CHAPTER 1:WETLAND BASICS

WETLAND DEFINITION

Is a wetland the same as a swamp? A bog? A marsh? The answer to all of these questions is yes! Swamps, bogs and marshes are all types of wetlands. The presence of water is the defining characteristic of wetlands. To be a wetland, an area must have enough water at some time during the year to alter hydrology and soil conditions that in turn support vegetation and wildlife that are adapted to live in a wet environment (Mitsch and Gosselink, 1993; Tiner, 1997). The features of the unique hydrology, soils, and plants that define wetlands are discussed in detail later in this chapter.

Defining wetlands using specific parameters and **delineating** the boundaries between **jurisdictional wetlands** and adjacent uplands are important in the study and regulation of wetlands. (Outside of narrowly-defined regulatory purposes, it can be very difficult to distinguish the natural boundaries of wetlands.) Wetlands have many definitions in the United States as a result of their diversity, the need for their inventory and the regulation of their uses. Partly due to increases in wetland regulation, defining wetlands has become controversial and complicated. Politics plays a large role in developing wetland definitions.

The following is a regulatory definition used by U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency to administer Section 404 of the federal Clean Water Act (see Chapter 5 for a description of federal and state wetland regulations):

> "Wetlands are those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas."

Jurisdictional wetlands, which are protected by Section 404, are wetlands that exhibit all of the characteristics described in this definition.

The Natural Resources Conservation Service created their own wetland definition to implement the "Swampbuster" provision of the Food Security Act of 1985, which prevents some wetlands on agricultural lands from being drained. According to NRCS:

> "Wetlands are defined as areas that have a predominance of hydric soils and that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions, except lands in Alaska identified as having a high potential for agricultural development and a predominance of permafrost soils."

Some state and local governments have developed wetland definitions for their own regulatory and permitting purposes.

A widely accepted scientific definition used today was developed in 1979 by the U.S. Fish and Wildlife Service and was published in the report *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al, 1979). The U.S. Fish and Wildlife Service uses this definition to periodically conduct an inventory of the wetlands in the United States. It states:

> "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... 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" (Cowardin, et al. 1979).

Although the above definitions have subtle wording differences, each refers to three main characteristics of a wetland: surface water or water in the root zone, undrained hydric soils, and vegetation adapted to thrive in wet conditions (**hydrophytes**). These components vary and are not always obvious, which often makes it difficult to determine whether or not a particular area is a wetland. For example, wetness can vary seasonally and yearly. Many wetland species of plants and animals are **facultative**, which means they have an equal chance of being in a wetland or upland area (50 percent occurrence), or **obligate**, which means they are nearly always found in wetlands (99 percent occurrence). In many cases, the presence or absence of these types of plants help wetland scientists determine if an area is a true wetland.

WHAT MAKES A WETLAND WET

(Mitsch and Gosselink, 1993)

The "wetness" or **hydrologic regime** of a wetland is one of its defining characteristics and is a vital component of the entire system. Hydrologic regime refers to how water enters and exits the wetland system. To be called a wetland, an area of land does not need to have permanent standing water. A wetland requires only the presence of water either on the surface or in the root zone for a portion of the growing season. Hydrologic factors affect the amount of oxygen available, the accessibility of nutrients, and soil and water chemistry. All of these factors, combined, determine the types of plant and animal communities that will live in the wetland.

Defining a few key concepts will help you understand wetland **hydrology** better. A **hydroperiod** is the seasonal fluctuating pattern of the water level. Variables include **flood duration** (the amount of time a wetland is under standing water) and **flood frequency** (the average number of times a wetland is flooded during a particular period of time). Hydroperiods are affected by the weather, the season, location on the landscape, **inflows** and **outflows** such as streams and springs feeding into and draining from the wetland, the surrounding watershed, groundwater, and other waterbodies in the area.

There is considerable variation in hydroperiod from year to year in some wetlands. For example, in some prairie pothole systems, wet or dry cycles can last 10 to 20 years! Many

wetlands along rivers have a pulsing hydroperiod, which means that the water level varies regularly depending on the season (or daily in the case of coastal or tidal wetlands).

Hydrology is a major factor affecting the types of plant communities. It also influences an area's overall **biodiversity**. This is because plant species have different tolerance levels for saturated soils and the changes in oxygen and nutrient availability that occur as the water level changes. In general, wetlands that are flooded frequently seem to have lower **species diversity**, that is fewer species, than drier areas. Overall **species richness**, the number of individuals, however, increases with the amount of water flowing into and out of a wetland. This is probably because of the constant renewal of nutrients, **organic** material and available oxygen transported by the exchange of water.

