WETLANDS CURRICULUM

POCONO MOUNTAIN SCHOOL DISTRICT

ACKNOWLEDGMENTS

This curriculum was funded through a grant from Pennsylvania's Growing Greener Program administered through the Pennsylvania Department of Environmental Protection. The grant was awarded to the Tobyhanna Creek/Tunkhannock Creek Watershed Association to support ongoing watershed resource protection. The views herein are those of the author(s) and do not necessarily reflect the views of the Pennsylvania Department of Environmental Protection.

Special appreciation is extended to the Pocono Mountain School District, especially Mr. Thomas Knorr, Science Supervisor, and Dr. David Krauser, Superintendent of Schools for their support of and commitment to this project.

Project partners responsible for this project include:

- Pocono Mountain School District
- Tobyhanna Creek/Tunkhannock Creek Watershed Association
- Pennsylvania Department of Environmental Protection
- The Nature Conservancy Science Office
- Monroe County Planning Commission
- F. X. Browne, Inc.

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INTRODUCTION

Wetlands have not always been a subject of study. In fact, up until the 1970's, not too many people cared about wetlands. Wetlands were viewed by most people as mosquito infested lands that took up valuable space; people couldn't farm or build on wetlands, therefore their value to humans appeared to be non-existent. Because of this attitude, over half of the nation's wetlands have been destroyed; most of them filled to be utilized by people.

Once the consequences of wetland destruction, such as decline in waterfowl populations, became evident, people began to realize how important wetlands were to humans and to the natural world. Scientists began to study wetlands in order to learn more about the functions and values of wetlands in the natural landscape. Laws, such as the Section 404 of the Clean Water Act, were passed that protected wetlands. Wetlands that were once believed to be mosquito infested Awastelands@ were now viewed as an integral part of environment.

Today wetlands are still surrounded by controversy. Even though their role and its importance in the natural world is much more clearly understood, wetlands still limit the way humans utilize land. Many have come to believe that our remaining wetlands must be preserved. However, others feel that landowners have the right to utilize their land in the manner that best fits their own need, even if that land is a wetland.

The purpose of this curriculum is to provide students with a general introduction to wetlands. The following is a list of objectives to keep in mind while reading this curriculum and participating in both the classroom and field wetlands activities:

$ Determine what exactly is a "wetland." Understand the regulatory definition of a wetland.
$ Understand the types of wetlands found in Pennsylvania and in other regions of the United States.
$ Examine the distribution of Pennsylvania=s wetlands. Understand why they are distributed the way they are. Discover some of the local, unique wetland habitats.
$ Understand one of the main classification systems of wetlands. Acknowledge that other classification systems exist.
$ Determine and understand the three main components examined when studying wetlands.
$ Examine and understand the functions and values of wetlands.
$ Understand how wetlands are protected, at the federal, state, and local levels.
$ Examine the approach used for making a wetlands determination; understand the main components of the process.
$ Develop an understanding for bog habitats, including the processes in which they form and the unique flora and fauna that inhabit them. Discover why bogs are important to people. Explore the valuable wetland resource you have in the backyard of your own school.

This is just a list to guide you through your discovery. You will probably come across information and ideas that may have not been discussed in this curriculum. Do not consider them unimportant. While this curriculum may guide you through your investigations, the true learning process will come from your own personal questions and thoughts.

Enjoy your wetland explorations.

WETLANDS - WHAT ARE THEY EXACTLY?

<u>SECTION OBJECTIVES:</u>

(1) Develop an understanding of the term "wetland."

(2) Understand what makes a "wetland" different from an "upland" - what are the main components that define a "wetland" area?

(3) Develop a definition of "wetland" in your own words.

Common Cattail (*Typha latifolia*) is a freshwater and estuarine marsh species. (Taken from www.epa.gov/owow.)

What is a wetland? The term "wetland" is a word that may be unfamiliar to many people, and if not unfamiliar…perhaps, confusing and undefined. Actually, it's very likely that you know a great deal about wetlands, and you just don't realize it!

Before defining the term "wetlands," it is very important to understand that wetlands are a natural part of our environment, and that they serve many extremely valuable functions for plants, animals, and even we humans. Unfortunately, many people still consider wetlands to be "wastelands," a conclusion which they base on many of the characteristics that actually make wetland areas so valuable. On the contrary, wetlands are not only valuable, but they are the most productive of all ecosystems on earth!

Since the dawn of our time, mankind has used wetland areas to fulfill many needs including a source of food, clean water, and fuel for heating. Early cultures also included certain types of wetlands, especially bogs and swamps, in their religious beliefs, perceiving such areas as home to their gods or as sacred burial grounds where bodies would not decay. It is unquestionable that many of the earlier uses of wetlands impacted these natural systems. The impacts by these primitive activities, however, were relatively minor and most cases, could be easily assimilated by "Mother Nature."

During more recent times, however, the impacts to wetlands increased dramatically. This increase was due primarily to the industrial revolution, combined with the ever increasing human population and our demand for natural resources. The resulting mass destruction of wetlands and their valuable functions grew tremendously during the decades following the industrial revolution. Eventually, the impacts became so great that protection of the remaining resources was critical.

Before protection of wetlands could be established, however, it was first necessary to develop a clear-cut definition of the term "wetlands." This definition could then be applied "in the field" to locate and mark (or flag) the boundary lines between "wetlands" areas and "uplands" areas.

So…how are wetlands defined? There actually are several different definitions of the term "wetlands." These definitions vary somewhat because they were developed by many different people and groups of people with different interests and educational backgrounds, including scientists, politicians, regulatory agencies, and others. Most definitions, however, contain common primary components. As an example, nearly all definitions would agree that wetlands are lands transitional between terrestrial (or uplands) and deep water habitats. Likewise, most would agree that wetlands contain three basic components that work well to define wetland conditions: presence of water (hydrology), certain soil characteristics (hydric soils), and vegetation or plant types (hydrophytic vegetation). As for "hydrology," most would agree that wetlands are lands where the water table is usually at or near the soil surface and/or where the land is saturated or covered with shallow water. With regards to soil conditions found in wetlands, most definitions agree that the soils within wetlands are "hydric soils," which means that they have developed certain characteristics under anaerobic (lacking oxygen) conditions due to sustained periods of saturation, flooding, or ponding. Finally, "hydrophytic vegetation," or vegetation that exhibits special adaptations to live under saturated conditions, is present or would be present under undisturbed conditions. To sum it up, a wetland is a transitional area between land and water which exhibits hydology, has hydric soils, and supports hydrophytic vegetation.

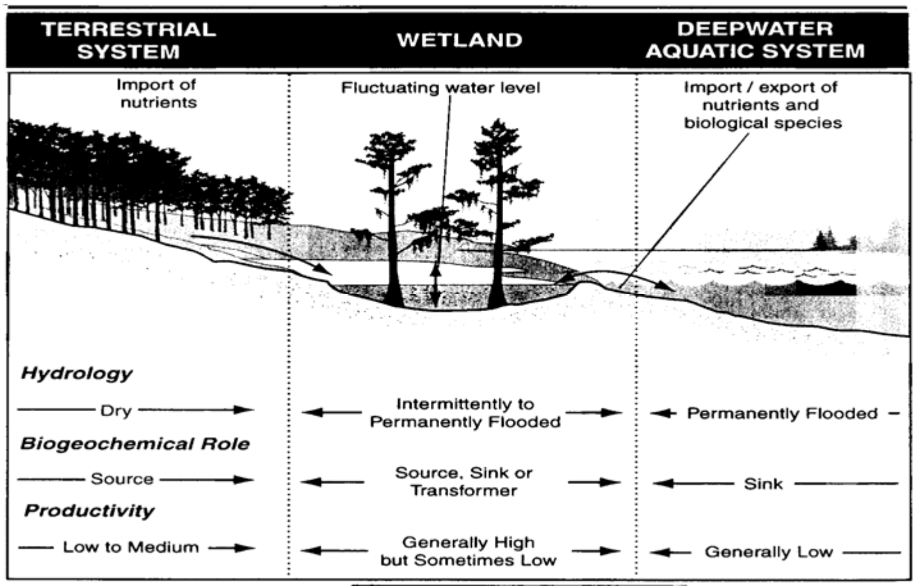


Figure 1. Wetlands are transitional lands between terrestrial and deepwater systems.
(Figure taken from Mitsch and Gosselink 2000.)

A more formal definition, provided by the United States Corp of Engineers and the United States Environmental Protection Agency follows:

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." (U.S. Army Corps of Engineers, 1987)

What is the difference between a fen (pictured above) and a bog?

(Picture taken from www.epa.gov/owow.)

WETLAND TYPES

You probably have heard the terms bog, marsh, and swamp before, but do you actually know why a bog is a bog and not a fen or a marsh? Vegetation, soils, and hydrology all help determine wetland type. This section provides a list of various wetland types found in Pennsylvania and in other regions of the United States followed by a description of their characteristics.

SECTION OBJECTIVES:

(1) Determine the main characteristics that distinguish each wetland type.

(2) Recall the wetlands that you have seen in this area and think about what type they may be.

WETLAND TYPES FOUND IN PENNSYLVANIA

BOG: A peat-accumulating wetland that has no significant inflow or outflow of water and supports acidophillic (acid loving) mosses, particularly Sphagnum. Due to acidic conditions and low nutrient availability, vegetative growth is usually extremely slow and plant species diversity is very low.

FEN: A peat- accumulating wetland that receives some drainage from surrounding lands with "normal" nutrient concentrations. Species diversity is typically very high.

The pileated woodpecker (*Dryocopus pileatus*) can be found in swamps and in other forested habitats. (Taken from www.epa.gov/owow)

SWAMP: Wetland dominated by predominantly by trees with or without shrubs.

SCRUB/SHRUB WETLAND: Wetland dominated by predominantly by shrubs with or without herbs.

MARSH: A frequently or continually inundated wetland characterized by emergent herbaceous vegetation adapted to saturated soil conditions. Also known as an EMERGENT WETLAND

VERNAL POOL: A term used to indicate wetlands that are only temporally flooded in the spring, and do not support fish species.

Tom Blagden, Jr.

The tidal marsh in this picture is located along the Edisto River, South Carolina. (Taken from epa.gov/owow)

A marsh is a type of wetland with which you may be familiar. Marshes are defined as wetlands frequently or continually inundated with water, characterized by emergent soft-stemmed vegetation adapted to saturated soil conditions. There are many different kinds of marshes, ranging from the prairie potholes to the Everglades, coastal to inland, freshwater to saltwater. All types receive most of their water from surface water, and many marshes are also fed by groundwater. Nutrients are plentiful and the pH is usually neutral leading to an abundance of plant and animal life.

WETLANDS FOUND IN OTHER REGIONS OF THE UNITED STATES

In addition to the wetland types discussed above, the following wetlands can be found the United States:

BOTTOMLAND: Lowland along streams and rivers, usually on alluvial floodplains, that is periodically flooded. When forested, it is called a bottomland hardwood forest in the southeastern and eastern United States.

MANGROVE: Subtropical and tropical coastal ecosystem dominated by halophytic (salt loving) trees, shrubs, and other plants growing in brackish to saline tidal waters. The word "mangrove" can also refer to the dozens of tree and shrub species that dominate mangrove wetlands.

MUSKEG: A large expanse of peatlands or bogs; particularly used in Canada and Alaska.

PLAYA: An arid to semiarid region wetland that has distinct wet and dry seasons. This term is used in the southwest United States for marsh-like ponds similar to potholes, but with a different geologic origin. Playa lakes are round hollows in the ground in the Southern High Plains of the United States. They are ephemeral, meaning that they are only present at certain times of the year.
(Picture taken from www.epa.gov/owow)

POCOSIN: Peat-accumulating, non-riparian freshwater wetland, generally dominated by evergreen shrubs and trees and found on the southeastern Coastal Plain of the United States. The term comes from the Algonquin for "swamp on a hill."
(Figure taken from www.epa.gov/owow)

SALT MARSH: A halophytic grassland on alluvial sediments (deposited by water) bordering saline water bodies where water level fluctuates either tidally or non-tidally.

SLOUGH: An elongated swamp or shallow lake system, often adjacent to a river or stream. A slowly flowing shallow swamp or marsh (e.g. cypress slough, as found in the southeastern United States). From the Old English word "sloh" meaning a watercourse running in a hollow.

TIDAL FRESHWATER MARSH: A marsh along rivers and estuaries close enough to the coastline to experience tides by non-saline water. Vegetation is often similar to non-tidal freshwater marshes.

WET MEADOW: Grassland with waterlogged soil near the surface but without standing water for most of the year.

WET PRAIRIE: Similar to a marsh, but with water levels usually intermediate between a marsh and a wet meadow.

(All the above definitions were taken from Mitsch and Gosselink, 2000.)

WETLANDS CLASSIFICATION

SECTION OBJECTIVES:

(1) Develop an understanding of the classification system discussed. Understand the main components of the system and determine how you would apply this system when examining a wetland.

(2) Acknowledge that there is more than one classification system and that classification systems can be based on a variety of parameters.

Wetlands may be classified based on a variety of their characteristics such as flooding depth, vegetation types, and wetland function. The use of a classification system allows for more consistent descriptions and assessment of functions and values for various wetland types, which can be exceptionally useful during the permit process for determining the extent and severity of impacts that are proposed to different wetland types and systems.

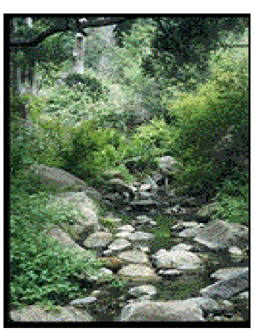
The "Classification of Wetlands and Deepwater Habitats of the United States" proposed by Cowardin and others, uses a hierarchical approach based on systems, subsystems, classes, subclasses, dominance types, and special modifiers to define wetlands and deepwater habitats precisely. This classification system can be compared to the taxonomic classifications used to identify plant and animal species (Mitsch and Gosselink 2000). The following is a closer look at the each division in the Cowardin classification system:

THE SYSTEM

The system, the broadest level, includes a group of wetlands and deepwater habitats that share the influence of similar hydrologic, geomorphologic, chemical, or biological factors (Mitsch and Gosselink 2000). Systems include:

Marine: Open ocean overlying the continental shelf and its associated high-energy coastline.

Estuarine: Deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partially obstructed, or sporadic access to the ocean and in which the ocean water is at least occasionally diluted by freshwater runoff from the land.



Riverine: 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) deepwater habitats with water containing ocean-derived salts in excess of 0.5 parts per thousand (ppt).

Lacustrine: 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 percent aerial coverage; and (3) total area in excess of 8 hectares (approximately 20 acres). Similar wetland and deepwater habitats totaling less than 8 hectares are also included in the lacustrine system when an active wave-formed or bedrock shoreline feature makes up all or part of the boundary or when the depth in the deepest part of the basin exceeds 2 meters at low water.

Palustrine: All nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and all such wetlands that occur in tidal areas where salinity stemming from ocean-derived salts is below 0.5 ppt. It also includes wetlands lacking such vegetation but with all of the following characteristics: (1) area less than 8 hectares; (2) lack of active wave-formed or bedrock shoreline features; (3) water depth in the deepest part of the basin of less than 2 meters at low water; and (4) salinity stemming from ocean-derived salts of less than 0.5 ppt.

(All of the above pictures were taken from www.mip.berkely.edu/wetlands)

The following figures provide an organized view of each system along with the system's possible components:

