Carolina. Some resort communities such as Atlantic City, NJ and Miami Beach, FL are built on barrier islands.

Barrier islands serve two main functions. First, they **protect the coastlines** from severe storm damage. Second, they **harbor several habitats** that are refuges for wildlife. In fact, the salt marsh ecosystems of the islands and the coast help to purify runoffs from mainland streams and rivers. Each of these habitats has distinct animal and plant life.

Barrier islands are fragile, highly dynamic, subject to geologic and storm actions, along with human developments, all of which can change the nature of the islands. They contain constantly changing ecosystems that are important for coastal geology and ecology. They also provide important protection of coastlines from severe storms. Because of their land/water interface, they are popular tourist locations and valued for vacation homes and condominiums. (In addition to the Outer Banks, mentioned above, other notable barrier islands are St. Simons and Jekyll Islands along Georgia's coast.) But the development environment on barrier islands is subject to severe damage from coastal storms because of exposure.

For all the above reasons, the Congress took action to protect them from further development by enactment of the Coastal Barrier Resources Act of 1982 and the Coastal Barrier Improvement Act of 1990. (Chapter Eleven will provide a more detailed discussion of the Acts). The Acts established the Coastal Barrier Resources System, comprised of undeveloped portions of coastal barrier islands and other areas along the coast and shores. New federal expenditures and financial assistance are prohibited for all but a few types of activities within the System.

Homework Assignment

Utilizing the U.S. Fish and Wildlife's Wetlands Mapper on their Internet website, determine if wetlands data are available in digital form for the area where you live, or were born, or where your parents or another relative live. If not, choose another area of interest. Print a wetlands map, circle five designated wetlands and identify them by System, Subsystem (if appropriate), Class, Subclass, and Modifiers.