How Water Enters and Exits Wetlands

There are a variety of pathways that water can take into and out of wetlands. Some wetlands are influenced primarily by one of the following pathways while other wetlands are affected by multiple patterns.

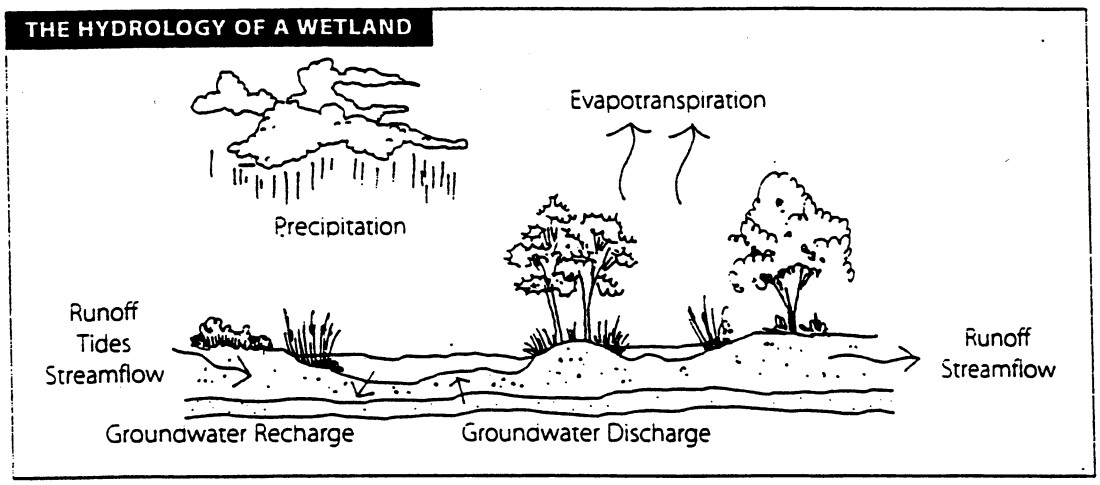

Figure 2-1

•**PRECIPITATION** has well-defined and fairly predictable yearly patterns in North America. In other parts of the world, rain and snow affect wetlands in less predictable ways because the amount of precipitation varies widely from season to season and year to year.

•**SURFACE WATER** includes in-stream flow and **overland flow** — water running over the surface of the land rather than within a channel. Overland flow usually follows rainfall or spring thaw. In-stream flow may enter or exit a wetland year-round. In-stream flow can flow into or out of wetlands that are adjacent to stream channels. For example, water levels in wetlands that are adjacent to the Kankakee River in northwest Indiana fluctuate as the river level rises and drops.

•**GROUNDWATER** affects the hydrology of some wetlands. When the wetland water level is lower than the water table of the surrounding area, water moves from the groundwater into the wetland via **subsurface flow** or **interflow**. This makes the wetland a **discharge site.**

Conversely, when the wetland water level is higher than that of the water table, the wetland can serve as a **recharge** point for the area as water moves from the wetland into the groundwater (see Figure 2–1). In **perched** wetland systems, soils are **impermeable**, or do not allow water to pass through them, and therefore do not affect groundwater (Mitsch and Gosselink, 1993). In Indianapolis, the Lake Sullivan **wetland complex** along Cold Spring Road contains a spring seep that is fed by groundwater. Several other seeps that once occurred here (explaining the road's name) were destroyed when the groundwater system in the area was artificially altered for development projects.

• **EVAPOTRANSPIRATION** is purely an outflow mechanism. This involves both the water that **evaporates** from the land and bodies of water as well as water that escapes from plants. **Transpiration** occurs when water moves from plant pores (stomata) into the atmosphere. Evapotranspiration is affected by the availability of water and weather conditions such as heat, humidity and wind.

Effects of Hydrology on Wetland Processes

The availability of nutrients is influenced significantly by the hydrologic regime of a wetland. Nutrients are carried into a wetland system through rain and snow, flooding, surface flow and groundwater. When plant production and **decomposition** are high (flowing water can elevate these), **nutrient cycling** increases. Access to nitrogen, a primary plant nutrient, is decreased during saturated conditions. Flooding also affects the **pH** — a measure of the **acidity** or **alkalinity** — of the soil, which impacts the availability of nutrients. Some minerals and nutrients only convert to useable forms at certain soil pH levels.

Primary productivity is the amount of plant growth that occurs in a wetland. Studies indicate that productivity is highest where water enters a wetland through a stream or river. Primary productivity is low in stagnant or low-flow conditions and generally is low under constantly flooded or constantly dry conditions (Niering, 1985). This is due, in part, to the lack of nutrient inflow under these circumstances.

