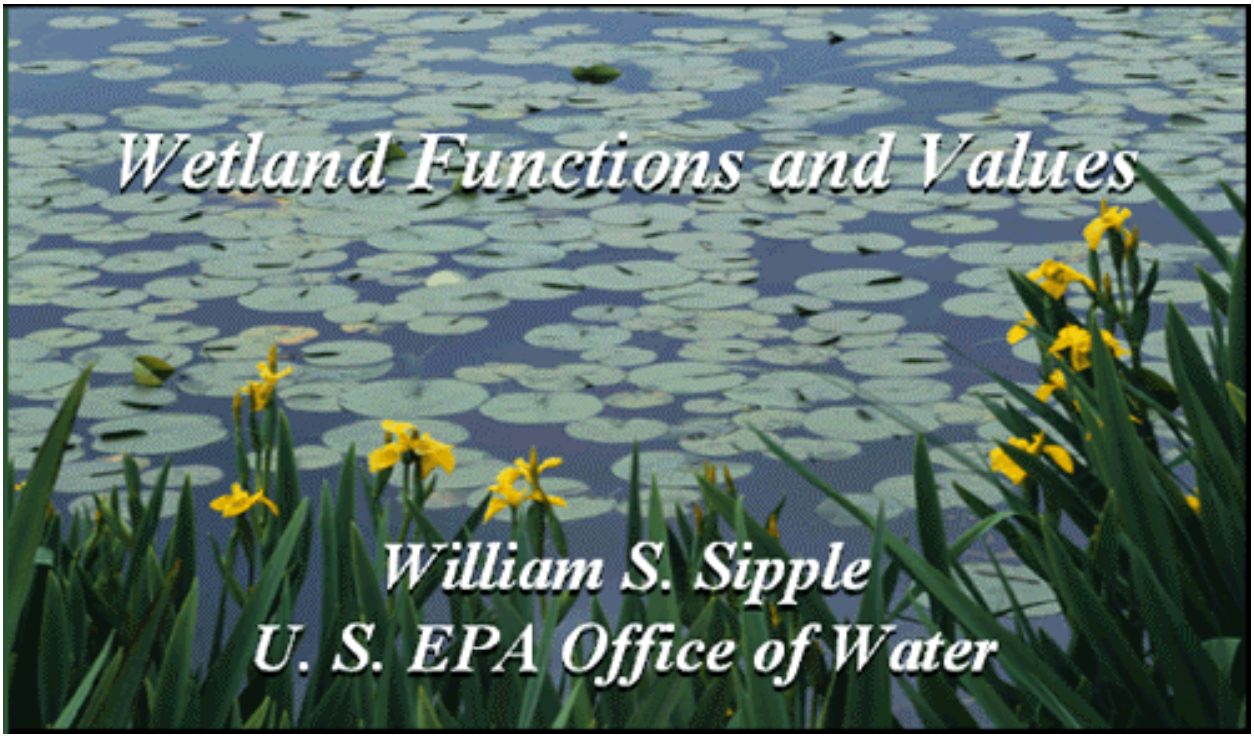

NOTICE: This PDF file was adapted from an on-line training module of the EPA's ***Watershed Academy Web***, found at http://www.epa.gov/watertrain. To the extent possible, it contains the same material as the on-line version. Some interactive parts of the module had to be reformatted for this non-interactive text presentation. Review questions are included at the end of the file as a self-test.

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Introduction

This module is about the benefits, or values, that wetlands provide. These values arise from the many ecological functions associated with wetlands. These societal benefits and ecological functions are discussed in detail below, and in some instances resource-specific or site-specific examples are presented. Much of the material was drawn from sources that are cited in the Acknowledgments, References, and World Wide Web Sources sections following the body of the text. All the Wetland functions and values discussed in this module appear in ***red, bold italics***.