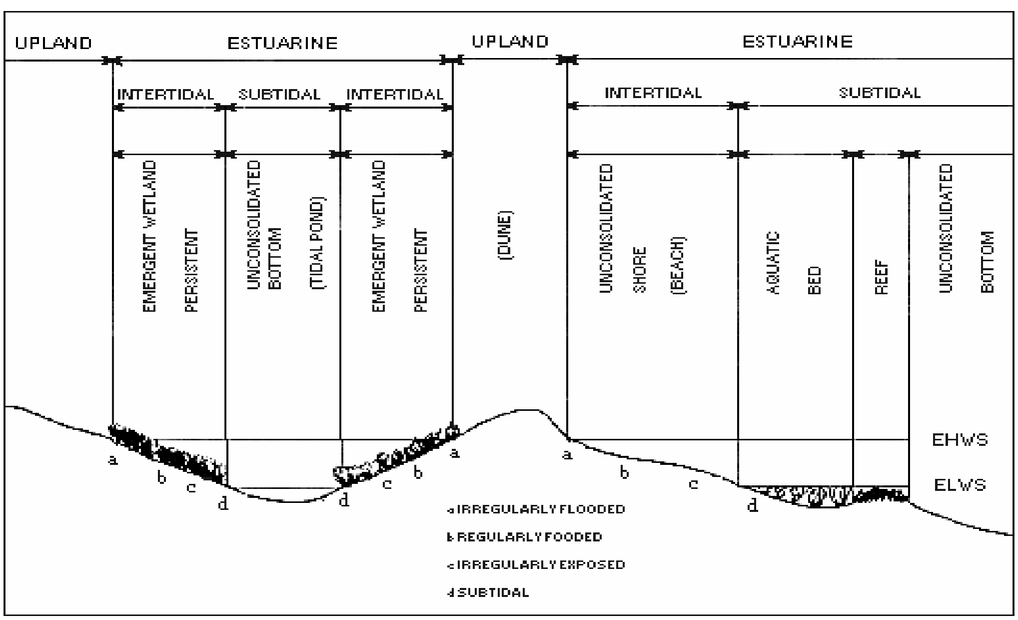


Figure 1. The Estuarine System

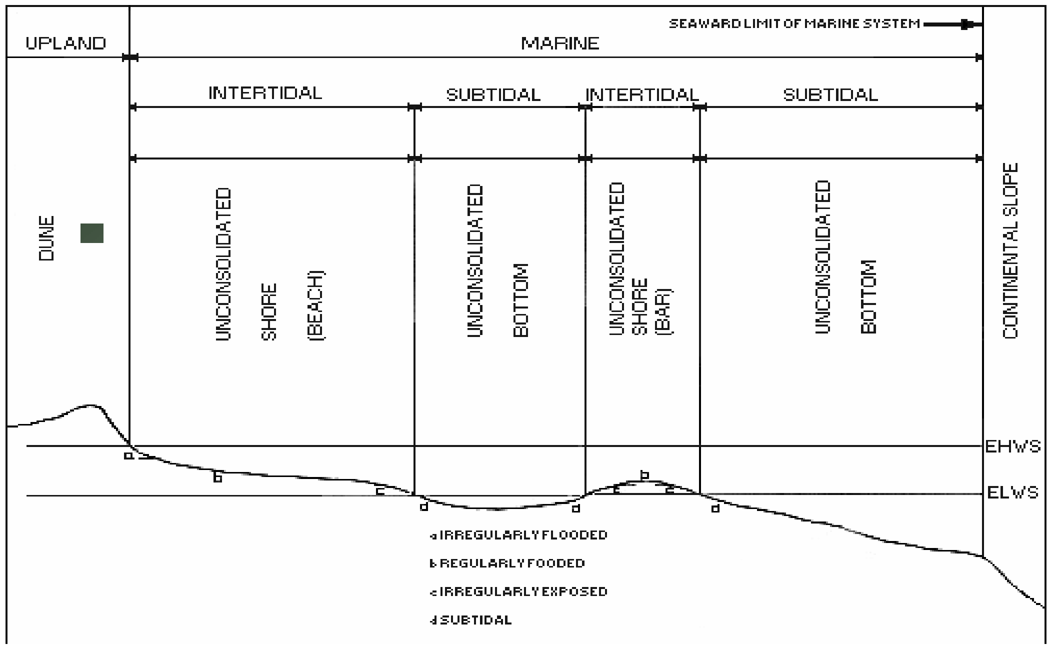


Figure 2. The Marine System

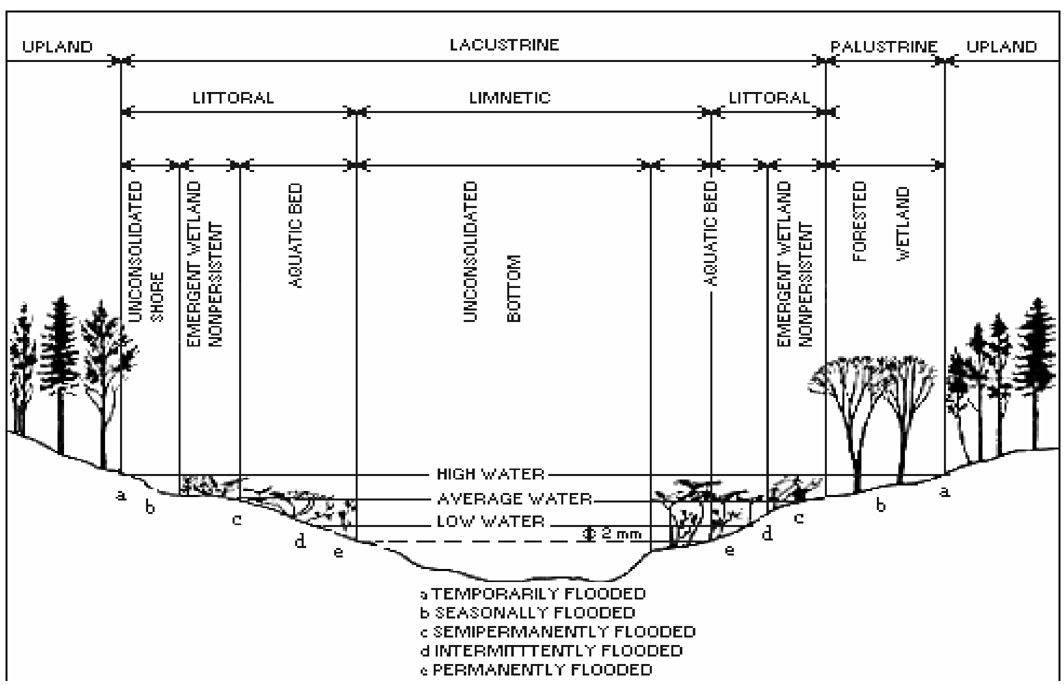


Figure 3. The Lacustrine System

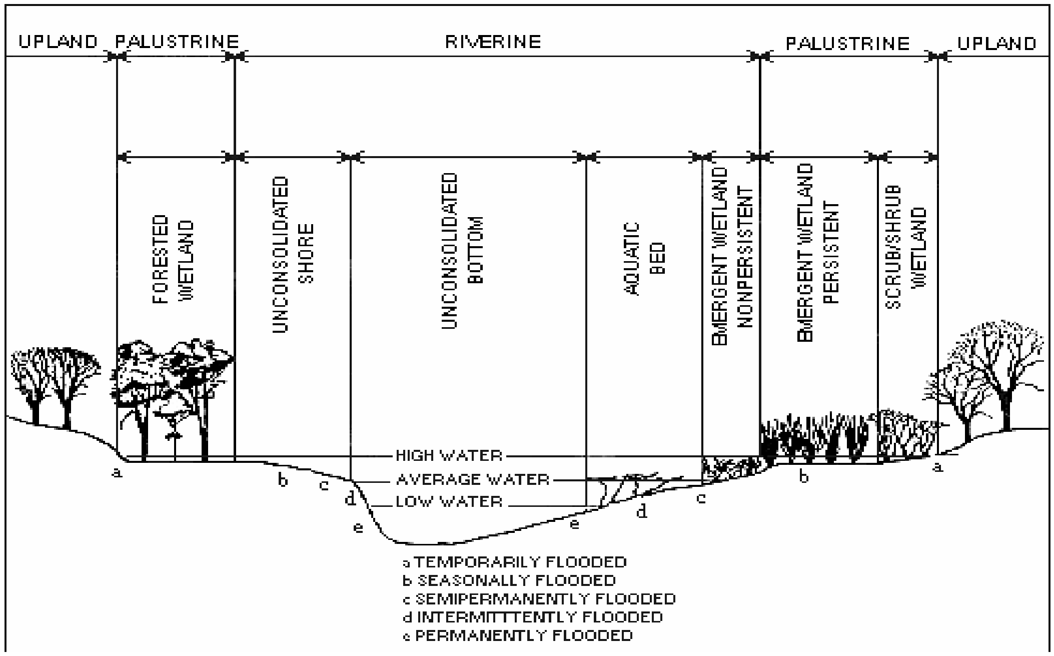


Figure 4. The Riverine System

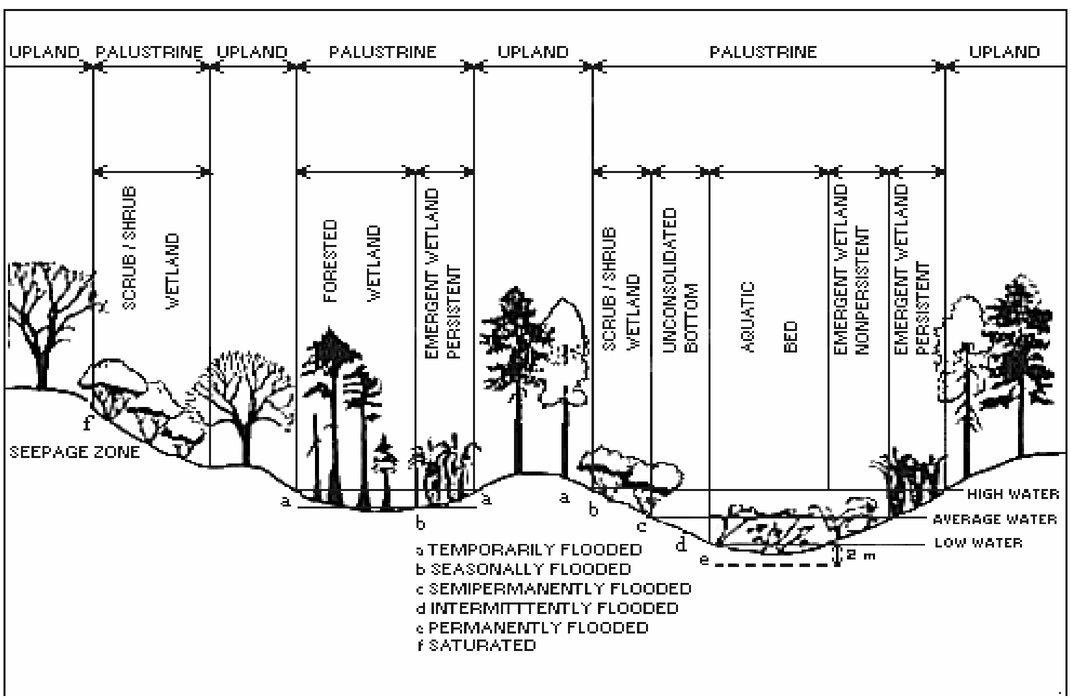


Figure 5. The Palustrine System

THE SUBSYSTEM

Subsystems help to further define the systems. They basically help describe the hydrology of the system. The subsystems include:

Subtidal: Substrate continuously submerged

Intertidal: Substrate exposed and flooded by tides, including the splash zone

Tidal: For Riverine systems, gradient low and water velocity fluctuates under tidal influence

Lower Perennial: Riverine systems with continuous flow, low gradient, and no tidal influence

Upper perennial: Riverine systems with continuous flow, high gradient, and no tidal influence

Intermittent: Riverine systems in which water does not flow for part of the year

Limnetic: All deepwater habitats in lakes

Littoral: Wetland habitats of lacustrine systems that extend from shore to a depth of 2 meters below low water or to the maximum extent of nonpersistent emergent plants (e.g. vegetated lake shorelines)

(All of the above definitions were taken from Mitsch and Gosselink, 2000.)

THE CLASS

The division of class basically refers the general appearance of a wetland of deepwater habitat in terms of either the dominant vegetation life form or substrate. When more than 30 percent of the substrate is covered by vegetation, a vegetative class, such as "scrub-shrub wetland," is used. When less than 30 percent of the substrate is covered by vegetation, a substrate class, such as "unconsolidated bottom," is used (Mitsch and Gosselink, 2000).

THE SUBCLASS

The subclass further defines the class by describing the vegetation or substrate. For example, subclasses under the "forested wetland" class include broad-leaved deciduous, needle-leaved deciduous, broad-leaved evergreen, needle-leaved evergreen, and dead. Subclasses under the "rock bottom" class include bedrock and rubble.

THE DOMINANCE TYPE

The dominance type indicates dominate vegetative or animal species observed. For example, in a forested broad-leaved deciduous wetland, a dominant vegetation type could be "red maple," a very common tree in most northeastern wetlands. Under the marine system in the rock bottom class with a bedrock subclass, the dominance type could be "lobster."

THE MODIFIER

Modifiers are used to help provide more information about the physical and chemical characteristics of the system. They can describe the pH, salinity, soil, or water regime. An example of a water regime modifier would be "permanently flooded" – defined as, when water covers the land surface throughout the year in all years.

THE HYDROGEOMORPHIC CLASSIFICATION SYSTEM

As previously mentioned, other wetland classification systems do exist. The Hydrogeomorphic Wetland Classification System, better known as the HGM system, is used to assess the physical, chemical, and biological functions of wetlands. This system examines three main components: (1) Geomorphology - the topographic location of the wetland in the surrounding landscape; (2) Water source - be it groundwater, precipitation, or surface water and (3) Hydrodynamics - the direction and strength of water movement within a wetland (Mitsch and Gosselink 2000). This system is not used to identify, or define "regulated" wetlands, but rather is used to compare the quality of wetland function between wetlands in the same functional class. The use of such a classification system may be very helpful and important in assessing proposed impacts to wetlands during the permitting process (discussed below in greater detail).

PENNSYLVANIA WETLANDS

Pennsylvania is the home to approximately 404,000 acres of wetlands (Heist and Reif). Among these wetlands exist some very unique wetland habitats. Many of these unique habitats exist right here in the Pocono Region.

Green Frogs, *Rana clamitans*, are usually found in shallow water, springs, swamps, brooks, and at the edges of ponds and lakes. They may be found among rotting debris of fallen trees. (Taken from www.frogs.org)

SECTION OBJECTIVES:

(1) Consider the main types of wetlands found in Pennsylvania. Recall the types you have seen locally.

(2) Understand why Pennsylvania's wetlands are not evenly distributed.

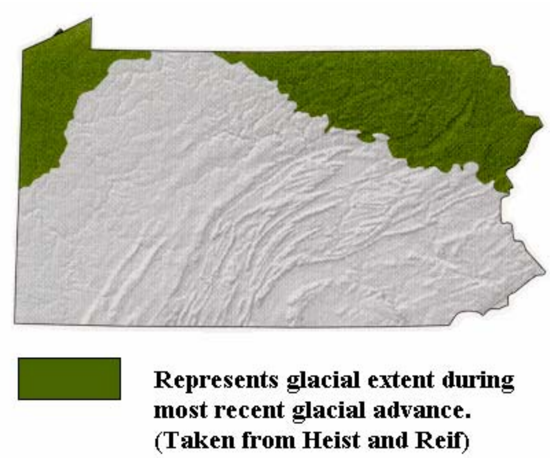
FIRST, A QUICK LOOK AT THE STATISTICS...

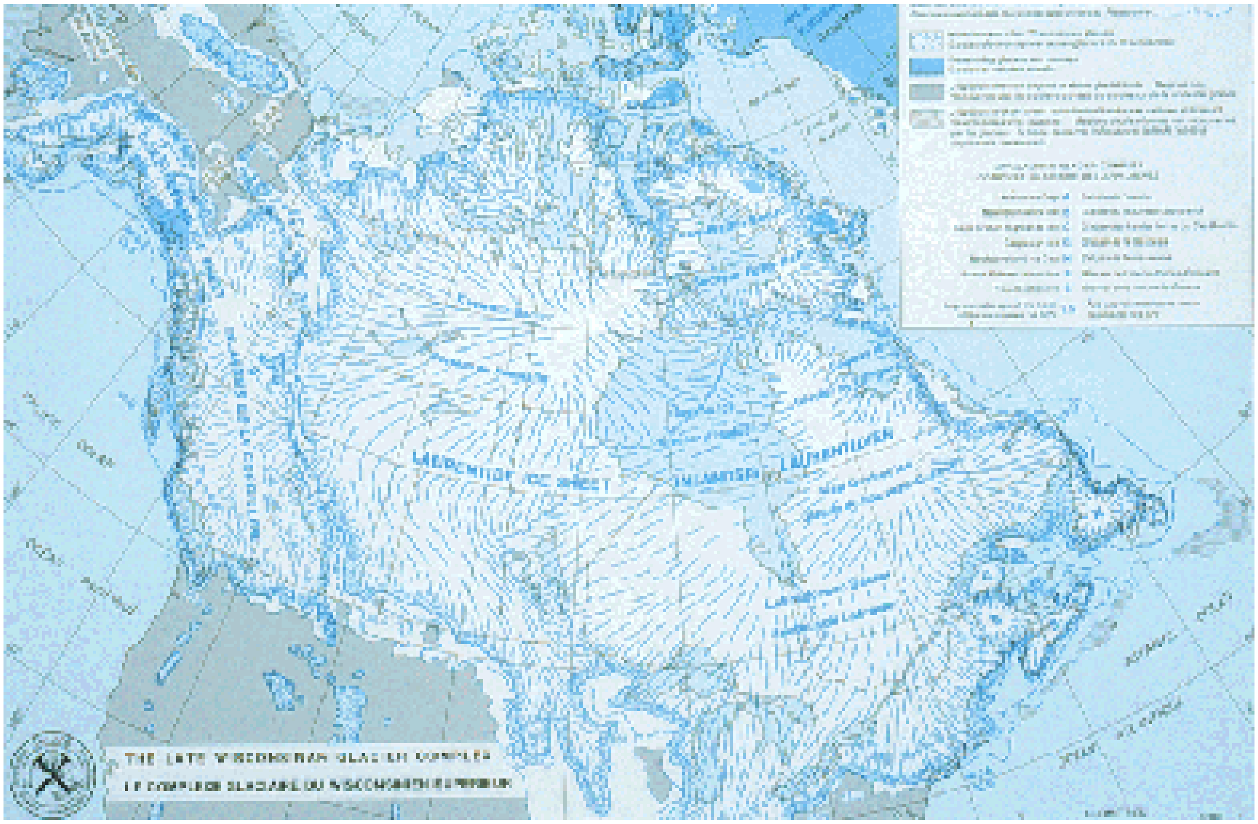
* Approximately 1.4 percent of Pennsylvania's land surface is covered by wetlands.
* 97 percent of the Pennsylvania's wetlands are palustrine
* 2 percent of Pennsylvania's wetlands are lacustrine
* 1 percent of Pennsylvania's wetlands are riverine.

Pennsylvania's 392,000 palustrine wetlands consist of 178,000 acres of deciduous and evergreen forested wetlands, 62,000 acres of open water, 52,000 acres of emergent wetlands, 49,000 acres of deciduous and evergreen scrub-shrub wetlands, 25,000 acres of mixed deciduous scrub-shrub and emergent wetlands, and 26,000 acres of other wetland types (Heist and Reif).

WETLAND DISTRIBUTION

Pennsylvania's wetlands are heavily distributed (42 percent) in the northeastern and northwestern parts of the state. Why do you think this is? Looking at the map showing the extent of the latest period of glaciation may give you a good clue. Glaciers are capable of moving and depositing massive amounts of earth through both the incredible weight they exhibit on the earth below them and through the outflow of their meltwaters as they retract. The glacial scouring and deposition from our last "ice age" left surface depressions and impermeable soils that were ideal for wetland development, and therefore, many wetlands formed in areas touched by glaciers (Heist and Reif). So how did wetlands form in areas unaffected by glaciers? Many wetlands have formed along streams and rivers due to (1) a source of water (either by flooding or ground water) and (2) sediment depositions of silt, mud, and clay that help to create a slow draining substrate.





Extent of glacial ice sheet across North America during the Wisconsinan glaciation period.

UNIQUE WETLAND HABITATS IN OUR BACKYARD

The Pocono Mountains are home to many unique wetland habitats. More than 80 percent of Pennsylvania's endangered and threatened animals and most of Pennsylvania's endangered and threatened plants are wetland dependent. However, the wetland with the highest concentration of known endangered plants and animals is the wetland at Tunkhannock Creek near Long Pond (Heist and Reif). Peatlands, or bogs, in the Pocono Mountains are the southernmost peatlands of recent glacial origin and are considered rare habitats in Pennsylvania (Heist and Reif). The Tannersville Cranberry Bog is the southernmost boreal bog in North America and houses a variety of unique flora including pitcher plants, sundews, orchids, and marsh marigold.

WETLANDS LOST

The U.S. Fish and Wildlife Service has estimated that, from the 1780's to the 1980's more than half (56%) of Pennsylvania's wetlands were destroyed. Conversion to cropland, channelization, forestry, mining, urban development, and the construction of impoundments contributed to widespread wetland loss or degradation (Heist and Reif). Today, federal and state laws help protect and conserve Pennsylvania's remaining wetlands.