WETLAND SOILS

Soils found in wetlands are called **hydric soils**. A hydric soil is "a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop **anaerobic** conditions in the upper part" (Natural Resources Conservation Service, 1992); anaerobic refers to oxygen-free. The USDA criteria for hydric soil includes soils that are frequently ponded or flooded for a long duration (minimum of 7 consecutive days) during the growing season. These criteria apply regardless of physical appearance (Department of Agriculture, 1991). Hydric soils are either organic or mineral.

Organic soils are defined by the depth and content of **organic matter**. These dark, soft soils primarily consist of plant remains that accumulate in wetlands during anaerobic conditions. The plant remains may come from mosses, grasses, or wood and leaf litter, depending on the wetland type. Commonly recognized names for certain organic soils are **peat** and **muck**. Peat soils are brown to black, and most of the decomposing plant material is still recognizable. In

muck soils, plants are decomposed beyond recognition and will stain the hands. Mucks are greasy and black when moist and almost liquid when wet (Welsch, et al). In many parts of the United States, naturally-occurring organic soils are uncommon or rare and merit special consideration.

Mineral soils are defined as containing usually less than 20 percent organic matter. The two most commonly recognized characteristics of hydric mineral soils are **gleying** and **redoximorphic features**. Gleyed mineral soils are indicative of prolonged saturation and usually are greenish or blue-gray in color. Mineral soils that are seasonally saturated can develop redoximorphic features, also referred to as **mottles**. These are small spots or blotches of various shapes and colors that indicate the presence of iron oxide or manganese oxide. Mottles occur when iron compounds are reduced (chemically altered) by soil **microbes** in anaerobic soils. Microbes use oxygen-containing iron compounds instead of elemental oxygen in their respiratory process because saturated soils lack elemental oxygen (Welsch, et al). The abundance, size, and color of the redoximorphic features usually reflect the duration of the saturation period and indicate whether or not the soil is **hydric**. Mineral soils that are predominantly gray with brown or yellow redoximorphic features usually are saturated for long periods during the growing season. Soils that are predominantly brown or yellow with gray features are saturated for shorter periods and may not be hydric (Tiner, 1988).

WETLAND PLANTS

Waterlogged conditions and fluctuating water levels present in many wetlands are stressful to plants. The frequently flooded conditions of some wetlands create a saturated and oxygen-poor root zone, making oxygen exchange difficult for plants. Flood-tolerant plant species, or hydrophytes, have several **adaptations** that allow them to survive with limited oxygen. These adaptations can be divided into three categories: **morphological**, reproductive, and **physiological** (COE Wetland Delineation Manual, 1987).

Morphological Adaptations

The morphological adaptations of plants are modifications to the structure of the plant. These changes in physical structure may provide the plant with increased support and may increase the uptake of nutrients and oxygen exchange.

• **BUTTRESSED TREE TRUNKS** — swollen trunks found on species such as bald cypress trees, water tupelo and swamp blackgum.

• **ADVENTITIOUS ROOTS** — roots that protrude from a stem above fluctuating water levels.

• **SHALLOW ROOT SYSTEMS** — roots that grow near the surface where they can obtain oxygen.

• **PNEUMATOPHORES** — modified roots that may increase **respiration**. Cypress knees are the most common example in temperate climates.

• **INFLATED LEAVES, STEMS OR ROOTS**— spongy tissues in leaves, stems and roots that provide buoyancy and a reservoir for oxygen. Many herbaceous wetland plants, such as cattails and bulrush, have inflated tissues.

• **FLOATING LEAVES** — leaves that have a thick, waxy cuticle to prevent water penetration.

• **FLOATING STEMS** — stems with large internal air spaces that allow plants to root in shallow water and float.

• **HYPERTROPHIED LENTICELS** — large pores on plant stems that allow oxygen exchange.

Reproductive Adaptations

The following are some examples of reproductive strategies plants use to survive flooded conditions:

• **PROLONGED SEED VIABILITY** — seeds are viable for 20 years or more, which allows them to postpone **germination** until a very wet area dries and they are exposed to air.

• **SEED GERMINATION UNDER LOW OXYGEN CONCENTRATIONS** — seeds germinate when submerged and do not need to wait for exposure to air.

• **SEED/SEEDLING ADAPTATIONS** — seed production is timed for the non-flood season; seeds float to dry ground to germinate; seeds germinate while still attached to the plant; or seedlings are flood-tolerant.

Physiological adaptations

These adaptations occur when plants alter their life processes to survive in flooded conditions. For example, some wetland plants have the ability to grow in low oxygen conditions. Others have the ability to transfer oxygen from their roots into the surrounding soil. This prevents root deterioration and assists in water and nutrient absorption under water-logged and anaerobic conditions. Ethanol is a potentially **toxic** by-product of upland plants when they respire under waterlogged conditions. Some wetland plants avoid the buildup of toxic materials by producing malate, a harmless substance, in place of ethanol.