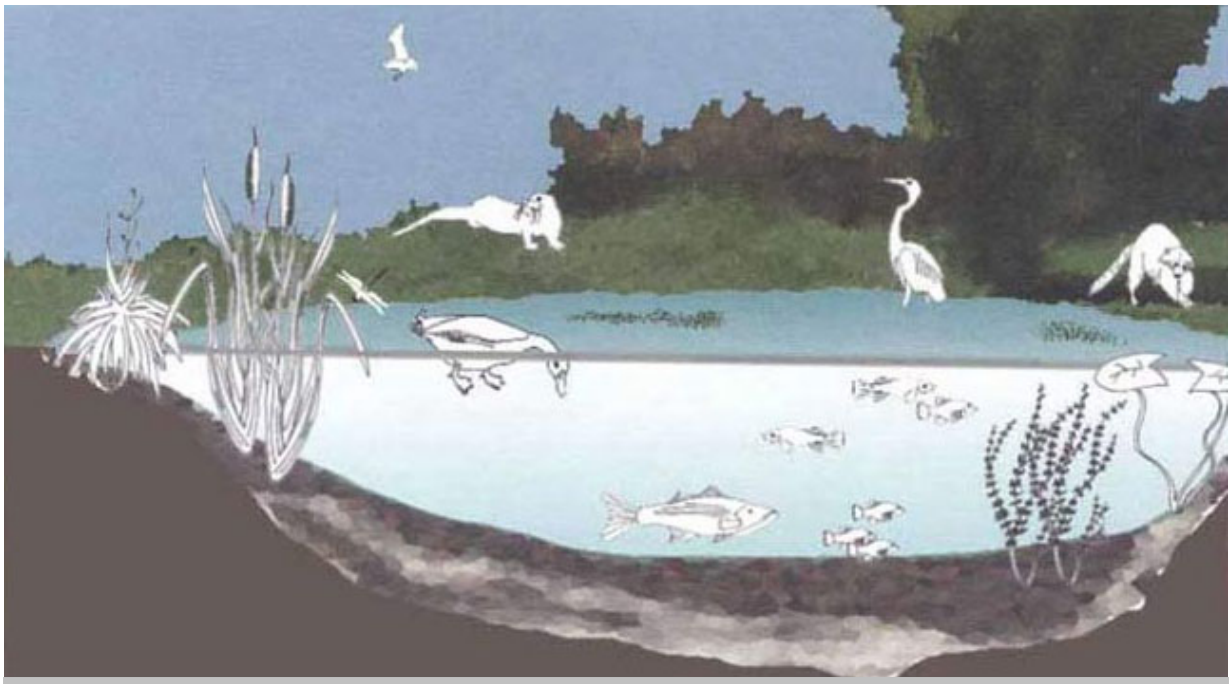
Only relatively recently have we begun to understand the many ecological functions associated with wetlands and their significance to society. Wetlands were once considered useless, disease-ridden places (e.g., malaria and yellow fever) that were to be avoided. We now realize that wetlands provide many benefits to society – such as ***fish and wildlife habitats, natural water quality improvement, flood storage,shoreline erosion protection, opportunities for recreation and aesthetic appreciation, and natural products for our use at little or no cost***. Protecting wetlands can, in turn, ***protect our health and safety by reducing flood damage and preserving water quality*.**

Wetlands are among the most productive ecosystems in the world, comparable to rain forests and coral reefs. They also are a ***source of substantial biodiversity*** in supporting numerous species from all of the major groups of organisms – from microbes to mammals. Physical and chemical features such as climate,topography (landscape shape), geology, nutrients, and hydrology (the quantity and movement of water) help to determine the plants and animals that inhabit various wetlands. Wetlands in Texas, North Carolina, and Alaska, for example, differ substantially from one another because of their varying physical and biotic nature.

Wetland Functions and Values

Wetlands can be thought of as "biological supermarkets." They ***produce great quantities of food*** that attract many animal species (Figure 1). The complex, dynamic feeding relationships among the organisms inhabiting wetland environments are referred to as food webs. The combination of shallow water, high levels of inorganic nutrients, and high rates of primary productivity (the synthesis of new plant biomass through photosynthesis) in many wetlands is ideal for the ***development of organisms that form the base of the food web*** -- for example, many species of insects, mollusks, and crustaceans (Figure 2). Some animals consume the above-ground live vegetation (herbivore-carnivore food web); others utilize the dead plant leaves and stems, which break down in the water to form small, nutrient-enriched particles of organic material called detritus (Figure 3).

As the plant material continues to break down into smaller and smaller particles, it becomes increasingly enriched (nutritious) due to bacterial, fungal and protozoan activity. This enriched proteinaceous material, including the various microbes that colonize it, feeds many small aquatic invertebrates and small fish (Figure 4). Many of these invertebrates and fish then serve as food for larger predatory amphibians, reptiles, fish, birds, and mammals (Figure 5). Numerous species of ***birds and mammals rely on wetlands for food, water, and shelter, especially while migrating and breeding***.



Wetlands support a rich food web, from Microscopic algae and submerged vascular plants to great blue herons and otters.