THE THREE H'S: HYDROLOGY, HYDRIC SOILS, AND HYDROPHYTES

HYDROLOGY

Hydrology encompasses the properties, distribution, and circulation of water on and below the earth's surface (Merriam-Webster 1998). Hydrology includes the "presence of water" and its patterns, such as what time of year the water is present, how long it is present (duration), and how many times in a given time period it is present (frequency). Hydrology is probably the single most important determinant of the establishment and maintenance of wetlands. Water depth, flow patterns, and the duration and frequency of flooding affect the chemistry of the soils which in turn affect the type of biota (vegetation, animals, and microbes) that inhabit the wetlands (Mitsch & Gosselink 2000). Basically, wetland hydrology is the driving force behind the existence and type of a wetland.

Water alone is not always the sole ingredient influencing wetland hydrology. Obviously some source of water is necessary, be it from precipitation, the ground, or the earth's surface. Many other factors, however, affect the wetness of an area, including topography (the slope of the land), stratigraphy (geology), soil permeability (how fast the water drains into the soil), and plant cover (Fish and Wildlife Service and others 1989). [For example, imagine you fill with water a bowl that has thousands of tiny holes; the water will drain out relatively quickly. Then, if you fill another bowl that has only ten tiny holes; the water will take a lot longer to drain. The same concept is true in some wetlands. Certain soils hold water longer than others, and therefore, either surface ponding or groundwater recharge occurs, accordingly. A source of water (ground, surface, or precipitation) will provide a quantity of water and the soil characteristics will determine the "retention time" in the system. So, even though a water source is necessary, many other factors play a role in wetland hydrology.]

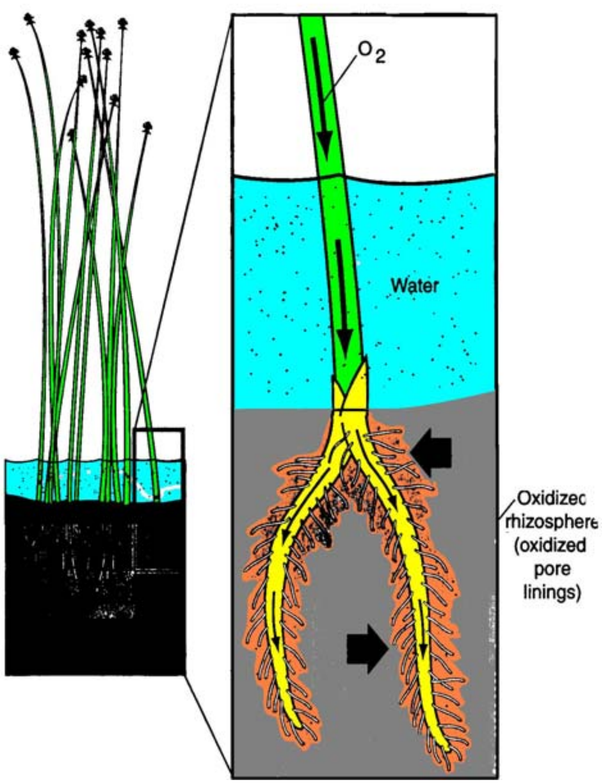
In some instances, it is very obvious that wetland hydrology is present. For instance, saturated soil or shallow water is an obvious indication of hydrology. Other times, however, ponding and/or saturation are not present, but other clues, or indicators of hydrology are. These include water marks left on trees, water stained leaves, sediment deposition, drift lines (debris left in a line) buttressed (heavily exposed) tree roots. Sometimes just the fact that hydric soils and/or hydrophytic vegetation are present can help you infer that hydrology is present. Remember, if it weren't for the driving force of hydrology, the hydric soils and hydrophytes would not sustain.

HYDRIC SOILS

As previously mentioned, hydric soils are soils that have developed anaerobic conditions due to conditions of saturation, flooding, or ponding (Mitsch & Gosselink 2000). The term anaerobic means without oxygen; therefore an anaerobic condition is a state without oxygen. Because oxygen is absent in hydric soils, certain characteristics can sometimes be observed. These include:

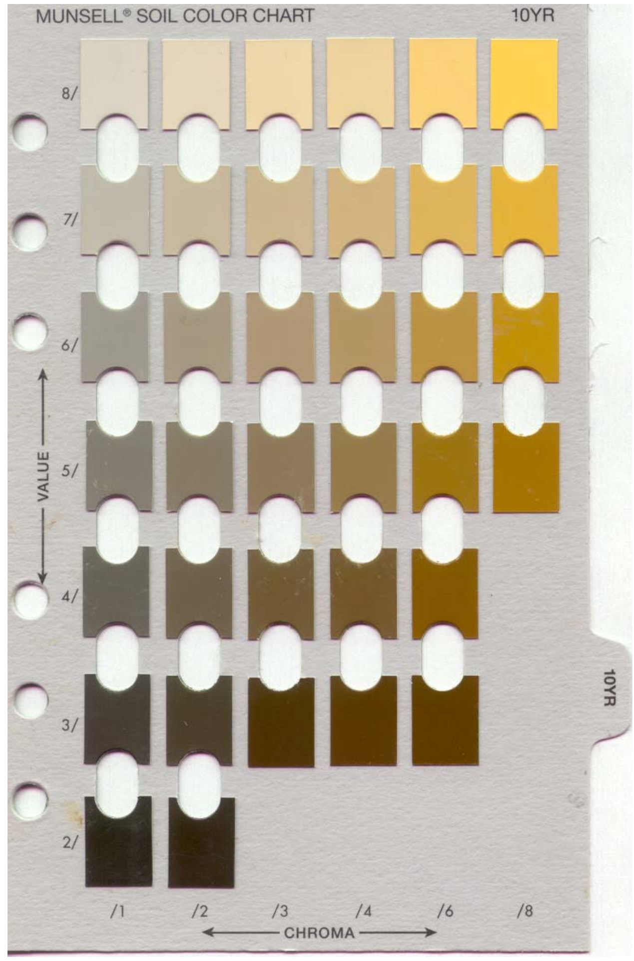
Gleying: The development of black, grey, or sometimes greenish or blue-gray soil colors among the soil matrix associated with anaerobic conditions. Just as you can turn blue by holding your breath, so can soil, kind of.

Mottling: Bright colors of red/orange noted throughout the soil matrix. Mottles are usually noted in areas that are seasonally flooded, especially by those that alternate between wet and dry periods (Mitsch & Gosselink 2000). Just as a gleyed soil is associated with the absence of oxygen, mottled soil is associated with the presence of oxygen. But aren't hydric soils anaerobic? Well yes, for extended periods of time, but during dry periods oxygen can make its way back into the soil long enough to affect the chemistry to cause mottles. That's why mottles are an indication of seasonal flooding, that down time in between the wet, anaerobic conditions. Fluctuation in the wetness of an area is sometimes a characteristic of wetland hydrology.



Oxidized (or oxygen influenced) Root Channels: In case you didn't know, roots respire. That's right, they can breathe. And the roots of hydrophytes are no exception. Just as the in-flux of oxygen into soils that occurs during dry periods can cause bright colored mottles to develop, so can excess oxygen that diffuses from the roots of hydrophytic plants into the surrounding wet soils. The result of this process is seen as brightly colored channels (in the surrounding gleyed soils) in the outline shape of a root.

Exactly how can you define the color(s) of a soil? Just like in your old box of Crayola 64, there are basic colors such as red, orange, and yellow, but there are also so many variations and shades in between, making a naming, or color definition, system necessary. To simplify the process, soil charts have been developed that help scientists determine the color of a soil using a basic numbering system. The most widely used reference chart is the Munsell (r) Soil Color Chart. This chart examines three characteristics of color including:



Hue: the notation that describes the spectral color(s) of the soil, such as red or yellow. The hue is read in the upper right hand corner of the chart (i.e. – 10YR, YR meaning "yellow-red").

Value: the notation that indicates the soil color lightness/darkness. This is read on the vertical scale of the chart.

Chroma: the notation that indicates the color strength or purity. The chroma is read on the horizontal scale of the chart, with the grayer soils to the left.

Soil samples taken in the field are compared with the soil colors on the chart. As and example, a very yellow soil may match the color of the uppermost right chip on the above page from the Munsell Soil Color chart, resulting in a color definition of 10YR 8/8 where "10YR" is the hue, the first "8" is the value, and the second "8" is the chroma. The chroma is usually what scientists look at the closest when determining if a soil is hydric. As a general rule, soils that have a chroma of 2 or less are considered to be hydric (Mitsch and Gosselink 2000), and a chroma greater than 2 are non-hydric.

HYDROPHYTIC VEGETATION

Hydrophytes are plants that live in water or on a substrate that is at least periodically anaerobic due to excess water (Tiner 1991). The word "hydrophyte" means "water (*hydro*) loving (*phyte*)," in Latin. Hydrophytes, unlike other plant species, are able to thrive in wet environments due to biological adaptations. Development of aerenchyma, or large air spaces in the roots and stems of some hydrophytes, is a good example of such an adaptation. Aerenchyma facilitate the diffusion of oxygen from the aerial portions of the plant into the roots (so they can breath in the oxygen depleted wetland soils) (Mitsch and Gosselink 2000).

All hydrophytes are not created equal! They can be divided into categories by their love for water, or more so by the chance that you would find them living in wetlands. For example, some hydrophytes are almost always are found (99% of the time) growing in wetlands. They are called obligate wetland plants. Think about how many times you have seen cattails growing in the middle of a dry forest. It would be safe to say, probably none. That is because they have adapted to life in wet conditions and that is where they thrive; the drier forest soils don't provide the conditions needed to support cattail populations. Other plants, such as red maple trees and high bush blueberries, may be found commonly in both wetlands and upland areas. And on the opposite end of the spectrum, upland plants that do not have the adaptations to live in wet conditions are almost never found in growing wetlands. Below is a chart that has been developed to better distinguish and define different categories of plant inhabitance of wetlands and uplands:

Indicator Category	Estimated chance of inhabiting a wetland	Estimated chance of inhabiting an upland
Obligate wetland plant (OBL)	Greater than 99%	Less than 1%
Facultative wetland plant (FACW)	67% to 99%	1% to 33%
Facultative plants (FAC)	33% to 67%	33% to 67%
Facultative upland plant (FACU)	1% to 33%	67% to 99%
Upland plant (UPL)	Less than 1%	Greater than 99%

When you look at a landscape and notice that the vegetative community is composed primarily of hydrophytes, even if you don't see water, you know that water is influencing the area in some way. On the other hand, if you see vegetation that is dominated by non-hydrophytes, or terrestrial upland plants, you know that it unlikely that you are in a wetland. Some examples of hydrophytes are:

Bladderworts are highly evolved, free-floating plants with submersed leaves, floating support leaves, and emergent flowering parts. There are about 200 species in the world, ranging in size from a few inches to several feet long. Tiny bladders attached to the leaves trap and digest small aquatic organisms that are free floating in the water. Bladderworts are generally found in nutrient poor waters. Their "carnivory" on other aquatic organisms is their primary way to obtain certain nutrients, primarily nitrogen which is essential to growth and reproduction.

All bladderworts are **rootless**. They have main **stems** from which lacy, often complex **leaves** grow. Bladderwort **flowers** are usually bright yellow (but sometimes lavender, depending on species); the flowers have two "lip-like" petals of about equal size. Flowers are on long **stalks** that emerge several inches above the water, supported by a radial array of spongy, air filled floating leaves. The carnivorous **bladders** are attached at regular intervals along the submerged leaf segments.

(Source of photograph unknown)

Skunk Cabbage (*Symplocarpus foetidus*) sprouts very early in the spring, melting the surrounding snow. The insects that pollinate it are attracted by its odor, which resembles decaying flesh. Skunk cabbage is an obligate wetland plant.

(Taken directly from www.epa.gov/owow)

Soft Rush, a common native hydrophyte, may be found as a single clump, as a colony of clumps or as a colony of single stems several feet tall, in water or less commonly on "dry" ground. It may also be found in freshwater or brackish (mildly salty) environments. Soft rush provides food and nesting to birds and other wildlife.

Soft rush is a true rush. Its pale-green **stems** are erect and two to five feet tall. Stems are cylindrical and filled with pith, a natural plant material that is much like styrofoam and provides the stems with rigidity and floatation. Soft rush has no **leaves**. Leaf-like reddish sheaths do however wrap the stems at the bottom of the plant. The **inflorescence**, or fruiting body, of soft rush appears to be coming out of the side of the stem. The inflorescence is open and branched. Each branch has 30-100 small **flowers**, each greenish-brown flower on its own stalk. Above the inflorescence is a "continuation" of the pointed stem, this being a stiff, rolled and pointed **bract**, usually brown or grayish when mature.

(Taken from *University of Florida, Center for Aquatic and Invasive Plants*)

ARE WETLANDS IMPORTANT?

Wetlands are extremely important! However, their importance to the earth was not always understood. Up until the 1970s, wetlands were largely considered a waste of good space that could be otherwise used for valuable agriculture or other land-uses. Wetlands were generally deemed worthless, mosquito infested areas. In fact, at one point in time, the federal government encouraged the filling of wetlands, leading many people to believe they were actually doing something good by creating useable land. As a result, approximately 53% of our nation's wetlands were destroyed and approximately 56% of Pennsylvania wetlands were lost (Brooks and Shannon 2000).

It was not until the noticeable decline of waterfowl populations that anyone really stopped to consider the consequences of wetland destruction. The intensive study of wetlands functions and values which followed, however, indicated that not just waterfowl, but all life on our planet is dependent in some way on wetlands, including us humans.

Today, the federal government is the lead agency in the protection and preservation of our nation's remaining wetlands. Wetlands are also protected by many state governments, and in some cases, even by local municipal governments.

THE FUNCTIONS AND VALUES OF WETLANDS

Wetlands are an extremely valuable natural resource to humans and wildlife. Their role, or function, in the natural world includes:

Flood Control: Wetlands act like a sponge by absorbing stormwater runoff during heavy rainfall then slowly releasing it at a more even rate to downstream waterways.

River/Stream Bank Stabilization: The root systems of wetland vegetation help to stabilize soils by holding them in place, reducing erosion (when soils get transported from one area to another). Wetlands vegetation occurring in swales, streams, and ditches also helps to reduce the speed of flowing water, which also helps to reduce erosion and flooding.

Improvement of Water Quality: Wetland ecosystems can actually improve water quality. The plants, algae, bacteria, and other microbes within wetland systems readily take-up and renovate large amounts of nutrients and toxic compounds that may otherwise cause downstream ecosystems such as rivers, ponds, lakes and estuaries to become polluted and eutrophic, a nutrient enrichment condition that can lead to unfavorable events such as severe algal blooms, oxygen depletion, and fish kills. Additionally, the ability of wetlands to store water along with the filtration action of the wetlands vegetation, results in great settling of suspend solids such as sediments and other un-dissolved compounds that are commonly transported by flowing waters. This reduction in suspended solids within wetlands systems reduces siltation to downstream waterways, and thereby prevents smothering of bottom dwelling organisms, along with other impacts associated with the accumulation of nutrient laden sediments such as nutrient enrichment, shallow water depths, nuisance growth of aquatic plants, growth of exotic and invasive aquatic plants, and devastation of fish habitat.

Ground Water Recharge: Some wetlands recharge groundwater supplies by trapping water and slowly releasing it to underground aquifers.

Wildlife Habitat: Many wildlife populations rely on wetland habitats for their survival. Eighty percent of America's breeding bird population relies on wetlands (Mitsch and Gosselink 2000). Many species of birds, fish, shellfish, mammals, reptiles, amphibians, and insects depend on wetlands in some way be it for food, protection, and/or nesting and spawning sites. Many endangered and threatened species rely on wetland habitats to some degree. Fifty percent of the nations endangered animals and more than 80% of Pennsylvania's endangered animals depend on wetlands during their life cycle (Heist and Reif) (Mitsch and Gosselink 2000). So wetlands do not only play an integral part in maintaining present wildlife populations but also in preserving the remaining populations of endangered and threatened species.

Besides for their functions in the natural world, humans value wetlands because wetlands support the fish and shellfish industry. Over 95% of the fish and shellfish species that are harvested in the United States are wetland dependent. The fishing industry contributed $1.9 billion to the US gross national product in 1998, so the fish are not only providing income to many people but also a nice meal (Mitsch and Gosselink). Cranberries, peat, timber, and animal furs are other resources utilized by humans, supported by wetlands.

Humans also value wetlands for their aesthetics. Many people enjoy exploring, photographing, and learning about wetlands. A walk through a cranberry bog with blooming orchids and pitcher plants can be a wonderful experience. Some people may not be interested in wetland exploration, but they like to know that wetlands exist and that they could visit them if they would want. This is known as "existence value."

Swamp Pink, an herbaceous perennial, is a member of the Orchid Family *(Orchidaceae)* and a member of the endangered species list. Only three of 26 historical populations in Pennsylvania can still be found. Although Swamp Pink has been historically rare, there is little doubt that the species currently is in grave trouble, threatened with extinction due to loss of its wetland habitat. Swamp Pink grows in open, sunny sphagnum moss bogs and swampy meadows.

(Taken from www.dnr.state.va.us)

WETLANDS PROTECTION

Wetlands are protected, and after reading the section on functions and values, you probably understand why. Wetlands are valued by humans and play integral roles in the natural environment. Since over 50% of our nation's and state's wetlands have been destroyed, preservation of remaining wetlands is a must. Federal and State laws and local ordinances help protect wetlands today.

State and federal laws, such as the ones discussed below, require that projects that impact wetlands obtain a permit. Obtaining a permit is a complicated and lengthy process that usually requires: (1) a wetland investigation, (2) a thorough look at the project and how it will impact the wetland, (3) reports and plans exhibiting that the project fulfills the requirements of the state/federal laws (compliance) and (4) a plan on how the impact will be mitigated (how the wetland loss will be replaced or compensated for).

In addition to federal and state laws, municipalities may adopt an ordinance(s) that help conserve and protect wetlands. The following is a closer look at wetland protection at the federal, state, and local levels.

FEDERAL REGULATION

Section 404 of the Federal Water Pollution Control Act (aka Clean Water Act) requires that anyone dredging or filling in "waters of the United States," including wetlands, must receive a permit from the U.S. Army Corps of Engineers.