BIOGEOCHEMISTRY

(Welsch, et al)

Biogeochemical cycling refers to the combination of the many physical, chemical and biological processes in the environment that provide the pathway for the basic elements that occur in living organisms to move through the environment. These elements include nitrogen, phosphorus, sulfur, iron, and carbon. Biogeochemical cycling greatly affects the productivity of the wetland **ecosystem**. Both the hydrology (water level, duration, and source) and the presence of an oxygenated top layer of soil affect how the different processes work. For example, flooding of wetlands permits anaerobic conditions that are needed for the cycling of nutrients like nitrogen.

Biogeochemical cycling can be divided into two categories: 1) transformation processes within a wetland; and 2) exchange of nutrients, organic matter, and other chemicals between the wetland and the outside world For example, nitrogen is transformed within a wetland when dead plant material decays. Nitrogen also can enter or leave a wetland through surrounding air or water. Both transformation and exchange processes determine whether a wetland is an **open system**, with a high degree of material exchange with surrounding ecosystems, or a **closed system**, having little or no material exchange. Open systems have higher levels of primary productivity because nutrients constantly are replenished from external sources.

TYPES OF WETLANDS AND WETLAND CLASSIFICATION

Wetland habitats are very diverse, and often have been referred to by names such as marsh, wet meadow, bog, swamp, bottomland forest and playa. The problem with using these common names alone to describe wetlands is that they are not strictly defined (Majumdar, et al., 1989). In fact, the common names vary from region to region and country to country.

A **classification** system for wetlands specifically defines types and provides information about each wetland's **functions** and placement in the landscape. Functional classifications, like groundwater recharge wetlands, require a standardized functional assessment method that can be used by scientists and regulators in the field. However, this is a new approach and it has not been fully developed for practical use yet. The Army Corps of Engineers is currently piloting-testing a functional classification system called the hydrogeomorphic method. Wetland scientists in Indiana are currently developing a functional assessment method that can be used to classify wetlands across the state.

The more common way of classifying wetlands currently is to use major vegetation types and landscape features. The following section provides examples and descriptions of common wetland types found in Indiana. Following the description of wetland types is a section outlining a more specific classification system based on wetland hydrology, plants, and soils. A more detailed description of wetland communities found in Indiana as developed by the Indiana Department of Natural Resources is found in the Appendix.

Nontidal Freshwater Wetlands

Some nontidal freshwater wetlands contain mostly grasses, sedges and other **emergent** vegetation; others have forested and scrub-shrub communities as well. These wetlands can be small, like a prairie pothole or **vernal** pool, or large, like the Florida Everglades. Wetlands in this group are thought to be the most diverse of all wetland types. Here are some examples of various types of nontidal freshwater wetlands found in Indiana:

Marshes

Marshes are found throughout Indiana and are characterized by shallow water, by little or no peat deposition, and by mineral soils. These ecosystems are inundated frequently or continually with water and derive their water from streams, overland flow and groundwater. Marshes are dominated by emergent aquatic plants such as cattails, arrowheads, pickerelweed, smartweed, reeds, ferns and sedges, or by floating-leafed plants such as duckweed and

waterlilies. These species do not occur randomly in the wetland, but follow a definite pattern of **zonation** (Mitsch and Gosselink, 1993). Species adapted to frequent flooding occur at low elevations while species less tolerant of flooding occur at higher elevations that are less subject to inundation.

Unfortunately, **invasive** plant species are a problem in many freshwater marsh systems, especially in areas that have been damaged and disturbed. In Indiana, purple loosestrife, reed canarygrass, and giant reedgrass are some of the plants that cause native plant displacement or choke open waterways. Illustrations and field notes for the common invasive plants of Indiana's wetlands are provided in Chapter 4.

Many insects and animals inhabit these nontidal marshes as well. Most people are familiar with dragonflies, damselflies, whirligig bugs, and water striders. Muskrats and beavers are the dominant mammals. Many species of birds, especially waterfowl, are abundant in freshwater marshes. Waterfowl, marsh birds, and wading birds use different regions of freshwater marshes for nesting, wintering and resting throughout the year. Like plants, many of these birds also inhabit different elevations in the marsh. In general, more fish are found in marsh systems adjacent to deeper, open water.