Figure 1 **Photo credit: Mary Sharp**

Figure 2 **Photo credit: Bill Sipple**

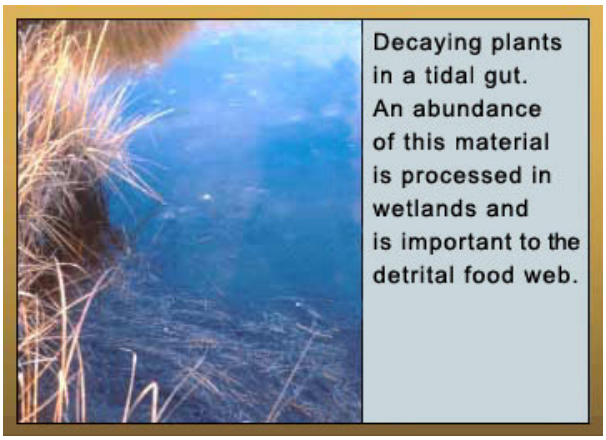


Figure 3 **Photo credit: Bill Sipple**

Figure 4 **Photo credit: Joel Rogers**

Figure 5 **Photo credit: Bill Sipple**

Many animals need wetlands for part or all of their life-cycles. In late winter and early spring, for example, adult tiger salamanders migrate from uplands to vernal pools for ***breeding and egg deposition*** (Figure 6). The gilled larvae resulting from their fertilized eggs then develop further, eventually producing lungs. Therefore, they must leave the vernal pools for adjacent upland, generally forested, habitat as adults, where they are mainly subterranean. In this instance, a complex of wetlands within a forest matrix is important as the life-cycle requirements of the tiger salamanders change. Thus, for the existence of the tiger salamander, both wetlands and uplands are important and essential. This can similarly be said of other amphibians like the spotted salamander as well as many other animals.

Figure 6 **Photo credit: Matt Perry**

A watershed is a geographic area in which water, sediments, and dissolved materials drain from higher elevations to a common low-lying outlet or basin at a point on a larger stream, lake, underlying aquifer, or estuary.

Figure 7

The diversity of habitats in a watershed (Figure 7) or larger landscape unit is also important for other ecological functions associated with wetlands. One such function, ***biogeochemical cycling***, involves the biologic, physical, and chemical transformations of various nutrients within the biota, soils, water, and air. Wetlands are very important in this regard, particularly relating to nitrogen, sulfur, and phosphorous. A good example of this occurs in anaerobic (non-oxygenated) and chemically reduced wetland soils and the muddy sediments of aquatic habitats like estuaries, lakes, and streams, which support microbes that function in nitrogen and sulfur cycling. Upon death and decay, the nitrogen and sulfur in plant and animal biomass is released through mineralization. Much of this is eventually transformed into gaseous forms and released into the atmosphere, where it once again becomes available to certain plants and their associated nitrogen-fixing bacteria in the soil. This is literally a major defense for mud, since it is the anaerobic and chemically reducing conditions in the substrate, in conjunction with various microbes, that ensure the gaseous release of the nitrogen and sulfur. On the other hand, phosphorous does not have a gaseous form, but vascular plants in wetlands transform inorganic forms of phosphorus (that might otherwise be shunted into undesirable algal blooms) into organic forms in their biomass as they grow. Thus, ***wetlands provide the conditions needed for the removal of both nitrogen and phosphorus from surface water.***

Scientists also point out that ***atmospheric maintenance*** is an additional wetland function. Wetlands ***store carbon within their live and preserved (peat) plant biomass instead of releasing it to the atmosphere as carbon dioxide, a greenhouse gas*** affecting global climates. Therefore, ***wetlands world-wide help to moderate global climatic conditions***. On the other hand, filling, clearing and draining wetlands releases carbon dioxide.

Wetlands also play an important role in the ***hydrologic cycle*** -- a cycle we all experience quite readily, for example, with the precipitation from a thunderstorm and the evaporation of ponded water from a puddle or bird bath. ***Wetlands can receive, store, and release water in various ways*** -- physically through ground water and surface water, as well as biologically through transpiration by vegetation -- and therefore function in this very important global cycle.

Some specific examples of the benefits of wetlands to society are elaborated below. In addition, since wetlands play an integral role in the ecology of watersheds, two related Watershed Academy Web modules, Watershed Ecology (http://www.epa.gov/watertrain/ecology/) and Wetlands and Watersheds (under development), are also pertinent. These additional modules will be very helpful in understanding the ecology of watersheds and the role of wetlands in a watershed context.