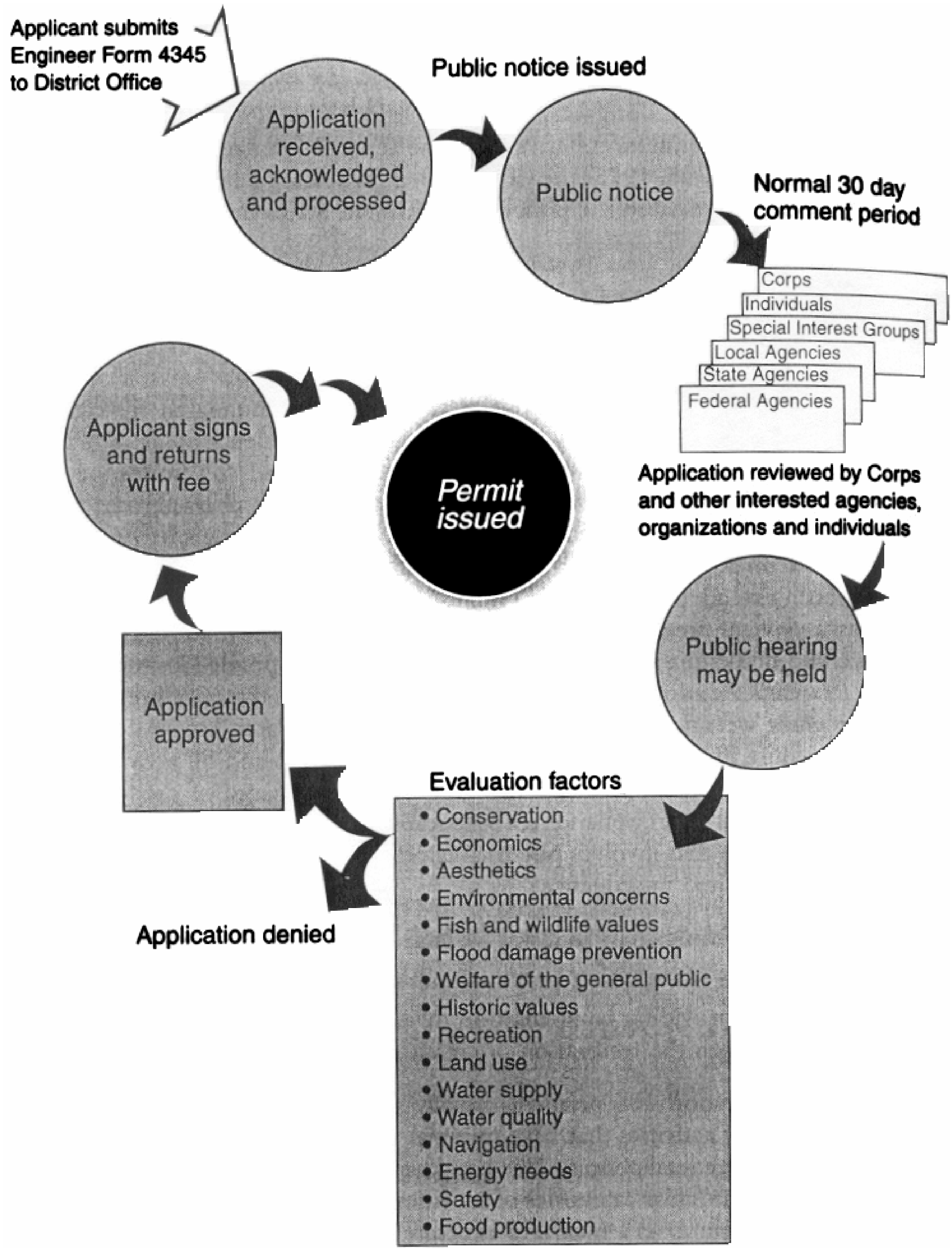
The basic premise of the program is that no discharge of dredged or fill material can he permitted if a practicable alternative exists that is less damaging to the aquatic environment or if the nation's waters would be significantly degraded. In other words, when one applies for a permit, he/she must show that they have

- taken steps to avoid wetland impacts where practicable
- minimized potential impacts to wetlands
- provided compensation for any remaining, unavoidable impacts through activities to restore or create wetlands.

Regulated activities are controlled by a permit review process. An individual permit is usually required for potentially significant impacts. However, for most discharges that will have only minimal adverse effects, the Army Corps of Engineers often grants up-front general permits. These may be issued on a nationwide, regional, or state basis for particular categories of activities (for example, minor road crossings, utility line crossings, and boat ramps) as a means to expedite the permitting process.

The permit application process is a complicated and lengthy process. Once a permit application has been submitted, the Army Corps of Engineers reviews the project application and may grant or deny the permit, basing their decision on a number of considerations including conservation, economics, aesthetics and other factors listed in the below figure (Mitsch and Gosselink 2000).

United States Army Corps of Engineers – Permit Process



STATE REGULATION

In addition to the Federal Clean Water Act, wetlands are also protected at the state level. Chapter 105 of the Pennsylvania Code (Dam Safety and Waterway Management) requires that any project with an associated impact on any body of water, including wetlands, must obtain a Dams and Waterway Encroachment Permit (Chapter 105 permit).

The Chapter 105 permit may be granted if a series of criteria are met. The criteria may be different depending on the value or the quality of the wetland. Exceptional value wetlands for example, are wetlands that provide (or are near) habitat for an endangered or threatened species. Wetlands that are located in or along exceptional quality waters and/or a wild trout stream and wetlands that exist near a river (or other water) designated as a wild or scenic river (under federal or state Wild and Scenic Rivers Acts) are also considered exceptional value wetlands. Exceptional value wetlands are given the highest degree of protection, and therefore, projects that may impose impacts on those wetlands need to meet a more elaborate list of requirements.

Like federal permits, the nature and size of the project dictates the type of permit required. **Statewide General Permits** are issued for projects with minor impacts to wetlands. If a project is believed to fall under a Statewide General Permit, an application for the permit is submitted to the Pennsylvania Department of Environmental Protection (DEP) or to a County Conservation District that has the capacity to review the application package, as approved by the DEP. Different Statewide General Permits are issued for different activities, and those activities may only be conducted in a certain manner. For example, a Statewide General Permit #7 is issued for construction of a minor road crossing through a wetland under the condition that the crossing will not exceed 100 feet in length. Many conditions must be satisfied in order to receive any Statewide General Permit. To further simplify the permit approval process, the federal government (as administered by the U.S. Army Corps of Engineers) has granted the state government the right to give federal approval to most Statewide General Permits. This federal approval is actually a permit between the federal government and the state government and is known as the **Pennsylvania State Programmatic General Permit No. 2 (PASPGP-2, the 2 standing for the second revision of this permit).** The PASPGP-2 is allowed because the federal government reviewed Pennsylvania's permitting review process and concluded that it meets the requirements of the federal Clean Water Act, and is therefore consistent with the permit requirements of the federal government. Stated in another way, if a project receives a PASPGP-2 it does not need to apply separately to the federal government for the federal approval. So basically, an application for a Statewide General Permit will be submitted to the DEP (or County Conservation District, where approved), and if the project activity meets all the conditions under the permit, then a PASPGP-2 will be granted along with the state approval, and no further approval for the proposed activity in wetlands is required.

Sometimes a project cannot meet the conditions under the Statewide General Permits or the type of the activity is not included under any of the available Statewide General Permits. Under such circumstances, a Joint Permit may be necessary. This permit is called a “Joint” Permit because two agencies, the DEP and the Army Corps of Engineers review the project. Even though the two agencies review the project, the Army Corps of Engineers makes the final decision on the issuance of a permit. Sometimes the Army Corps of Engineers concludes that the project activity meets the conditions of a General Permit close enough that it can be included under a PASPGP-2. The PASPGP-2 is then issued by the DEP with no further federal review. Other times, the project, because of its size or nature, cannot be granted a PASPGP-2, and an Individual Permit (Section 404 permit) from the federal government is necessary along with the state permit. If the Army Corps of Engineers determines that the project meets the requirements to be issued a federal Section 404 permit, then the Section 404 permit is issued along with the state permit (Chapter 105 permit). So basically, when an application for a Joint Permit is submitted, two things usually happen: (1) the Army Corps of Engineers determines that the project can qualify for a PASPGP-2 and the PASPGP-2 is granted or (2) the Army Corps of Engineers determines that the project needs federal review and permitting and if the project qualifies, a Section 404 permit (along with a Chapter 105 permit) will be issued.

LOCAL REGULATION

Municipal Ordinances: Municipal ordinances are basically laws adopted at the township and borough level. Ordinances are adopted by municipalities and therefore only apply to the township or borough that adopted the ordinance. Ordinances can provide additional wetland protection in different ways. Municipalities may adopt ordinances that call for the conservation of natural features and therefore may allow only slight impacts or not allow a wetland to be impacted at all, even if a state/federal permit is obtained. Other ordinances may further restrict activities in a wetland, such as prohibiting the cutting of wetland vegetation (for any reason). Areas surrounding wetlands, known as buffers or transition areas, may become protected under local ordinances as well in order to ensure the protection of the wetland. It is important to note that even though every municipality has the power and capacity to adopt ordinances of this nature, very few exist in the state of Pennsylvania.

SUMMARY OF WETLANDS REGUATION

Wetlands are protected through state and federal laws and through municipal ordinances. Municipal ordinances can protect wetlands for example, by requiring additional protection for natural areas (such as wetlands). Two laws that require a permit for regulated activities in wetlands are the Federal Clean Water Act, Section 404 and Chapter 105 of the Pennsylvania Code.

Many projects, due to their mild size and nature, only need a PASPGP-2, which grants state and federal approval. At other times, a Joint Permit is necessary due to a greater wetland impact. The Joint Permit includes an Individual Permit from the United States Army Corp of Engineers and a Section 105 permit from the Pennsylvania Department of Environmental Protection. Applicants rarely apply directly to the federal government for a nationwide, regional, or statewide general or individual permit. In Pennsylvania, the permit application is almost always sent directly to the Department of Environmental Protection.

It should be understood that the permit process is a lengthy, complicated process that confuses many people. So, if you are scratching your head a little bit, you're not alone. It is not essential that you fully understand the permitting process and how it works under all scenarios. Rather, you should just have a basic understanding of the various regulations and a firm understanding that all wetlands and “waters” are regulated by federal, state, and sometimes local agencies, and that any activities within such areas likely require permits from those agencies.

DETERMINING THE WETLAND BOUNDARY... THE WETLAND DELINEATION

Since wetlands are regulated resources, their exact location needs to be determined. If a project calls for a road to be built across a wetland, the amount of wetlands being impacted must be determined in order to find out if the project conditions qualify under a permit. The only way to know the amount of wetlands impacted is to determine the exact boundary of wetlands. This is done through wetland delineation. It may sound like an easy task, but since wetlands are transitional lands between terrestrial and water habitats, this task can many times be challenging.

The method used to determine wetland boundaries needed to be standardized mainly for regulatory purposes. The Army Corp of Engineers wrote several manuals for wetland delineation. Today in Pennsylvania, the 1987 Army Corp of Engineer's Wetland Delineation Manual is used to determine wetland boundaries.

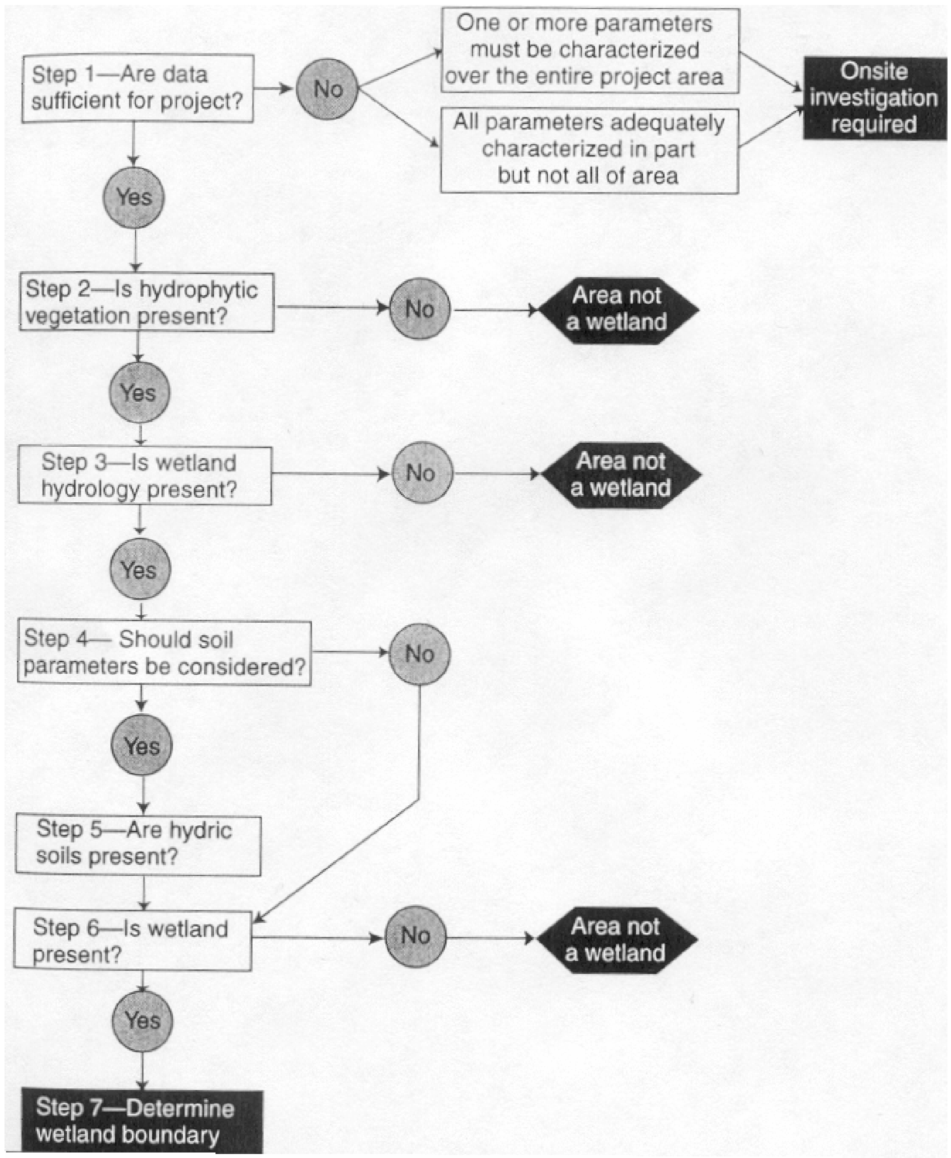
In order for an area to be considered a wetland under the 1987 Manual, three parameters must be fulfilled. They include:

1. Hydrophytic vegetation: In order for an area to meet the hydrophytic vegetation parameter, more than 50 percent of the dominant plant species must either have obligate wetland, facultative wetland or facultative plant indicator status.

2. Hydric Soils: Soils that have been classified as hydric or soils with characteristics associated with reducing soil conditions must be present in order to fulfill the hydric soil parameter. Many indicators of hydric soil can fulfill this parameter. Soil color is an indicator widely used; soil colors with a chroma of 1 or a chroma of 2 with mottles or soil colors that are gleyed indicate hydric soils.

3. Hydrology: Evidence of hydrology is required to fulfill this parameter. Indicators of hydrology, as previously discussed, include inundation or saturated soil conditions, drift lines, watermarks, butressed tree roots, water stained leaves, sediment deposits, and drainage patterns (evidence of flow). Some indicators are stronger than others, and when a decision is made using some of the weaker indicators (such as sediment deposits), more than one indicator may be necessary to determine the presence of hydrology.

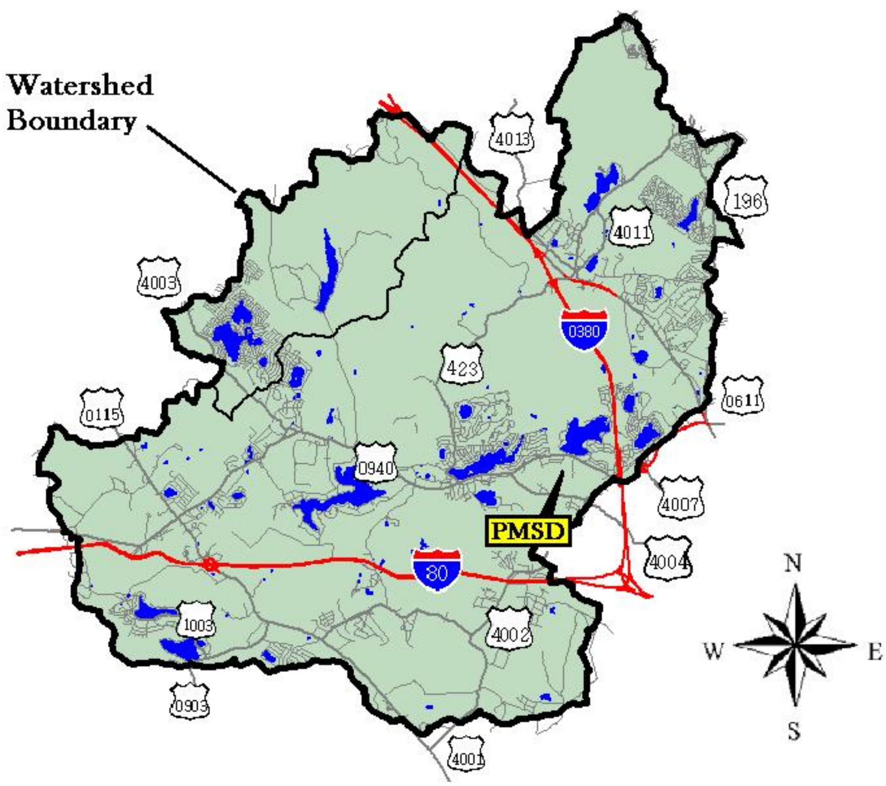
United States Army Corps of Engineers – Wetlands Determination



This flow chart, taken from the 1987 United States Army Corp of Engineers Wetland Delineation Manual, can be used when making a wetland determination. While this chart provides a basic overall approach for wetland determination, all of the characteristics of the site should be considered in order to make a correct determination. Under normal (or natural) conditions, it is highly likely that all three parameters would be satisfied in "wetland" areas. Normal conditions are not always observed in today's world, however, due to our significant disturbance to the earth's surface and on-going development and construction projects. Many construction projects, particularly those that occurred prior to the Clean Water Act, have caused changes to natural wetlands and have created new wetlands. For example, water may become impounded on a newly constructed site in areas where it was not naturally impounded, perhaps due to an alteration to the landscape such as construction of a new road. The site may then begin to support hydrophytic vegetation in the new wet areas. However, the indicators of hydric soils may not yet be present; as such changes in the soils may take many years. Under this set of circumstances, the soils may not be required to meet the typical evaluation for "hydric soils," and the wetlands may be defined using only the hydrology and vegetation assessment. In the above diagram, "Step 4 - Should hydric soils be considered?," accounts for this particular circumstance.