Prairie Potholes

Thousands of years ago, the movement of **glaciers** in the northcentral part of the country created hundreds of depressions and formed what are known today as prairie potholes. Potholes, which are not a common type in Indiana, are shallow, marsh-like ponds (Mitsch and Gosselink, 1993). Warm summers and rich soils cause prairie potholes to be very fertile, and are important resting stops for migratory birds. In Indiana, this wetland type is found primarily in the northeast lakes region. However, many of the glacially-formed wetlands in northeast Indiana that are commonly called potholes, may in fact be more accurately described as other types of depressional emergent wetlands such as wet prairie or sedge meadow wetlands. An increase in residential development in northeast Indiana is a threat to these wetlands.

Vernal Pools

Vernal pools are small shallow depressions in grasslands or forests that are dry during most of the year. They become pools of water in the winter and early spring when precipitation exceeds evaporation. Vernal pools, which occur throughout Indiana, are critical habitats for the life cycles of some animals. Many amphibians, including salamanders and frogs, rely on vernal pools for reproduction (Watersheds Website, 1997).

Wet Meadows and Wet Prairies

Wet meadows and wet prairies have vegetative communities that are similar to those found in marshes but are drier than most marshes. In addition, they are found in lower areas in flat landscapes surrounded by upland meadows or prairie grasses. These wetlands obtain most of their water from precipitation. Wet prairies also may obtain water from intermittent streams and groundwater. Wet meadows including sedge meadows occur throughout Indiana. Wet prairies are relatively rare in Indiana largely because all but 1% of the state's historic prairie acreage has been converted for farming or development. The eastern lobe of the country's tall grass prairie

ecosystem extends into northwest Indiana where most of the remaining wet prairie wetlands occur. Animals found in wet meadows and wet prairies include insects, grassland birds, rodents, and marsh hawks.

Spring Seeps

Seep wetlands are fed by groundwater discharge and may occur on hillsides or in depressional areas. They are dominated by grasses, sedges, rushes, ferns and other flowering plants like blue flag and New England aster. Seeps can be found throughout Indiana where natural spring systems have not been disrupted by development. Insects, such as dragonflies and damselflies, and amphibians can be found in seeps.

Northern Peatlands

Peatlands are unique wetlands that occur in cold climates where precipitation rates exceed evapotranspiration rates. The hydrologic sources for peatland wetlands are precipitation and groundwater. They are found mostly in the northern most parts of Indiana but occur as far south as Hamilton County.

Organic matter decays slowly in these wetlands because of the cold weather. The partially decayed organic matter forms peat. Peat has been used for fuel and agricultural soil enhancement throughout history. Measuring the depth of peat also can be used to determine the age and development of peatland because it accumulates without decomposing for thousands of years.

Bogs and fens

The most common types of peatlands are bogs and fens. Bogs are wetlands that have acidic peat deposits, a high water table, few inlets or outlets, and have plants that thrive in acidic soils or water (**acidophilic vegetation**) such as the sphagnum and other mosses. Indiana also has circumneutral bogs where the water has a slightly higher pH than acid bogs. Pinhook Bog in the National Lakeshore is one of the few true bogs in Indiana. "Cowle's Bog" in Porter County and "Celery Bog" in Tippecanoe County are actually other wetland types (the latter was once a bog but is now a marsh based on hydrological changes). Fens, in contrast to bogs, are wetlands that are fed primarily by groundwater, are dominated by **vascular plants** and have grasses, sedges and reeds (Mitsch and Gosselink, 1993). Fens are relatively rare in Indiana and are primarily found in northern counties. The calcareous nature of the bedrock through which the groundwater flows gives the fens an alkaline water chemistry.

Plants and animals that inhabit bogs and fens have developed some unique characteristics and adaptations. They must deal with many stresses, such as acidic water of bogs (alkaline water of fens), low nutrient levels, extreme temperatures and being waterlogged.

Mosses, particularly those of the genus *Sphagnum*, are critical to the development of peat in most bogs and some fens. They grow in thick mats and tend to hold water. This causes the tops of the mats to continue to grow while the bottom layers die off and accumulate as peat. Vascular plants are generally sparse in sphagnum-dominated peatlands. Several interesting carnivorous plants, such as the pitcher plant and the sundew, which eat insects to survive, are sometimes present as well. Sedges, shrubs, trees and other acid-loving plants also inhabit these wetlands.

Low levels of productivity and the apparent unpleasant taste of bog plants may account for the fact that very few wildlife species inhabit bogs and fens. The acidity level of the water — a pH level below 5 — makes peatlands inhospitable for amphibians and reptiles. Many species of birds use peatlands during the year, but few depend upon them year-round.

Riparian and Forested Wetlands

Riparian wetlands are formed along, and influenced by, a stream or river. While **riverine** wetlands, under the Cowardin classification, refer only to the area within the river or stream channel, areas directly influenced by the channel but located beyond the channel's banks are considered riparian. Riparian wetlands adapt to large fluctuations in water flow and nutrients because they are open systems. This means that water flows into and out of these wetlands through the river. Riparian areas can be wide expanses that encompass entire river valleys or narrow strips of vegetation along a streambank. The largest riparian ecosystems in Indiana occur in Southwest Indiana and are associated with the **floodplains** of the Wabash, Ohio, Patoka, and White Rivers.