Habitat for Fish, Wildlife, and Plants

Fish and wildlife use wetlands to varying degrees depending upon the species involved. Some live only in wetlands for their entire lives; others require wetland habitat for at least part of their life cycle; still others use wetlands much less frequently, generally for feeding. In other words, for many species wetlands are primary habitats, meaning that these species depend on them for survival; for others, wetlands provide important seasonal habitats, where food, water, and cover are plentiful (Figure 8).

Figure 8 **Photo credit: Bill Sipple**

For example, wetlands are essentially the permanent habitat of the beaver, muskrat, wood duck (Figure 9), clapper rail, mud minnow, wild rice (Figure 10), cattail, broadleaf arrowhead (Figure 11) and swamp rose. For other species, such as largemouth bass, chain pickerel, woodcock, hooded warbler, otter (Figure 12), black bear, raccoon, and meadow vole, wetlands provide important food, water, shelter, or nesting habitat.

Wood ducks

Figure 9 **Photo credit: Tim McCabe**

Wild rice, a wildlife food as well as a natural wetland product for human consumption.

Figure 10

Broadleaf arrowhead

Figure 11

River otter

Figure 12
Photo credit: Texas Parks and Wildlife Department

Figure 13 **Photo credit: Herb Stein**

Numerous birds -- including certain shorebirds, wading birds (Figure 13), and raptors, and many songbirds (Figure 14) -- feed, nest, and/or raise their young in wetlands. Migratory waterfowl, including ducks, geese, and swans, use coastal and inland wetlands as resting, feeding, breeding, or nesting grounds for at least part of the year. For example, in the Chesapeake Bay Region (a major wintering area for waterfowl), coastal wetlands supported an annual average of nearly 79,000 wintering black ducks over a 45-year period (1950-1994); over the same period, it supported an annual average of about 14,000 wintering pintails. Most of these ducks rely on the prairie potholes (depressional wetlands) in upper mid-western United States and adjacent Canada and interior wetlands in northeastern North America for nesting. Indeed, an international agreement to protect wetlands of international importance was developed because some species of migratory birds are completely dependent on certain wetlands and would become extinct if those wetlands were destroyed (read on for the economic values associated with these resources.)

Figure 14 **Photo credit: Tom Blagden, Jr.**

Figure 15 **Photo credit: John Taylor**

The U.S. Fish and Wildlife Service estimates that up to ***43% of the federally threatened and endangered species rely directly or indirectly on wetlands for their survival*** (e.g., the wood stork, Florida panther, whooping crane, swamp pink, and Canby's dropwort). Many others use wetlands at some point in their lives (Figure 15).

Because they produce so much plant biomass and invertebrate life, ***estuaries and their coastal marshes serve as important nursery areas*** for the young of many game (recreational) and

commercial fish and shellfish. Menhaden, flounder (Figure 16), sea trout, spot, croaker, and striped bass are among the more familiar fish that depend on coastal wetlands. Such areas are also critical nursery habitat for young commercial shrimp along the Southeast and Gulf Coasts. Freshwater fish, such as the chain pickerel and northern pike (Figure 17), use well-flooded or ponded wetlands as breeding and nursery areas. Some fish, like the brown bullhead and mud minnow, even subsist in wetlands that have natural low dissolved oxygen concentrations that unadapted species cannot endure. ***In the Pacific Northwest, some wetlands release cooler water to salmon-bearing streams and rivers***; in places this is critical to the health of coldwater fish populations.