TOBYHANNA CREEK/TUNKHANNOCK CREEK WATERSHED ASSOCIATION

Tobyhanna Creek/Tunkhannock Creek Watershed Association (TC/TCWA) is a nonprofit organization composed entirely of volunteers committed to the protection of the surface- and groundwater resources within the Tobyhanna and Tunkhannock creek watersheds. The watersheds comprise 125 square miles of privately and publicly held lands perched on the ecologically unique Pocono Plateau. The entire watershed drains into the Lehigh River and is located within Monroe, Wayne, and Carbon Counties; the Townships of Tobyhanna, Coolbaugh, Tunkhannock, Lehigh, and Kidder; and the Borough of Mt. Pocono. The unique geology and the geographic location of the watershed provide exceptional water quality and globally rare wildlife habitats. Many of these habitat areas are located within the Tunkhannock Creek Watershed and are protected from direct impacts through purchase by the Nature Conservancy and location within state game lands. These "preserves" are located within the Pocono Plateau which is considered to be so unique and special that The Nature Conservancy has designated this area as being one of the "Last Great Places" on earth worth preserving. The preserves and other areas within the Pocono Plateau support and provide critical habitat for many threatened and endangered floral and faunal species.



The water quality and water resources in this area are, however, threatened by the ever increasing pressures and impacts of residential and commercial development. The current development trend presents a serious threat to these resources. Extremely rapid growth has occurred within the Tobyhanna & Tunkhannock creek watersheds and is projected to continue well into the twenty-first century. Monroe County is the second fastest growing county in Pennsylvania; and, Coolbaugh and

Tunkhannock Townships which comprise the vast majority of our watershed, are the first and second fastest growing townships in Monroe County, respectively. In fact, Coolbaugh Township is the fastest growing township in the Commonwealth of Pennsylvania amongst those townships with a population over 10,000 individuals. This rapid growth has both direct and indirect impacts to surface- and groundwater quality and quantity. Therefore, the protection and preservation of the water resources is a primary focus of the TC/TCWA. Maintaining the existing high standard of water quality within the Tobyhanna & Tunkhannock creek watersheds is absolutely vital to the protection and preservation of the many unique and critical wildlife habitats that this area supports.

One way to ensure the protection and preservation of Tobyhanna and Tunkhannock creek watershed resources is to educate students about the water resources within the watersheds. Comprehension of the different types of resources and their importance can encourage student involvement in watershed protection and preservation. This particular program was developed to educate students about wetlands, for they are an integral part of the water resources of the Tobyhanna and Tunkhannock creek watersheds. This wetland education program is just one component of TC/TCWA's Watershed Protection Project.

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HOMEWORK ASSIGNMENT #1 - TEST YOUR WETLAND IQ: WHAT DO YOU KNOW ABOUT WETLANDS?????

1. Wetlands are wet lands. List as many other terms as you can think of for these types of ecosystems.

2. What are some characteristics of wetlands?

3. What kinds of plants are found in wetlands?

4. What kinds of animals are found in wetlands?

5. In what ways are wetlands important to the environment?

6. In what ways are wetlands important to people?

7. How do human activities affect wetlands?

HOMEWORK ASSIGNMENT #1 - TEST YOUR WETLAND IQ: WHAT DO YOU KNOW ABOUT WETLANDS?????

1. Wetlands are wet lands. List as many other terms as you can think of for these types of ecosystems. **Bog, fen, swamp, marsh, mangrove, etc. (see list in packet)**

2. What are some characteristics of wetlands? **Answers may vary. Students may bring up smells, vegetation, soils, animals, water.**

3. What kinds of plants are found in wetlands? **Examples that may come up in discussion include cattails, grasses and reeds, red maples, cranberries, sphagnum moss, and pitcher plants.**

4. What kinds of animals are found in wetlands? **Examples that may come up in discussion include fish and shellfish, crabs (fiddler, marsh, blue), birds (herons, egrets, loons, ducks), turtles, mammals (deer, bear, minks, muskrats, and raccoons), and insects.**

5. In what ways are wetlands important to the environment? **Examples include habitat for diverse plant and animal species, improvement of water quality, and the aid in control of floods and erosion.**

6. In what ways are wetlands important to people? **Examples include food, jobs, recreation, water supply. Wetlands are also important to people for the above reasons.**

7. How do human activities affect wetlands? **Wetlands are filled or drained for agriculture and for residential, commercial, and industrial development. Nonpoint source pollution also degrades wetlands.**

HOMEWORK ASSIGNMENT #2: USING PLANT IDENTIFICATION GUIDES

The purpose of using of a plant field guide is to facilitate quick and positive plant identification. Field guides are usually divided into different categories to help eliminate other questionable possibilities. Different plant keys may vary a little in format, but overall they provide the same information.

The Petersons Field Guide to Trees and Shrubs will be used to provide an example of an overall format for a plant identification guide. Leaf type is one of the first characteristics of a plant to be examined and can provide a lot of information to aid in identification. And since leaf type is a broad enough category, it is the first category utilized in this book. Peterson's Field Guide divided leaf type into five categories:

I. Plants with needle-like or scale-like leaves
II. Plants with opposite compound leaves
III. Plants with opposite simple leaves
IV. Plants with alternate compound leaves
V. Plants with alternate simple leaves

These first five categories provide the starting point in plant identification. Once you have determined your main category, you are then given another series of options to look at. These options may include analysis of buds, leaf scars, thorns, and/or further analysis of the leaf including leaf shape and/or the presence of hair and teeth. If you are not sure what an opposite compound leaf with teeth might look like, that's ok. Definitions and diagrams in the front of the manual define the difference between simple and compound, opposite and alternate, toothed and un-toothed and any other traits you may be examining.

Basically when you use this key, or any key, you are given several options from which you need to choose. Once you examine your specimen and make your choice, you are presented with another series of options and so on. You continue examining different aspects of your specimen, in this case, a plant, until you reach the end result, your positive identification.

The best way to become familiar with the different aspects of a key is to use it. Below are several pictures of leaves taken from a few trees. After examining the leaves, use the key to determine the species of the tree from which it came.

Using a field guide to trees and shrubs, identify each plant species. First examine the characteristics of the leaves, twigs, and seeds. Then use the guide to make a positive identification.

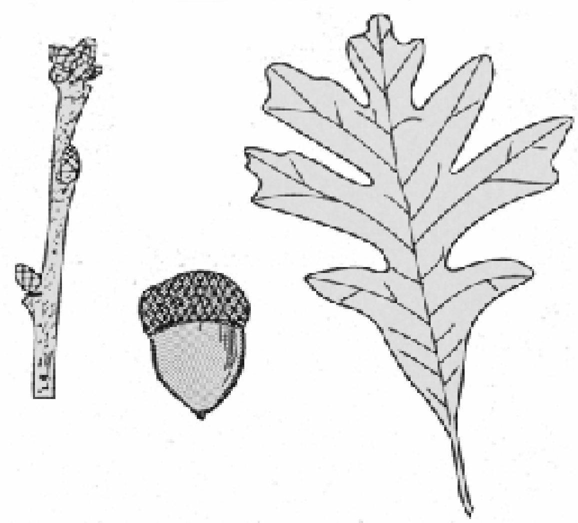
Plant ID #1

Hint: Leaf shape and margin characteristics, branching characteristics (look at buds, opposite or alternate?), and seed characteristics

Observed Characteristics:___________________________
____
____
____

Plant Species: __________________________

Plant ID #2



Hint: Shape of leaf, orientation of buds, acorn characteristics

Observed Characteristics:_________________________
____
____
____

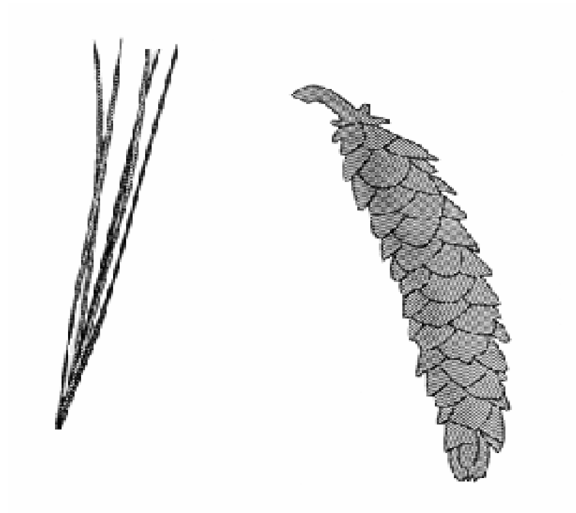
Plant Species: __________________________

Plant ID #3

Hint: Number of "leaves," or needles, in each "bundle," and the average length of leaves (approx. 3 inches)

Observed Characteristics:___________________________
____
____
____

Plant Species: __________________________

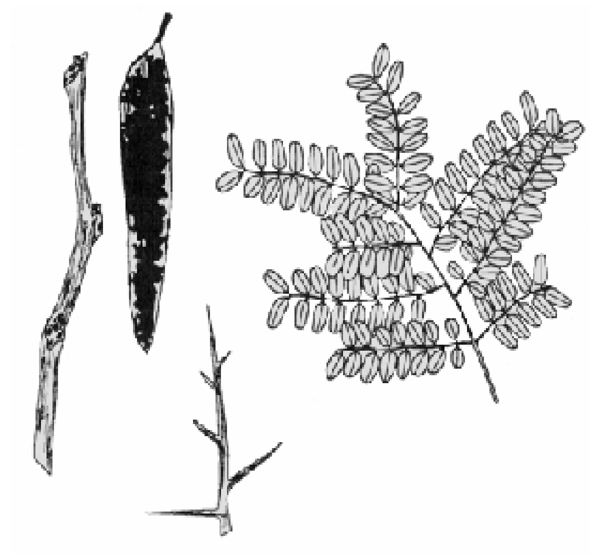


Plant ID #4

Hint: Alternate branching (as evidenced by the leaf picture). Also consider the type of leaf, leaf scars (shown on the "twig"), the seed pod, and the thorns

Observed Characteristics:___________________________
____
____
____

Plant Species: __________________________



Plant ID #1

Hint: Leaf shape and margin characteristics, branching characteristics (look at buds, opposite or alternate?), and seed characteristics

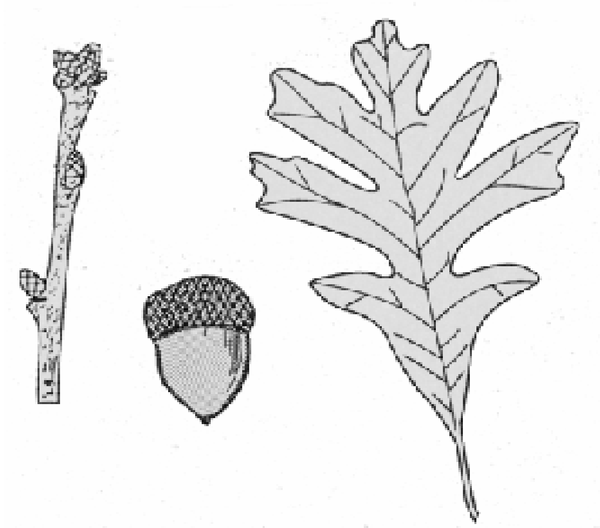
Observed Characteristics: Three (but sometimes five) main lobes, leaf margins are slightly serrated, notches between lobes are shallow, palmately veined, base of lobes are pointed. Plant has winged fruit known as a samara.

Plant Species: **RED MAPLE** *(Acer rubrum)* Deciduous

Plant ID #2

Hint: Shape of leaf, orientation of buds, acorn characteristics

Observed Characteristics: Alternate branching, leaves have seven to nine lobes, smooth leaf margin (no teeth), deep to shallow sinuses extending evenly to the midrib.



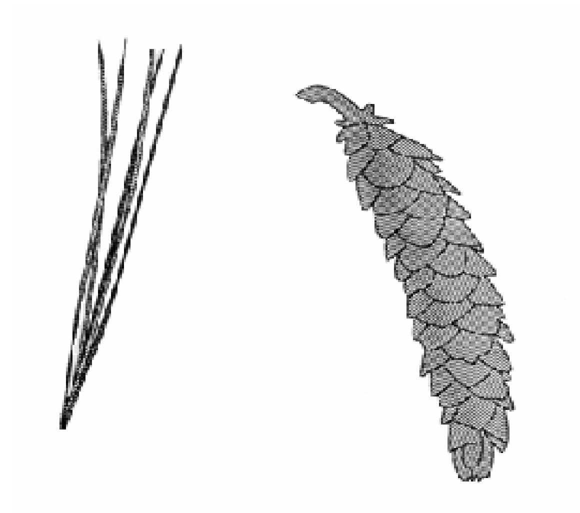
Plant Species: **WHITE OAK** *(Quercus alba)* Deciduous

Plant ID #3

Hint: Number of "leaves," or needles, in each "bundle," and the average length of leaves (approx. 3 inches)

Observed Characteristics: Needles are 3 to 5 in. long and in groups (clusters) of fives. Cones are slender, thornless, and 3 to 10 in. long.

Plant Species: **WHITE PINE:** *(Pinus strobus)* Evergreen conifer

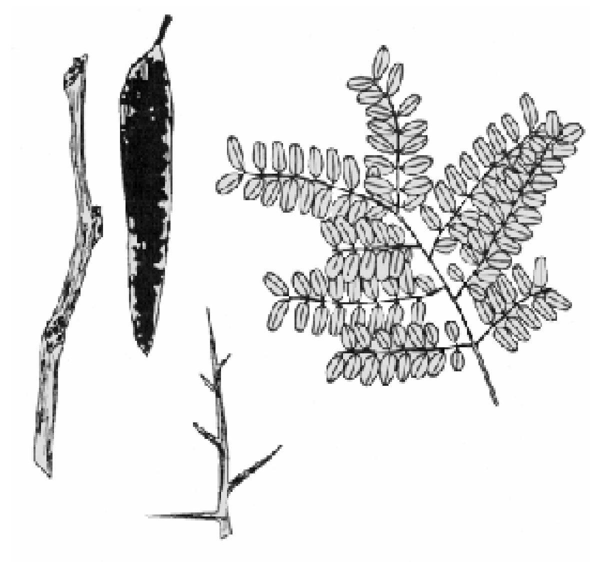


Plant ID #4

Hint: Alternate branching (as evidenced by the leaf picture). Also consider the type of leaf, leaf scars (shown on the "twig"), the seed pod, and the thorns. Students should look at the leaf scars and/or buds to determine leaf position

Observed Characteristics: Leaf is both pinnate and bipinnately compound, divided into numerous narrow leaflets which may be slightly toothed. These leaflets, in turn, are subdivided Leaflets may be slightly toothed. (refer to picture). Bark often has clusters of many large thorns.

Plant Species: **HONEYLOCUST:** *(Gleditsia triacanthos)* Deciduous



HOMEWORK ASSIGNMENT #3: POSITION PAPER

Note: If necessary, you should re-read the preceding section entitled "WETLANDS PROTECTION," as a basic understanding of this section will be assumed for this assignment.

Since the dawn of the Clean Water Act in 1972, real estate developers and landowners have been challenging the extent of the federal government's authority with regards to wetlands regulation. You should realize how the protection of wetlands and other surface water resources can be very costly to developers and landowners who were no longer free to develop and sell land with no concern for impacts to these natural features. Many landowners feel that they have a right to do whatever they want to on their own property.

Two landmark legal battles have created great controversy and have resulted in some very serious issues for wetlands protection by our federal government. These two cases are most commonly known as:

- ⌘ **Tulloch Rule** (North Carolina Wildlife Federation v. Tulloch)
- ⌘ **SWANCC Decision** (Solid Waste Agency of Northern Cook County v. United States Army Corps of Engineers)

Both cases were extremely well covered by the media, and there are numerous articles available on the Internet that adequately describe each case and their implications. An Internet search using either of the above bolded names will provide you with all the links necessary to learn a great deal about both cases.

For this assignment, you should choose one of the above cases and write a brief (1-2 page, single spaced, typed) position paper on it. Position papers generally conform to the following basic formula:

Introduction

1. A statement that establishes the controversial issue that your paper will examine.
2. A summary of the issues, and a brief background synopsis.
3. Definitions of key terminology.
4. A thesis to assert your position on the subject.

Body

1. Analysis of the issues, both pro and con.
2. Arguments in defense of your position.
3. Evidence from your reading, including paraphrases and quotations as appropriate, properly documented.

Conclusion

Reestablishment of your thesis to clarify your position, which should grow logically from your analysis and discussion of the issues.

FIELD STUDY #1: FORESTED WETLANDS

Note: If necessary, you should re-read the preceding materials on Determining the Wetlands Boundary – The Wetlands Delineation and the Three – H's: Hydrology, Hydric Soils, and Hydrophytes, as a basic understanding of these sections will be assumed for this field study and corresponding field exercise.

Forested wetlands are all wetlands having trees as a primary vegetation cover. Other vegetation such as shrubs and herbs may be present in great abundance, or may be completely absent in forested wetland systems. Forested wetlands take tens of years, or longer, to develop, and are very sensitive to changes in hydrology. For example, even a change of one foot in the average water table elevation in a forested wetlands system, due to something like beaver damming in the area or roadway development, may cause mortality of all tree species present. The result of such a change would likely be a conversion from forested wetlands system to a scrub/shrub, herbaceous, or marsh type of system. For this reason, along with the valuable wildlife habitat they offer, forested wetlands demand great study, management, and protection.

Forested wetlands in the Pocono Region vary greatly in size and species composition. Areas observed may be small isolated wetland patches with little species diversity, and they may be vast tracts that are complexes of varying forested wetland types with great species diversity. Tree species composition may include hardwood deciduous trees, coniferous deciduous trees, and coniferous evergreen trees. Density of vegetation ranges from sparse to nearly impenetrable. Hydrology ranges from nearly indistinguishable from uplands to areas of deep water pools.