Bottomland hardwood forests

One of the dominant types of riparian wetlands in Indiana is the bottomland hardwood forest. This wetland type is characterized as wide flat forest areas that cover river floodplains. Forested wetlands can be managed for sustainable timber production while maintaining many ecological functions. Over 50 percent of Indiana's remaining wetlands are forested. Unfortunately, bottomland hardwood forests are being eradicated at a rapid rate due to development.

The types of trees found in forested wetlands vary in different parts of the state and between different parts of a single wetland. Some of the common species include black willow, silver maple, several species of oak (swamp white, overcup, burr, swamp chestnut), water hickory, pin oak, bald cypress, and cottonwood. River birch, silver maple, and green ash can be found in dense stands on the river banks. Higher in the floodplain, American elm, sweetgum, red maple, sycamore and willow oak occur. These species do not inhabit certain areas exclusively; there is some overlap. The understory vegetative community is often sparse due to the periodic scouring of the wetland by flood surges from the river or stream and dense shade from mature trees. Seedlings and saplings of willow and other species on sandbars can be extremely dense. River banks often contain natural or artificial **levees** where tree species that tolerate drier conditions may grow.

Wildlife is abundant in riparian wetland areas. This may be due to a natural phenomenon called the "**edge effect**" which occurs when an area between two distinct ecosystems has the greatest biodiversity. Riparian wetlands are at the interface of terrestrial, upland and aquatic ecosystems. These areas are extremely beneficial to wildlife. The degree and duration of flooding helps determine the diversity of habitats in riparian areas. Woody vegetation provides shelter, roosting areas and **niches** for multiple species of animals. This vegetation also shades the stream, stabilizes the streambanks and produces organic matter to feed aquatic **macroinvertebrates** (insects and other animals without a backbone that are visible to the eye). The river or stream in

a riparian wetland system also provides abundant food and water for wildlife. Both the channels and the backwater wetlands associated with the channels can be prime breeding and feeding area for some fish species. In addition to providing wildlife habitats, riparian areas also serve as critical corridors for wildlife to travel between habitats or to areas safe from predation (Brinson et al, 1981).

Deepwater swamps

Most people associate these swamps with southern states like Louisiana. In Indiana, these forested wetlands are limited to the southwest part of the state. Bald cypress trees, swamp cottonwood, and buttonbush are indicator plants and there is permanent or almost permanent standing water. Depending upon the amount of freshwater input, deepwater swamps can be acidic or **neutral**. When these swamps are drained, they usually are invaded by pine or hardwood tree species. The Twin Swamps Nature Preserve in Posey County is probably the best example of this type in Indiana.

Trees associated with deepwater swamps have several interesting adaptations, such as "knees." These structures, also called "air roots," extend higher than the normal water level and are thought to improve the tree's gas exchange and enhance plant stability. Buttresses (swollen tree bases) also are common among several deepwater swamp species. Buttresses also may provide stability, but the specific function of this unique feature is unknown. These are visible from the boardwalk at the Twin Swamps Nature Preserve.

The seeds of these tree species require oxygen for germination and flowing water for distribution. The success of these populations depends on the wetting and drying cycles of the swamp. Individual trees can live for very long periods of time. For example, undisturbed stands of cypress can live for 1000 years. The existence of understory vegetation depends on the amount of sunlight that is able to penetrate. Buttonbush is an example of a species that may be present, depending on nutrient availability. Duckweed also may be present on the surface of the water.

Many macroinvertebrate species have been found in these deepwater wetland systems. They include crayfish, snails, freshwater shrimp, midges, insect larvae and clams that often use the large amount of decaying litter, or detritus, found in these swamps. Because they like faster-moving and highly oxygenated water, mayflies, caddisflies and stoneflies can be found near inflowing streams in these wetlands. Fish also use these swamps as temporary and permanent residences, where deepwater areas provide optimum habitat. Reptiles and amphibians are abundant in these wetlands due to their ability to adapt to the changing water levels. Species found in Indiana's swamps include the northern copperbelly water snake, banded water snakes, and cottonmouth water moccasin which is rare in Indiana. Birds that inhabit these swamps include wood ducks and several species of heron (black-crowned night, great blue, green). Swamp rabbits inhabit these wetlands as well.