The grounds of the Pocono Mountain School District complex along Route 940 are exceptionally blessed with very large and unique wetlands systems. Two primary systems, or complexes, exist on the grounds, one along each side of the school property. The location of these complexes are shown on the following map, showing the school property boundary, school facilities, and the various wetland types as mapped by the federal National Wetlands Inventory Program. All colored areas on the map represent wetlands, making the importance of proper delineation, protection, and management very clear.

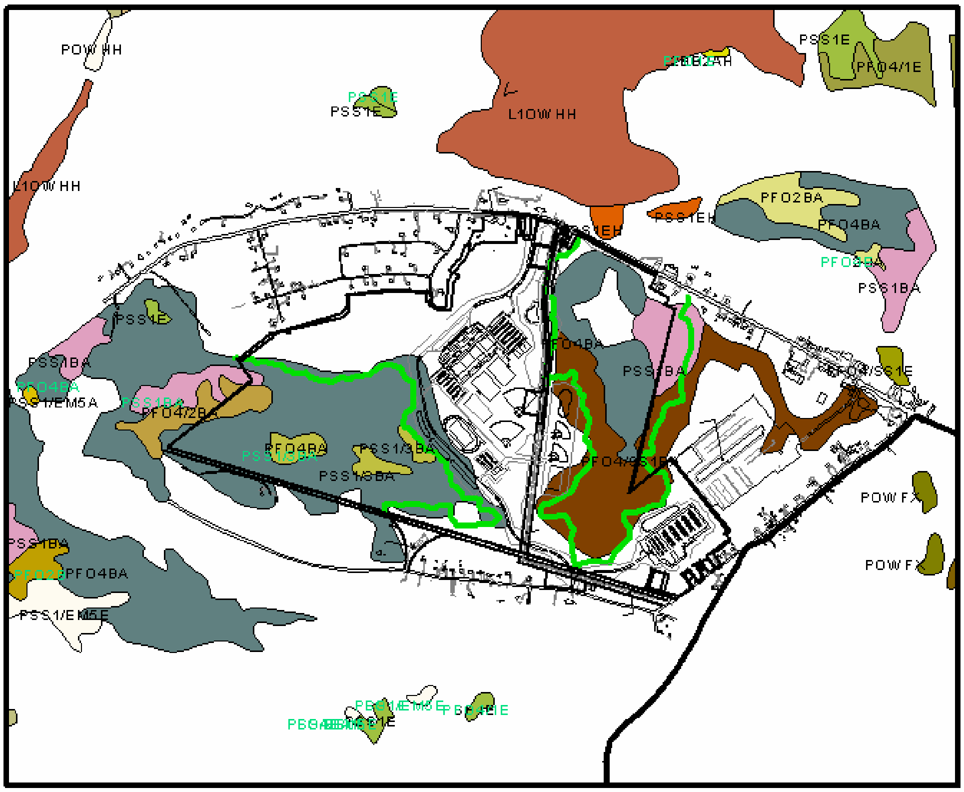


Figure 1 - National Wetlands Inventory mapping. All color areas indicate large wetlands tracts mapped by the United States Fish & Wildlife Service. The alphanumeric codes represent different wetland types.

The wetlands indicated on the above map vary greatly from open bog to extremely dense forested wetlands. The goal of the National Wetlands Inventory Program (NWI) is to roughly map the location of only very large wetlands tracts, typically only those wetlands greater than one acre. The analysis for this mapping is completed using topographic mapping, aerial photographs, and infrared aerial photographs (which show temperature variations at the earth's surface and in many cases clearly indicate the presence of water). The actual extent of wetlands on any given site, however, is generally much greater than the NWI maps indicate. Because **all** wetlands are protected under local, state, and federal laws, it is essential to have a qualified professional identify and delineate the exact wetland boundaries in the field, so that such areas are not disturbed by construction and other earthmoving projects.

The wetlands on the Pocono Mountain School District property were professionally delineated prior to construction of the buildings, parking areas, and athletic fields. The wetlands delineation line is shown clearly on the above map as a thick green line, which corresponds fairly well to the NWI wetlands.

FIELD EXERCISE – WETLANDS DELINEATION

By now, you know a great deal about wetlands, wetlands delineation, and the wetlands resources that are found on your school property…so, it's time to test yourself in the field to see just how well you can stack-up to the pros in identifying and delineating your wetlands!

For this exercise, you will travel with your teacher to the forested wetlands complex on the eastern portion of the school property where you will delineate the wetlands boundary at several points spaced approximately 100 feet apart. You will work in two or more different groups to evaluate the three different requirements for all areas regulated as wetlands – hydric soils, hydrophytic vegetation, and hydrologic characteristics. Each group will have a set of the necessary equipment and field data sheets. With guidance from the teacher, each group will work to delineate one or more points to define the wetlands boundary at several locations (connection of the points by "imaginary lines" then forms the boundary line between the wetlands and uplands). For each point, the group will fill out a field data sheet listing soils, vegetation, and hydrologic data for both the uplands and the wetlands on each side of the wetlands boundary at that point. The teacher will assist both groups in their evaluations, as necessary. The following step-by-step procedure should be used for determination of each point:

Step #1 – Hydrologic Evaluation - You should begin your evaluation at the edge of the athletic fields with a basic determination of hydrologic characteristics, or presence of water potential…which includes both surface and "shallow" groundwater. Hint: We know this area to be uplands…and basic, common sense should help you determine that the immediate forested area is "high-and-dry." As you move further into the wooded area from the athletic fields, you should notice that the land slopes downward, away from the athletic field and that changes in the plant community are apparent (due to changes in both soil and water conditions). As you travel further into the wooded area, you should notice that the ground becomes "spongy," and possibly even wet with standing water in small pockets. Sphagnum moss, a water dependent moss, also begins to appear in small depressions. The combination of these factors would be a good first indicator that you have identified obvious "hydrology." *Is this area a place that water seeps from the ground to the surface, or is it an area where water on the surface seeps into the ground to become groundwater…or is it both, depending on weather conditions?* Having water is obviously essential to having "wetlands," but very rarely can you delineate the exact boundary of wetlands based strictly on the "hydrology" factor. Rather, you must look to the soils and the plants to build upon positive confirmation for hydrology…and for wetlands! By this point, however, you should have noticed definite changes from the obvious uplands to obvious wetlands environments, and you should be able to estimate the area where these changes first begin to occur.

Now that you have established the "presence of water," and you know that you have both uplands and wetlands areas, it's time to better define the boundary that separates these two areas by looking at the soil conditions and the vegetation that are present.

Step #2 – Soils Evaluation - It is helpful to begin this evaluation in an obviously "high-and-dry" area where soils will be "dry" and will exhibit "bright" colors rather than shades of gray which indicate hydric soils that are saturated with water…remember, you are attempting to find the boundary line between the regulated wetlands and the un-regulated uplands, and soil conditions are a critical component in this determination.

Soil samples should be collected using the soil auger which is twisted into the soil to an approximate depth of 15-18 inches. The auger should be extracted from the soil by continuing to twist in the downward direction while pulling upward on the handle. By ding this, the sample will stick to the threads of the auger and can be easily pealed away for closer analysis.

Soil colors should be identified using the Munsell Soil color chart, with assistance on proper usage as necessary by the teacher. The upland soils should be a shade, or shades, of yellow, orange, or medium brown. If the soils appear very gray, you should move closer to the athletic fields and collect new soil samples showing these brighter colors.

Note: Once you have established that you are in an upland area, you should take note of the surrounding vegetation species and vegetation communities, along with other basic characteristics of that area. You should notice that the vegetation changes as the soil colors change, as you more from the uplands area into the wetlands area. *What is the cause for both the soil color and the vegetation changes? Answer: Water*

Continue taking soil samples as you move deeper into the wooded area, toward the obviously "wet" area and away from the uplands along the athletic fields. You should note that the soils will begin to change in color, and possibly in water saturation; you will likely see a mixture of colors, called mottling, and you may even begin to get saturation of the soil samples. The regulatory definition of "hydric soils" is that the chroma (as listed in the Munsell Soil Color Chart) of the sample collected at a depth of 15-18 inches is less than 2, or that the chroma is 2 and the sample exhibits mottles. You should recall that mottles occur as a result of periodic saturation; under permanent saturation, the chroma would be 0 or 1 and mottles would not occur, and under permanently dry conditions, the entire soil sample would exhibit brighter chroma(s), which would be the same chroma as that observed in the mottles of the saturated, or hydric, soil. The wetlands soil profile is typically mineral soils (soils derived from the breakdown of rock/bedrock) overlain by a variable thickness of organic matter (material derived from the accumulation and partial breakdown of organic matter such as decaying plants or leaf litter). Once you reach a point where the soil color (the matrix, or primary background color of the mineral soils collected at a depth of 15-18 inches) has become primarily gray and meets the regulatory criteria for hydric soils, you should hang a pink flag on a tree or shrub in that area to indicate that location as the change between wetlands soils and uplands soils.

Remember, you still need to evaluate for hydrophytic vegetation! The point which you have flagged for the change in soil conditions does not necessarily define the regulated boundary between the uplands and wetlands…but likely, it is very close! In most cases, the positive identification of the soils change is an accurate assessment of the wetlands delineation boundary. However, it is still necessary to evaluate the vegetation in the surrounding area to determine a positive change from uplands plant species to wetlands plant species. It is common and reasonable for the vegetation to change at the same location as the soils change, as water is the common denominator that drives both changes.

Step #3 – Vegetation Evaluation – Now that you know where the soils change occurs, it will be necessary to identify the vegetation in the immediate surrounding area to determine where the vegetation shifts from mostly uplands species to mostly wetlands species. The vegetation key included as an appendix to this curriculum will allow you to quickly identify the most common plants (trees, shrubs, and herbs), and lists each species' respective "wetlands indicator status." The criteria for wetlands vegetation is met once greater than 50% of the vegetation in a given area is comprised of "wetlands species," having an indicator status of FAC+, FACW-, FACW, FACW+, or OBL. Vegetation listed as FAC is essentially a neutral species that is found equally in both uplands and wetlands areas, and should not therefore be viewed as an indicator for either condition. Vegetation listed as FAC-, FACU+, FACU, FACU-, and UPL is indicative of upland conditions. The following table provides additional information on species occurrence in wetlands based on indicator status, with extension of "+" and "-" given to facultative species to better define likely occurrence within the listed ranges.

Wetland Indicator Category	Estimated chance of inhabiting a wetland	Estimated chance of inhabiting an upland
Obligate wetland plant (OBL)	Greater than 99%	Less than 1%
Facultative wetland plant (FACW)	67% to 99%	1% to 33%
Facultative plant (FAC)	33 to 67% (a.k.a. 50%)	33% to 67% (a.k.a. 50%)
Facultative upland plant (FACU)	1% to 33%	67% to 99%
Upland plant (UPL)	Less than 1%	Greater than 99%

Step #4 – Determine the Boundary - Once you have determined the basic break between the uplands and wetlands vegetation, you should take into consideration all three indicators; hydrology, soils, and vegetation to determine the point that best defines the boundary between the uplands and wetlands areas. There may be some variability in the opinions of different members of your group, but this should be expected as there is variability in natural processes and wetlands delineation is therefore not an exact science – rather, it is a reasonable approximation. After discussion amongst the various members of your group, a final decision of the boundary point should be decided and marked with a fluorescent pink flag tied securely to a shrub or tree. You have now determined one point along the wetlands boundary! Congratulations.

In the professional world, wetlands boundary lines for a given site are determined and mapped by locating numerous points along the wetlands boundary in a manner that allows for a "connect-the-dots" approach to defining a line that represents the wetlands boundary, or delineation, line. Typically a professional land surveyor will locate the wetlands boundary points, or flags, relative to the property boundary lines, and then will connect the points in a specified order (the flags are labeled accordingly) on their mapping to create the wetlands delineation line. This wetlands delineation line then represents the legal boundary line for the wetlands on that property. An entire property must be inspected thoroughly to ensure that all wetlands areas are identified and properly delineated.

Optional Step #1 – GPS Location of Wetlands Flags - Once each group has identified three to four points along the wetlands boundary and all field data sheets have been completed, use a hand-held Global Positioning Systems (GPS) unit to find the latitude and longitude coordinates of each flag. This data may be used along with the Geographic Information Systems (GIS) mapping for the school property to locate your flags and to make a comparison of your work to that of the professionally delineated wetlands line.

The GPS unit should be set up to read the coordinates as "decimal degrees" (i.e. – 43° 5.284') in WGS 84 projection. The teacher will assist you in the proper use of the GPS units to ensure that the data is correct and recorded with the highest possible degree of accuracy.

Optional Step #2 – GIS Mapping of Wetlands Flag Locations – Back in the classroom, you will create a "theme" for your wetlands delineation points to add to the GIS database that has been created for the school property. Your teacher will assist you in the creation of the theme, as the process is somewhat complicated. Once the data are properly entered into the GIS database, you will be able to see and compare your work with that of the professionals who delineated the wetlands as shown on the GIS mapping.

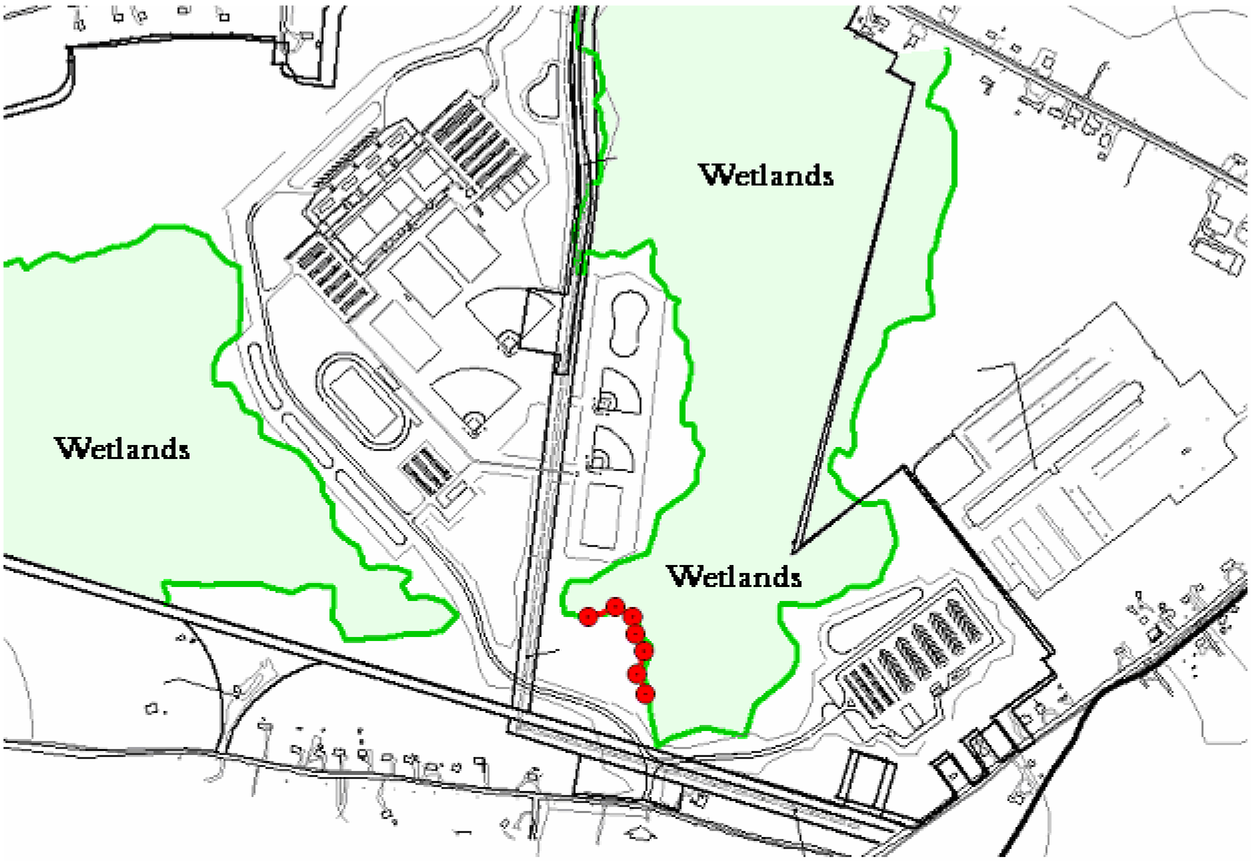


Figure 2 - Sample wetland delineation shown on GIS mapping. Points were located using a GPS unit. The green line represents the wetlands delineation line as determined by a professional consultant. The red points and line represent the sample GPS located points and corresponding wetlands boundary.

So, how did you match-up? It is very likely that your points are close to the professionally delineated wetlands line, but with some minor discrepancies. The differences between your line and the professionally delineated line may be based on differences in the boundary determinations, or could simply result from the unavoidable error involved in the GPS location process. Either way, you have now completed a "wetlands delineation," and you will surely get better with practice.

FIELD STUDY #2: THE BOG

Bogs are extremely unique habitats; they are like no other wetland systems. Their fascinating and unique vegetation, such as insect-eating plants and rare orchids, has intrigued and interested people for centuries. Discoveries of the Iron Age "bog people" of Scandinavia, who were found buried and preserved intact for up to 2,000 years, made bogs even more mystifying. Along with fens, bogs have been the subject of study more times than any other type of freshwater wetland, so for whatever the reason, humans have been attracted to bogs for thousands of years.

Bogs are found across the entire Northern Hemisphere, however, they are more likely to be found in areas that were recently glaciated (10,000 to 15,000 years ago) by the Wisconsin Glacier. Bogs can form through the variation of two processes: terrestrialization (the filling in of shallow lakes) or paludification (the blanketing of terrestrial ecosystems by overgrowth of peatland vegetation) (Mitsch and Gosselink 2000). Three major bog formation processes include:

"Quaking Bog" Succession: This process of terrestrialization includes the filling in of lake basins from the surface. Plant cover is only partially rooted in the basin bottom or it floats on top of the surface like a raft. Vegetation encroaches from the edges toward the middle of the lake; a mat of reeds, sedges, grasses, and other herbaceous plants develop along the leading edge of a floating mat of peat that is soon consolidated and dominated by Sphagnum and other bog flora (Mitsch and Gosselink 2000). When a force, such as walking, is imparted on the plant cover, the effects of the force can be seen in a wave of motion in the surrounding surface, hence giving it the term, quaking bog.

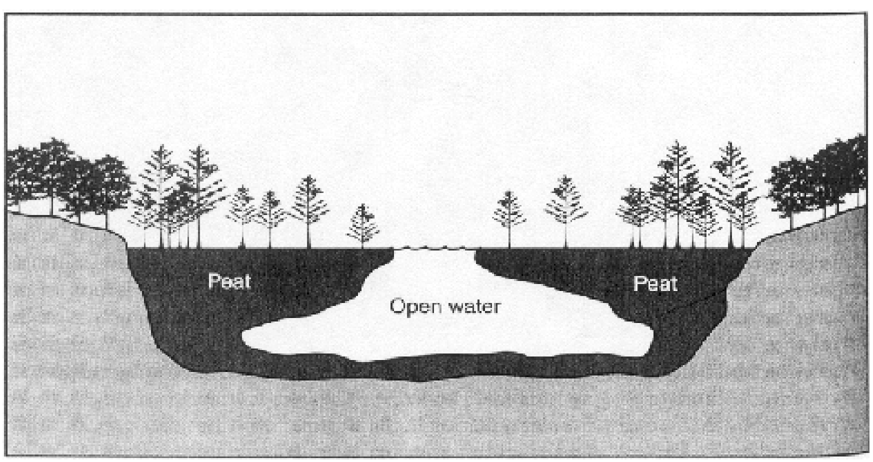


Figure 1. Typical Profile of a Quaking Bog. (Taken from Mitsch and Gosselink 2000.)

Paludification: Blanket bogs extend pass the boundaries of their basin and take over dry lands in the process of paludification. Peat can literally "blanket" very large areas far from the site of original peat accumulation and once the peat encroaches on an area its presence creates conditions favorable for bog species. The process of paludification can be brought about by climatic change, geomorphological change, beaver dams, logging of forests, or the natural advancement of a peatland (Mitsch and Gosselink).

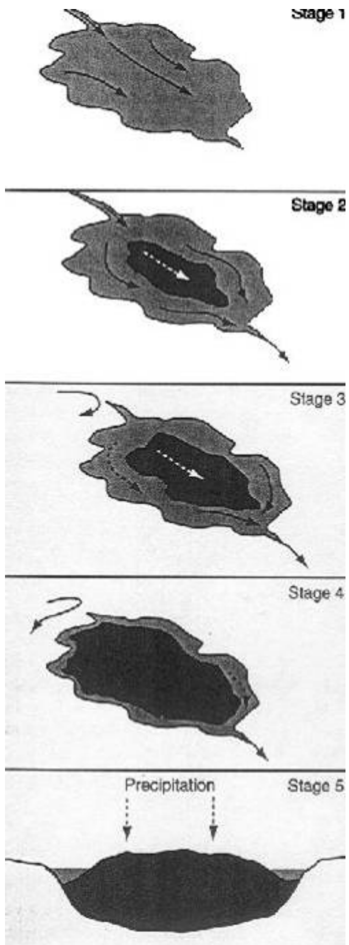


Figure 2. The five stages of Flow-through Succession

Flow-through Succession: This process falls in between terrestrialization and paludification and occurs when peatland development modifies the pattern of surface water flow. Five stages are involved in this process: (1) Excess organic matter and the inflow of sediments build up on the bottom of the lake. (2) The growth of the marsh vegetation contributes to the build up of the peat. (3) The major inflow of water may be diverted from the continuous build up of the peat. (4) Because of this diversion, areas may only become indundated during high rainfall. (5) In this final stage, the bog remains above the groundwater level and becomes a true ombrotrophic (rain fed; relying solely on precipitation for a source of water; no connection to ground or surface water) bog (Mitsch and Gosselink 2000).

The typical bog environment is not one that would appear favorable to life. Since bogs are ombrotrophic, their only source of nutrients is from precipitation, known as wet deposition. Ground and surface waters bear many more minerals and nutrients, therefore, bogs tend to be oligotrophic, or nutrient poor. The pH of the water and soil in bogs is fairly acidic. Two reasons for bog acidity include: (1) Sphagnum moss acidifies the environment through the production of organic acids and (2) the sulfur reserves in peat are oxidized to acid compounds, such as sulfuric acid. The environment is also oxygen poor. An oxygen poor environment and acidic conditions slow the rate of decomposition by retarding bacterial action. Decomposition in bogs is very slow, proven by the preservation of people and animals in bogs for thousands of years.

Many unique plants have evolved in bogs due to harsh environmental conditions. Sphagnum, cotton grass, orchids, cala lilies, shrubs such as cranberry, heather, leatherleaf, and Labrador tea, trees such as tamaracks and spruce, and insect eating plants such as pitcher plants and sundews are all wonderful examples are unique bog flora. These plants, and many others, have adapted to acidic, waterlogged, and nutrient poor conditions. Here's how they do it:

- Plants deal with waterlogged conditions through several adaptations including (1) the development of large intercellular spaces (aerenchyma or lacunae) for oxygen supply, (2) reduced oxygen consumption, and (3) oxygen leakage from the roots to produce a locally aerobic root environment (Mitsch and Gosselink). Many wetland plants have these adaptations.

- Bog plants have adapted to poor nutrient conditions through (1) evergreen-ness, (2) sclerophylly, or the thickening of the plant epidermis to minimize grazing, (3) uptake of amino acids, and (4) high root biomass. Another well-known adaptation to nutrient deficiency in bogs is the ability of carnivorous plants, such as the northern pitcher plant seen below, to trap and digest insects (Mitsch and Gosselink 2000). Other plants have adapted to oligotrophic environments through symbiotic nitrogen fixation, whereby nitrogen from the air is used by the plants in the absence of nitrogen in the saturated soils. Bog plants, such as bog myrtle and alder develop root nodules that house bacteria capable of fixing nitrogen from the atmosphere, making the nitrogen available to the plants for growth and reproduction (Mitsch and Gosselink 2000).

Northern Pitcher Plant - Here is a closer look at the northern pitcher plant *(Sarracenia purpurea),* also known as the purple pitcher plant. They are named after their rosettes of bronzy, reddish green, pitcher-shaped leaves. These plants also have a large, solitary, purplish red flower on a leafless stalk that rises above their rosettes of leaves. The leaves of these carnivorous plants secrete a substance that lures insects. An insect crawls inside one of the leaves, which is lined with curved hairs. These hairs make escape very difficult. The leaf, pitcherlike in form and function, contains water in its base to drown the insect when it becomes too weak to cling to the interior. After the insect has drowned, enzymes and bacteria within the leaf begin to digest it. The plant readily absorbs the nutrients, especially the nitrogenous compounds.

(Source: F. X. Browne, Inc.)

- The manner in which plants deal with acidic conditions is not fully understood. However, it is believed that some plants, mainly mosses such as Sphagnum, are able to maintain a higher and more stable pH in their living cells than in the surrounding water (Mitsch and Gosselink 2000). Other plants may be able to tolerate the acidic conditions, but their growth is stunted.

Cranberries are a common bog plant found throughout northeastern bogs and along the coast in acidic sandy wetland soils. This plant, specifically the berries that it produces, has great historical and current uses by humans. Long before the Pilgrims arrived in 1620, Native Americans mixed deer meat and mashed cranberries to make pemmican -- a convenience food that kept for long periods of time. The highly acidic nature of the cranberry was the primary mechanism in this type of preservation. The Native Americans also believed that cranberries had medicinal value, and consequently were used by medicine men as an ingredient in poultices to draw poison from arrow wounds. Cranberry juice was a natural dye for rugs, blankets and clothing. The Delaware Indians in New Jersey used the cranberry as a symbol of peace. The cranberry gets its name from Dutch and German settlers, who called it "crane berry." When the vines bloom in the late spring and the flowers' light pink petals twist back, they have a resemblance to the head and bill of a crane. Over time, the name was shortened to cranberry. The cranberry is one of three production fruits native to North America, the other two are blueberry and concord grape.
(Information taken from www.teachervision.com, picture taken from aggie-horticulture.tamu.edu)

Another important point to consider is how flowering plants avoid getting taken over by peat moss. Plants raise their shoot bases by elongating their rhizomes or by developing adventitious roots (Mitsch and Gosselink 2000).

Animal populations are typically low in bogs due to the low productivity and unpalatability of bog vegetation. Large mammals found in Pennsylvania bogs include bear and white tail deer which use wetlands for food and cover. Few reptiles and amphibians inhabit bogs due to acidic conditions. Many birds can be found in bogs during different times of the year. Insects also inhabit bogs, many of which are associated with the pitcher plant (Mitsch and Gosselink 2000).

Peat mined from bogs in the United States has been primarily used for agricultural and horticultural purposes, while other countries have used peat as fuel for electric power. United States' peat resources are estimated at about 310 billion tons, or about 16 percent of the world total (Mitsch and Gosselink 2000).

It is believed that North American bogs accumulate peat at a very slow rate of 100 to 200 cm per 1,000 years (Mitsch and Gosselink 2000), or 0.1 to 0.2 cm per year. Obviously, the accumulation of peat and subsequent formation of a bog is an extremely slow process. It is important to remember that once a bog is mined for its peat, it will no longer function as a bog and will likely return to an open water habitat. Therefore, the protection of our existing bogs is very critical!

FIELD EXERCISE – BOG TRAIL

We are extremely fortunate to have a bog complex right here on the grounds of the Pocono Mountain School District. A boardwalk has been constructed to provide easy access to the upper portion of this bog. Along the boardwalk, several interesting and rare plants and plant communities may be observed. Appendix A contains photographs of most of the bog vegetation species found along the way.

The bog is actually many times larger than the area that is covered by the boardwalk, but the area that is covered explores the most interesting portion and does feature many of the communities that are found throughout the remaining portion.

VERY IMPORTANT: PLEASE TREAD LIGHTLY!!! Bogs are highly sensitive environments due to their saturated, deep mucky soils and the low nutrient availability for supporting plant growth. The best way that you can protect this rare resource is to remain on the boardwalk at all times. It has been known for human footprints to remain noticeable in bogs for several years before being filled-in with peat and vegetation. A serious respect for your environment may not be more critical anywhere on earth.

For this exercise, you will travel as a group with your teacher from the school building to the bog trail head, where you will then enter the bog complex on the boardwalk to observe the bog plants and plant communities that are found along the way. Depending on the time of year and recent weather conditions, the bog may be more or less saturated. Therefore, we would recommend that you wear the proper footwear such as hiking shoes or boots, in the event that you accidentally stray from the boardwalk.

Appendix B contains a full key of all known vegetation within this particular bog. You should use this key to identify the various species and to learn about their unique and interesting characteristics. Surely, you will not recognize most of the species that you will encounter, as most do not grow in other environments. Depending on the time of year, you may see the beautiful flowering parts of many of species; particularly interesting are the white fringed orchid, bog goldenrod, and the cranberries (small and large).

Along the boardwalk, you will encounter several numbered stations. At each station, you should make a list of all vegetation species that you are able to identify, using the data sheets for this exercise found in Appendix D. You will have to look closely to see many of the smaller plants that grow at or near the ground level and to see the unique characteristics necessary to make a positive identification of many species.

While on site, you should discuss with your classmates and your teacher the different characteristics of the bog vegetation. Aside from their natural significance, many of these species have or had very interesting, unique, and special medicinal, religious, culinary, and manufacturing uses. Many of these uses are well described in the numerous references on plants and bogs that are available back in your classroom.

Optional Step #1 – Plant Use Research – Back in the classroom, as a class, discuss each of the plants that you identified along the way and make a list of each and their respective uses. It may be necessary to use the various references to complete this list.

Appendix A

Plant Photographs – Bog Site

Appendix B

Plant Keys – Bog Site

Appendix C

Wetlands Delineation Field Data Sheets

WETLANDS DELINEATION FIELD DATA SHEET

Hydrology:

Present: Yes or No

Indicators:
___ Standing Water
___ Soil Saturation to Surface
___ Soil Saturation between 0-18 inches

___ Mottles in Soil
___ Water Stained Leaves
___ Drift Lines
___ Water Marks
___ Presence of Sphagnum Moss
___ Hummocks/Depressions
___ Buttressed Tree Roots/Trunks

Soils:

Matrix Color: ____

Mottle Color: ____

Hydric Soil: Yes or No

Vegetation:

	Species	Indicator Status
Trees:	________________________________	_______________
	________________________________	_______________
	________________________________	_______________
	________________________________	_______________
	________________________________	_______________
	________________________________	_______________
	________________________________	_______________
Shrubs:	________________________________	_______________
	________________________________	_______________
	________________________________	_______________
	________________________________	_______________
	________________________________	_______________
	________________________________	_______________
	________________________________	_______________
Herbs:	________________________________	_______________
	________________________________	_______________
	________________________________	_______________
	________________________________	_______________
	________________________________	_______________
	________________________________	_______________
	________________________________	_______________

Percent Coverage by Hydrophytes: _______%

Meets Wetlands Criteria (>50% Coverage): Yes or No

Is point within a wetlands area? Yes or No

Appendix D

Bog Site Field Data Sheets

BOG SITE - FIELD DATA SHEET

Point/Station #: ________________

Description of Hydrology: ____
____
____

Description of Soils: ____

Vegetation:

	Species	Indicator Status	Uses
Trees:			
Shrubs:			
Herbs:			
Other:			

Appendix E

Glossary of Terms

GLOSSARY OF TERMS

Active water table - A condition in which the zone of soil saturation fluctuates, resulting in periodic anaerobic soil conditions. Soils with an active water table often contain bright mottles and matrix chromas of 2 or less.

Adaptation - A modification of a species that makes it more fit for existence under the conditions of its environment. These modifications are the result of genetic selection processes.

Adventitious roots - Roots found on plant stems in positions where they normally do not occur.

Aerenchymous tissue - A type of plant tissue in which cells are unusually large and arranged in a manner that results in air spaces in the plant organ. Such tissues are often referred to as spongy and usually provide increased buoyancy.

Aerobic - A situation in which molecular oxygen is a part of the environment.

Alluvial – Of, pertaining to, or composed of sediment deposited by flowing water, as in a river bed, flood plain, or delta.

Anaerobic - A situation in which molecular oxygen is absent (or effectively so) from the environment.

Aquatic roots - Roots that develop on stems above the normal position occupied by roots in response to prolonged inundation.

Aquic moisture regime - A mostly reducing soil moisture regime nearly free of dissolved oxygen due to saturation by ground water or its capillary fringe and occurring at periods when the soil temperature at 19.7 in. is greater than 5 C.

Arched roots - Roots produced on plant stems in a position above the normal position of roots, which serve to brace the plant during and following periods of prolonged inundation.

Areal cover - A measure of dominance that defines the degree to which aboveground portions of plants (not limited to those rooted in a sample plot) cover the ground surface. It is possible for the total areal cover in a community to exceed 100 percent because (a) most plant communities consist of two or more vegetative strata; (b) areal cover is estimated by vegetative layer; and (c) foliage within a single layer may overlap.

Atypical situation - As used herein, this term refers to areas in which one or more parameters (vegetation, soil, and/or hydrology) have been sufficiently altered by recent human activities or natural events to preclude the presence of wetland indicators of the parameter.

Backwater flooding - Situations in which the source of inundation is overbank flooding from a nearby stream.

Basal area - The cross-sectional area of a tree trunk measured in square inches, square centimeters, etc. Basal area is normally measured at 4.5 ft above the ground level and is used as a measure of dominance. The most easily used tool for measuring basal area is a tape marked in square inches. When plotless methods are used, an angle gauge or prism will provide a means for rapidly determining basal area. This term is also applicable to the cross-sectional area of a clumped herbaceous plant, measured at 1.0 in. above the soil surface.

Bench mark - A fixed, more or less permanent reference point or object, the elevation of which is known. The US Geological Survey (USGS) installs brass caps in bridge abutments or otherwise permanently sets bench marks at convenient locations nationwide. The elevations on these marks are referenced to the National Geodetic Vertical Datum (NGVD), also commonly known as mean sea level (MSL). Locations of these bench marks on USGS quadrangle maps are shown as small triangles. However, the marks are sometimes destroyed by construction or vandalism. The existence of any bench mark should be field verified before planning work that relies on a particular reference point. The USGS and/or local state surveyor's office can provide information on the existence, exact location, and exact elevation of bench marks.

Biennial - An event that occurs at 2-year intervals.

Buried soil - A once-exposed soil now covered by an alluvial, loessal, or other deposit (including man-made).

Canopy layer - The uppermost layer of vegetation in a plant community. In forested areas, mature trees comprise the canopy layer, while the tallest herbaceous species constitute the canopy layer in a marsh.

Capillary fringe - A zone immediately above the water table (zero gauge pressure) in which water is drawn upward from the water table by capillary action.

Chemical reduction - Any process by which one compound or ion acts as an electron donor. In such cases, the valence state of the electron donor is decreased.

Chroma - The relative purity or saturation of a color; intensity of distinctive hue as related to grayness; one of the three variables of color.

Comprehensive wetland determination - A type of wetland determination that is based on the strongest possible evidence, requiring the collection of quantitative data.

Concretion - A local concentration of chemical compounds (e.g. calcium carbonate, iron oxide) in the form of a grain or nodule of varying size, shape, hardness, and color. Concretions of significance in hydric soils are usually iron and/or manganese oxides occurring at or near the soil surface, which develop under conditions of prolonged soil saturation.

Contour - An imaginary line of constant elevation on the ground surface. The corresponding line on a map is called a "contour line."

Criteria - Standards, rules, or tests on which a judgment or decision may be based.

Deepwater aquatic habitat - Any open water area that has a mean annual water depth >>6.6 ft, lacks soil, and/or is either unvegetated or supports only floating or submersed macrophytes.

Density - The number of individuals of a species per unit area.

Detritus - Minute fragments of plant parts found on the soil surface. When fused together by algae or soil particles, this is an indicator that surface water was recently present.

Diameter at breast height (DBH) - The width of a plant stem as measured at 4.5 ft above the ground surface.

Dike - A bank (usually earthen) constructed to control or confine water.

Dominance - As used herein, a descriptor of vegetation that is related to the standing crop of a species in an area, usually measured by height, areal cover, or basal area (for trees).

Dominant species - As used herein, a plant species that exerts a controlling influence on or defines the character of a community.

Drained - A condition in which ground or surface water has been reduced or eliminated from an area by artificial means.

Drift line - An accumulation of debris along a contour (parallel to the water flow) that represents the height of an inundation event.

Duration (inundation/soil saturation) - The length of time during which water stands at or above the soil surface (inundation), or during which the soil is saturated. As used herein, duration refers to a period during the growing season.

Ecological tolerance - The range of environmental conditions in which a plant species can grow.