Other Forested Wetlands

Not all bottomland forested wetlands are directly influenced by a river or steam channel. Some of Indiana's floodplain areas are quite broad, like the Wabash River floodplain, and the portions further from the channel have a more subtle, indirect relationship with the flood surges

of the big rivers compared to wetlands located closer to the channel and to those in the floodplains of smaller channels. Furthermore, not all forested wetlands are even associated with river or stream channels. Examples include forested depressions in the northeast part of Indiana and flatwoods which are wetlands located on broad expanses of upland terrain between river valleys. Flatwoods, which contain wet depressions, are found throughout the state.

Classification of Wetlands

Many classification systems have been developed to categorize wetland types. One common classification system is used by the National Wetlands Inventory (NWI), a project of the U.S. Fish and Wildlife Service (USFWS) to identify and map all of the wetlands in the United States. Wetland determinations are made using aerial photography, satellite imaging, and ground survey.

Although wetlands are generally present if they are indicated on an NWI map, not all wetlands appear on the maps. Wetlands that do not appear on the maps are usually the drier wetlands which may have been dry at the time of year the NWI determination took place and therefore were difficult to detect. Wetlands that are difficult to interpret from photographs such as farmed or mowed wetlands, drained and grazed wetlands also may not appear on the maps (Tiner, 1997). In contrast, some wetlands that appear on the maps have been converted or destroyed since the NWI was conducted and no longer occur on the landscape.

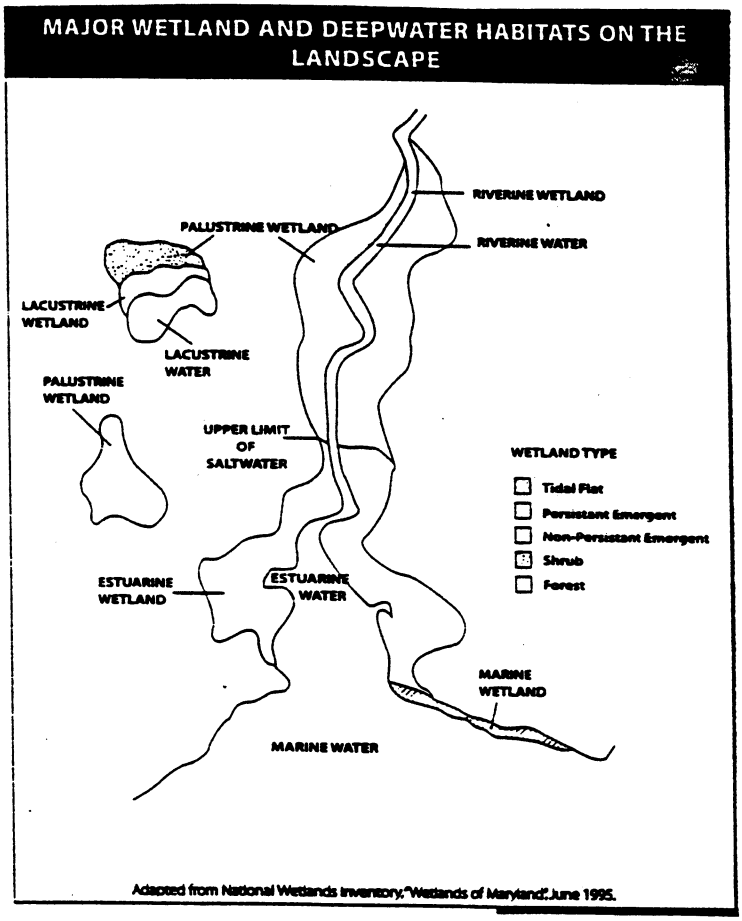

Figure 2-2

It is important to understand the USFWS classification system because NWI maps are used by government regulatory agencies, wetland consultants, scientists and volunteer involved in wetland **stewardship**. The classification system used is outlined in the U.S. Fish and Wildlife Service document "Classification of Wetlands and Deepwater Habitats of the United States" (Cowardin, et al, 1979). This classification system arranges wetland and deepwater **habitat** types into ecological **taxa** based on hydrology, dominant vegetation, soil types, flooding regime and other factors.

The USFWS uses five categories, which they call "systems," to classify wetlands and deepwater habitats based on location within the landscape. Two of them, **marine** and **estuarine**, are associated with saltwater and thus do not occur in Indiana. The three systems found here include