Emergent plant - A rooted herbaceous plant species that has parts extending above a water surface.

Field capacity - The percentage of water remaining in a soil after it has been saturated and after free drainage is negligible.

Fill material - Any material placed in an area to increase surface elevation.

Flooded - A condition in which the soil surface is temporarily covered with flowing water from any source, such as streams overflowing their banks, runoff from adjacent or surrounding slopes, inflow from high tides, or any combination of sources.

Flora - A list of all plant species that occur in an area.

Frequency (inundation or soil saturation) - The periodicity of coverage of an area by surface water or soil saturation. It is usually expressed as the number of years (e.g. 50 years) the soil is inundated or saturated at least once each year during part of the growing season per 100 years or as a 1-, 2-, 5-year, etc., inundation frequency.

Frequency (vegetation) - The distribution of individuals of a species in an area. It is quantitatively expressed as @TABLE ITEM = Number of samples containing species A<R> Total number of samples x 100. More than one species may have a frequency of 100 percent within the same area.

Frequently flooded - A flooding class in which flooding is likely to occur often under normal weather conditions (more than 50-percent chance of flooding in any year or more than 50 times in 100 years).

Gleyed - A soil condition resulting from prolonged soil saturation, which is manifested by the presence of bluish or greenish colors through the soil mass or in mottles (spots or streaks) among other colors. Gleying occurs under reducing soil conditions resulting from soil saturation, by which iron is reduced predominantly to the ferrous state.

Ground water - That portion of the water below the ground surface that is under greater pressure than atmospheric pressure.

Growing season - The portion of the year when soil temperatures at 19.7 inches below the soil surface are higher than biologic zero (5 C) (US Department o f Agriculture - Soil Conservation

Service 1985). For ease of determination this period can be approximated by the number of frost-free days (US Department of the Interior 1970).

Habitat - The environment occupied by individuals of a particular species, population, or community.

Headwater flooding - A situation in which an area becomes inundated directly by surface runoff from upland areas.

Herb - A nonwoody individual of a macrophytic species. In this manual, seedlings of woody plants (including vines) that are less than 3.2 ft in height are considered to be herbs.

Herbaceous layer - Any vegetative stratum of a plant community that is composed predominantly of herbs.

Histic epipedon - An 8- to 16-in. soil layer at or near the surface that is saturated for 30 consecutive days or more during the growing season in most years and contains a minimum of 20 percent organic matter when no clay is present or a minimun of 30 percent organic matter when 60 percent or greater clay is present.

Histosols - An order in soil taxonomy composed of organic soils that have organic soil materials in more than half of the upper 80 cm or that are of any thickness if directly overlying bedrock.

Homogeneous vegetation - A situation in which the same plant species association occurs throughout an area.

Hue - A characteristic of color that denotes a color in relation to red, yellow, blue, etc; one of the three variables of color. Each color chart in the Munsell Color Book (Munsell Color 1975) consists of a specific hue.

Hydric soil - A soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation (US Department of Agriculture-Soil Conservation Service 1985). Hydric soils that occur in areas having positive indicators of hydrophytic vegetation and wetland hydrology are wetland soils.

Hydric soil condition - A situation in which characteristics exist that are associated with soil development under reducing conditions.

Hydrologic regime - The sum total of water that occurs in an area on average during a given period.

Hydrologic zone - An area that is inundated or has saturated soils within a specified range of frequency and duration of inundation and soil saturation.

Hydrology - The science dealing with the properties, distribution, and circulation of water.

Hydrophyte - Any macrophyte that grows in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content; plants typically found in wet habitats.

Hydrophytic vegetation - The sum total of macrophytic plant life growing in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content. When hydrophytic vegetation comprises a community where indicators of hydric soils and wetland hydrology also occur, the area has wetland vegetation.

Hypertrophied lenticels - An exaggerated (oversized) pore on the surface of stems of woody plants through which gases are exchanged between the plant and the atmosphere. The enlarged lenticels serve as a mechanism for increasing oxygen to plant roots during periods of inundation and/or saturated soils.

Importance value - A quantitative term describing the relative influence of a plant species in a plant community, obtained by summing any combination of relative frequency, relative density, and relative dominance.

Indicator - As used in this manual, an event, entity, or condition that typically characterizes a prescribed environment or situation; indicators determine or aid in determining whether or not certain stated circumstances exist.

Indicator status - One of the categories (e.g. OBL) that describes the estimated probability of a plant species occurring in wetlands.

Intercellular air space - A cavity between cells in plant tissues, resulting from variations in cell shape and configuration. Aerenchymous tissue (a morphological adaptation found in many hydrophytes) often has large intercellular air spaces.

Inundation - A condition in which water from any source temporarily or permanently covers a land surface.

Levee - A natural or man-made feature of the landscape that restricts movement of water into or through an area.

Liana - As used in this manual, a layer of vegetation in forested plant communities that consists of woody vines. The term may also be applied to a given species.

Limit of biological activity - With reference to soils, the zone below which conditions preclude normal growth of soil organisms. This term often is used to refer to the temperature (5 C) in a soil below which metabolic processes of soil microorganisms, plant roots, and animals are negligible.

Long duration (flooding) - A flooding class in which the period of inundation for a single event ranges from 7 days to 1 month.

Macrophyte - Any plant species that can be readily observed without the aid of optical magnification. This includes all vascular plant species and mosses (e.g., Sphagnum spp.), as well as large algae (e.g. Chara spp., kelp).

Macrophytic - A term referring to a plant species that is a macrophyte.

Major portion of the root zone. The portion of the soil profile in which more than 50 percent of plant roots occur. In wetlands, this usually constitutes the upper 12 in. of the profile.

Man-induced wetland - Any area that develops wetland characteristics due to some activity (e.g., irrigation) of man.

Mapping unit - As used in this manual, some common characteristic of soil, vegetation, and/or hydrology that can be shown at the scale of mapping for the defined purpose and objectives of a survey.

Mean sea level - A datum, or "plane of zero elevation," established by averaging all stages of oceanic tides over a 19-year tidal cycle or "epoch." This plane is corrected for curvature of the earth and is the standard reference for elevations on the earth's surface. The correct term for mean sea level is the National Geodetic Vertical Datum (NGVD).

Mesophytic - Any plant species growing where soil moisture and aeration conditions lie between extremes. These species are typically found in habitats with average moisture conditions, neither very dry nor very wet.

Metabolic processes - The complex of internal chemical reactions associated with life-sustaining functions of an organism.

Method - A particular procedure or set of procedures to be followed.

Mineral soil - A soil consisting predominantly of, and having its properties determined predominantly by, mineral matter usually containing less than 20 percent organic matter.

Morphological adaptation - A feature of structure and form that aids in fitting a species to its particular environment (e.g. buttressed base, adventitious roots, aerenchymous tissue).

Mottles - Spots or blotches of different color or shades of color interspersed within the dominant color in a soil layer, usually resulting from the presence of periodic reducing soil conditions.

Muck - Highly decomposed organic material in which the original plant parts are not recognizable.

Multitrunk - A situation in which a single individual of a woody plant species has several stems.

Nonhydric soil - A soil that has developed under predominantly aerobic soil conditions. These soils normally support mesophytic or xerophytic species.

Nonwetland - Any area that has sufficiently dry conditions that indicators of hydrophytic vegetation, hydric soils, and/or wetland hydrology are lacking. As used in this manual, any area that is neither a wetland, a deepwater aquatic habitat, nor other special aquatic site.

Organic pan - A layer usually occurring at 12 to 30 inches below the soil surface in coarse-textured soils, in which organic matter and aluminum (with or without iron) accumulate at the point where the top of the water table most often occurs. Cementing of the organic matter slightly reduces permeability of this layer.

Organic soil - A soil is classified as an organic soil when it is: (1) saturated for prolonged periods (unless artificially drained) and has more than 30 percent organic matter if the mineral fraction is more than 50 percent clay, or more than 20 percent organic matter if the mineral fraction has no clay; or (2) never saturated with water for more than a few days and having more than 34 percent organic matter.

Overbank flooding - Any situation in which inundation occurs as a result of the water level of a stream rising above bank level.

Oxidation-reduction process - A complex of biochemical reactions in soil that influences the valence state of component elements and their ions. Prolonged soil saturation during the growing season elicits anaerobic conditions that shift the overall process to a reducing condition.

Oxygen pathway - The sequence of cells, intercellular spaces, tissues, and organs, through which molecular oxygen is transported in plants. Plant species having pathways for oxygen transport to the root system are often adapted for life in saturated soils.

Parameter - A characteristic component of a unit that can be defined. Vegetation, soil, and hydrology are three parameters that may be used to define wetlands.

Parent material - The unconsolidated and more or less weathered mineral or organic matter from which a soil profile develops.

Ped - A unit of soil structure (e.g. aggregate, crumb, prism, block, or granule) formed by natural processes.

Peraquic moisture regime - A soil condition in which a reducing environment always occurs due to the presence of ground water at or near the soil surface.

Periodically - Used herein to define detectable regular or irregular saturated soil conditions or inundation, resulting from ponding of ground water, precipitation, overland flow, stream flooding, or tidal influences that occur(s) with hours, days, weeks, months, or even years between events.

Permeability - A soil characteristic that enables water or air to move through the profile, measured as the number of inches per hour that water moves down ward through the saturated soil. The rate at which water moves through the least permeable layer governs soil permeability.

Physiognomy - A term used to describe a plant community based on the growth habit (e.g., trees, herbs, lianas) of the dominant species.

Physiological adaptation - A feature of the basic physical and chemical activities that occurs in cells and tissues of a species, which results in it being better fitted to its environment (e.g. ability to absorb nutrients under low oxygen tensions).

Plant community - All of the plant populations occurring in a shared habitat or environment.

Plant cover - See areal cover.

Pneumatophore - Modified roots that may function as a respiratory organ in species subjected to frequent inundation or soil saturation (e.g., cypress knees).

Ponded - A condition in which water stands in a closed depression. Water may be removed only by percolation, evaporation, and/or transpiration.

Poorly drained - Soils that commonly are wet at or near the surface during a sufficient part of the year that field crops cannot be grown under natural conditions. Poorly drained conditions are caused by a saturated zone, a layer with low hydraulic conductivity, seepage, or a combination of these conditions.

Population - A group of individuals of the same species that occurs in a given area.

Positive wetland indicator - Any evidence of the presence of hydrophytic vegetation, hydric soil, and/or wetland hydrology in an area.

Prevalent vegetation - The plant community or communities that occur in an area during a given period. The prevalent vegetation is characterized by the dominant macrophytic species that comprise the plant community.

Quantitative - A precise measurement or determination expressed numerically.

Range - As used herein, the geographical area in which a plant species is known to occur.

Redox potential - A measure of the tendency of a system to donate or accept electrons, which is governed by the nature and proportions of the oxidizing and reducing substances contained in the system.

Reducing environment - An environment conducive to the removal of oxygen and chemical reduction of ions in the soils.

Relative density - A quantitative descriptor, expressed as a percent, of the relative number of individuals of a species in an area; it is calculated by @TABLE ITEM = Number of individuals of species A <R>Total number of individuals of all species x 100

Relative dominance - A quantitative descriptor, expressed as a percent, of the relative size or cover of individuals of a species in an area; it is calculated by @TABLE ITEM = Amount<$F The "amount" of a species may be based on percent areal cover, basal area, or height.> of species A <R>Total amount of all species x 100

Relative frequency - A quantitative descriptor, expressed as a percent, of the relative distribution of individuals of a species in an area; it is calculated by @TABLE ITEM = Frequency of species A <R>Total frequency of all species x 100

Relief - The change in elevation of a land surface between two points; collectively, the configuration of the earth's surface, including such features as hills and valleys.

Reproductive adaptation - A feature of the reproductive mechanism of a species that results in it being better fitted to its environment (e.g. ability for seed germination under water).

Respiration - The sum total of metabolic processes associated with conversion of stored (chemical) energy into kinetic (physical) energy for use by an organism.

Rhizome – A rootlike, usually horizontal stem growing under or along the ground that sends out roots from its lower surface and leaves or shoots from its upper surface.

Rhizosphere - The zone of soil in which interactions between living plant roots and microorganisms occur.

Root zone - The portion of a soil profile in which plant roots occur.

Routine wetland determination - A type of wetland determination in which office data and/or relatively simple, rapidly applied onsite methods are employed to determine whether or not an area is a wetland. Most wetland determinations are of this type, which usually does not require collection of quantitative data.

Sample plot - An area of land used for measuring or observing existing conditions.

Sapling/shrub - A layer of vegetation composed of woody plants <<3.0 in. in diameter at breast height but greater than 3.2 ft in height, exclusive of woody vines.

Saturated soil conditions - A condition in which all easily drained voids (pores) between soil particles in the root zone are temporarily or permanently filled with water to the soil surface at pressures greater than atmospheric.

Soil - Unconsolidated mineral and organic material that supports, or is capable of supporting, plants, and which has recognizable properties due to the integrated effect of climate and living matter acting upon parent material, as conditioned by relief over time.

Soil horizon - A layer of soil or soil material approximately parallel to the land surface and differing from adjacent genetically related layers in physical, chemical, and biological properties or characteristics (e.g. color, structure, texture, etc.).

Soil matrix - The portion of a given soil having the dominant color. In most cases, the matrix will be the portion of the soil having more than 50 percent of the same color.

Soil permeability - The ease with which gases, liquids, or plant roots penetrate or pass through a layer of soil.

Soil phase - A subdivision of a soil series having features (e.g. slope, surface texture, and stoniness) that affect the use and management of the soil, but which do not vary sufficiently to differentiate it as a separate series. These are usually the basic mapping units on detailed soil maps produced by the Soil Conservation Service.

Soil pore - An area within soil occupied by either air or water, resulting from the arrangement of individual soil particles or peds.

Soil profile - A vertical section of a soil through all its horizons and extending into the parent material.

Soil series - A group of soils having horizons similar in differentiating characteristics and arrangement in the soil profile, except for texture of the surface horizon.

Soil structure - The combination or arrangement of primary soil particles into secondary particles, units, or peds.

Soil surface - The upper limits of the soil profile. For mineral soils, this is the upper limit of the highest (A1) mineral horizon. For organic soils, it is the upper limit of undecomposed, dead organic matter.

Soil texture - The relative proportions of the various sizes of particles in a soil.

Somewhat poorly drained - Soils that are wet near enough to the surface or long enough that planting or harvesting operations or crop growth is markedly restricted unless artificial drainage is provided. Somewhat poorly drained soils commonly have a layer with low hydraulic conductivity, wet conditions high in the profile, additions of water through seepage, or a combination of these conditions.

Stilted roots - Aerial roots arising from stems (e.g., trunk and branches), presumably providing plant support (e.g., <MI>Rhizophora mangle<D>).

Stooling - A form of asexual reproduction in which new shoots are produced at the base of senescing stems, often resulting in a multi-trunk growth habit.

Stratigraphy - Features of geology dealing with the origin, composition, distribution, and succession of geologic strata (layers).

Substrate - The base or substance on which an attached species is growing.

Surface water - Water present above the substrate or soil surface.

Tidal - A situation in which the water level periodically fluctuates due to the action of lunar and solar forces upon the rotating earth.

Topography - The configuration of a surface, including its relief and the position of its natural and man-made features.

Transect - As used herein, a line on the ground along which observations are made at some interval.

Transition zone - The area in which a change from wetlands to nonwetlands occurs. The transition zone may be narrow or broad.

Transpiration - The process in plants by which water vapor is released into the gaseous environment, primarily through stomata.

Tree - A woody plant 3.0 in. in diameter at breast height, regardless of height (exclusive of woody vines).

Typical - That which normally, usually, or commonly occurs.

Typically adapted - A term that refers to a species being normally or commonly suited to a given set of environmental conditions, due to some feature of its morphology, physiology, or reproduction.

Unconsolidated parent material - Material from which a soil develops, usually formed by weathering of rock or placement in an area by natural forces (e.g. water, wind, or gravity).

Under normal circumstances - As used in the definition of wetlands, this term refers to situations in which the vegetation has not been substantially altered by man's activities.

Uniform vegetation - As used herein, a situation in which the same group of dominant species generally occurs throughout a given area.

Upland - As used herein, any area that does not qualify as a wetland because the associated hydrologic regime is not sufficiently wet to elicit development of vegetation, soils, and/or hydrologic characteristics associated with wetlands. Such areas occurring within floodplains are more appropriately termed nonwetlands.

Value (soil color) - The relative lightness or intensity of color, approximately a function of the square root of the total amount of light reflected from a surface; one of the three variables of color.

Vegetation - The sum total of macrophytes that occupy a given area.

Vegetation layer - A subunit of a plant community in which all component species exhibit the same growth form (e.g., trees, saplings/shrubs, herbs).

Very long duration (flooding) - A duration class in which the length of a single inundation event is greater than 1 month.

Very poorly drained - Soils that are wet to the surface most of the time. These soils are wet enough to prevent the growth of important crops (except rice) unless artificially drained.

Watermark - A line on a tree or other upright structure that represents the maximum static water level reached during an inundation event.

Water table - The upper surface of ground water or that level below which the soil is saturated with water. It is at least 6 in. thick and persists in the soil for more than a few weeks.

Wetlands - 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.

Wetland boundary - The point on the ground at which a shift from wetlands to nonwetlands or aquatic habitats occurs. These boundaries usually follow contours.

Wetland determination - The process or procedure by which an area is adjudged a wetland or nonwetland.

Wetland hydrology - The sum total of wetness characteristics in areas that are inundated or have saturated soils for a sufficient duration to support hydrophytic vegetation.

Wetland plant association - Any grouping of plant species that recurs wherever certain wetland conditions occur.

Wetland soil - A soil that has characteristics developed in a reducing atmosphere, which exists when periods of prolonged soil saturation result in anaerobic conditions. Hydric soils that are sufficiently wet to support hydrophytic vegetation are wetland soils.

Wetland vegetation - The sum total of macrophytic plant life that occurs in areas where the frequency and duration of inundation or soil saturation produce permanently or periodically saturated soils of sufficient duration to exert a controlling influence on the plant species present. As used herein, hydrophytic vegetation occurring in areas that also have hydric soils and wetland hydrology may be properly referred to as wetland vegetation.

Woody vine - See liana.

Xerophytic - A plant species that is typically adapted for life in conditions where a lack of water is a limiting factor for growth and/or reproduction. These species are capable of growth in extremely dry conditions as a result of morphological, physiological, and/or reproductive adaptations.