U.S. FISH AND WILDLIFE SERVICE WETLAND CLASSIFICATION

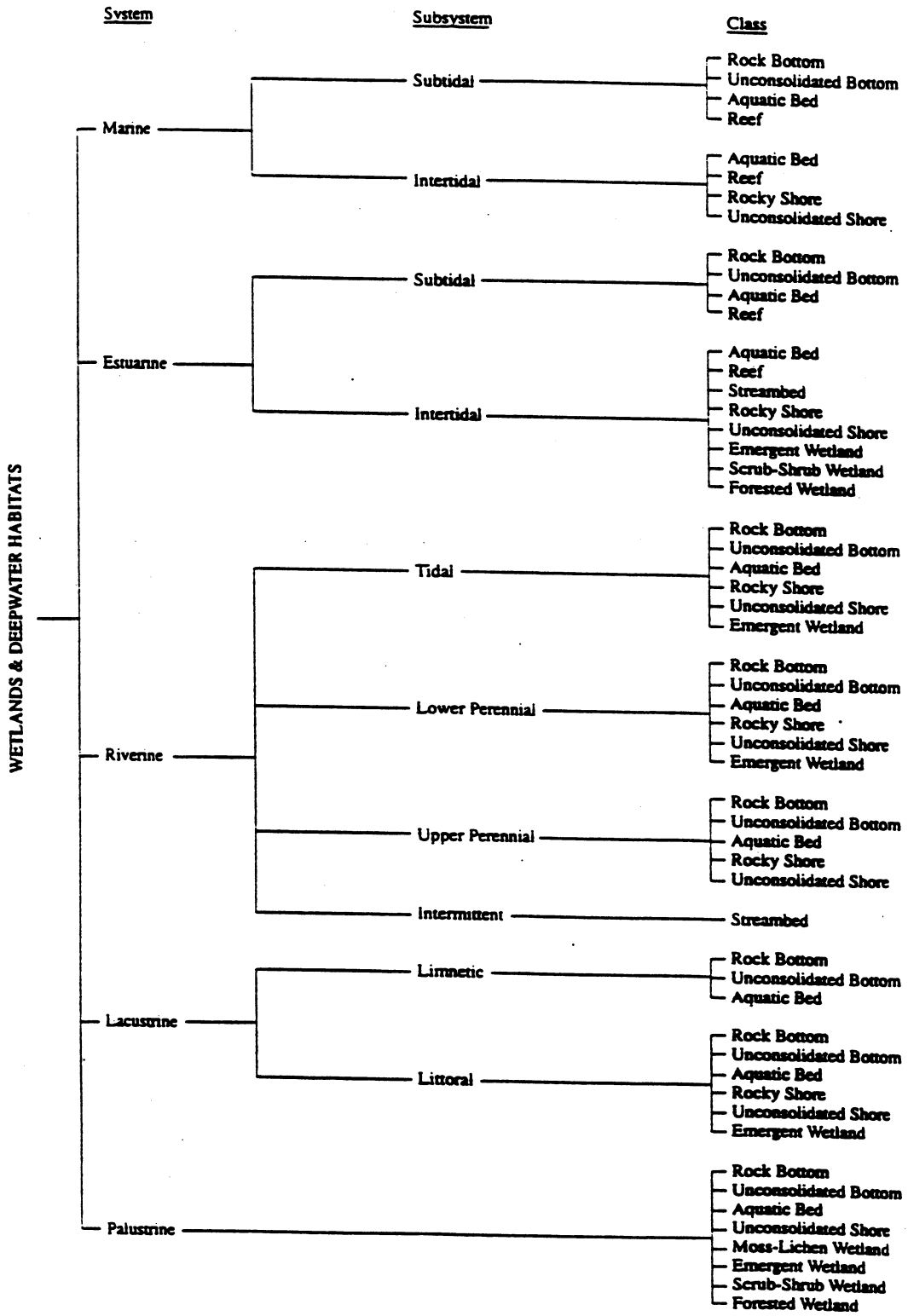

Figure 2-3

riverine, **lacustrine** and **palustrine**. Riverine wetlands occur within freshwater river channels that are dominated by emergents present only during the growing season. Lacustrine wetlands are wetlands on the edges of lakes or reservoirs where the water depth is less than 2 meters (6.6 feet). Palustrine wetlands are nontidal freshwater wetlands that are not riverine or lacustrine. Wetlands within a river channel that are dominated by trees, shrubs or **persistent emergents** — emergent vegetation that remains standing beyond the growing season, such as cattail and bulrush — also fall into the palustrine category. See Figure 2–2 for an example of where these types can be found on the landscape.

This classification continues with subsystems based on frequency of flooding and classes based on dominant vegetation and soil types. See Figure 2-3 for a further breakdown of the U.S. Fish and Wildlife Service classification into subsystem and class.

Most of the wetland types found in Indiana are palustrine wetlands. The following chart gives examples of some of the wetland types found in Indiana and their Cowardin classification.

Types	Classification
Freshwater marshes	Palustrine emergent
Northern Peatlands	Palustrine forested and scrub-shrub
Riparian Wetlands	Palustrine forested and scrub-shrub
Prairie Pothole	Palustrine emergent