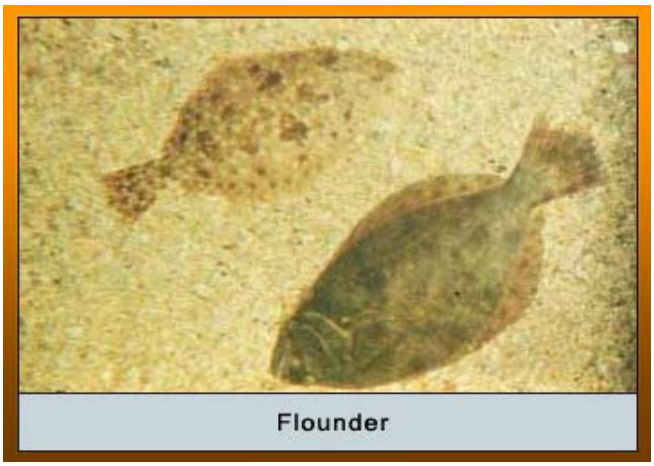


Figure 16 **Photo credit: EPA Region IV**

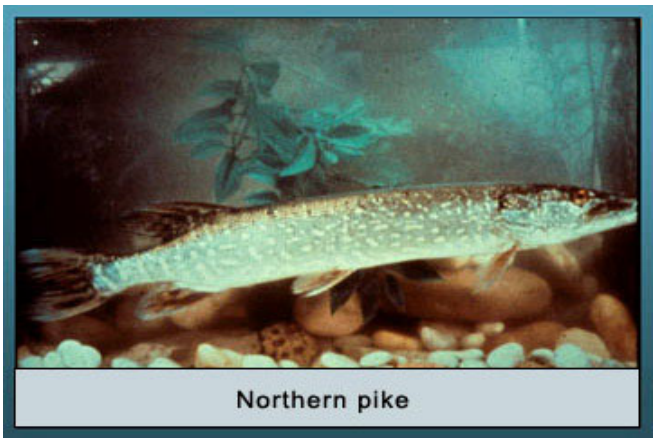


Figure 17

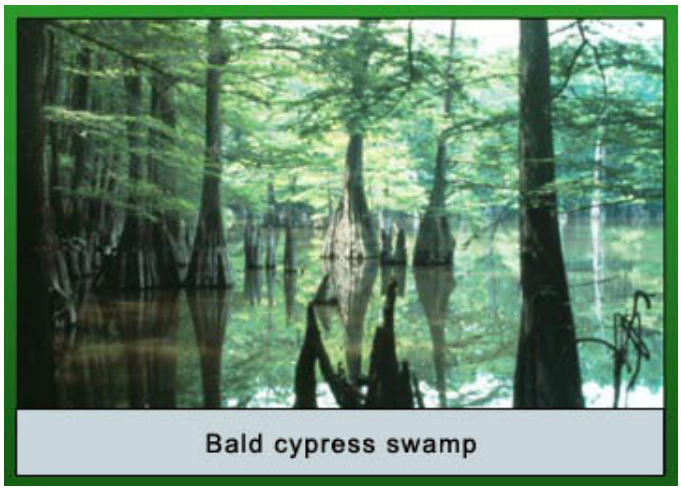


Figure 18 **Photo credit: Todd Votteler**

Improving Water Quality and Hydrology

Wetlands are valuable to us because they greatly influence the flow and quality of water (Figure 18). They help ***improve water quality, including that of drinking water, by intercepting surface runoff and removing or retaining inorganic nutrients, processing organic wastes, and reducing suspended sediments*** before they reach open water. For example, as the runoff water passes through wetlands, they retain or process excess nitrogen and phosphorus, decompose organic pollutants, and trap suspended sediments that would otherwise clog waterways and affect fish and amphibian egg development.

In performing this filtering function, wetlands save us a great deal of money. A 1990 study showed that, the Congaree Bottomland Hardwood Swamp in South Carolina, removes a quantity

of pollutants that would be equivalent to that removed annually by a $5 million waste water treatment plant. Another study at a 2,500 acre wetland in Georgia, indicated that it saves $1 million in water pollution abatement costs annually. ***Wetlands also reduce environmental problems, such as algal blooms, dead zones, and fish kills, that are generally associated with excess nutrient loadings***. However, the capacity of wetlands to function this way is not unlimited, and too much surface runoff carrying sediments, nutrients, and other pollutants can degrade wetlands and thus the societal services they provide.

In addition to improving water quality through filtering, ***some wetlands maintain stream flow during dry periods; others replenish groundwater***. Many Americans, of course, depend on groundwater for drinking. The Floridian aquifer system, for instance, is one of the more productive ground water sources in the United States. It occurs across the entire state of Florida, and into southern Georgia, and portions of South Carolina and Alabama. This huge subsurface reservoir produces some of the cleanest water in the nation. Its primary source is rainwater that filters through hundreds of feet of sand and rock. One calculation for 5-acre Florida cypress swamp recharging groundwater was that, if 80 percent of swamp was drained, available ground water would be reduced by an estimated 45 percent.

Flood Protection

Because of their low topographic position relative to uplands (e.g., isolated depressions, floodplains), ***wetlands store and slowly release surface water, rain, snowmelt, groundwater and flood waters.*** *Trees and other* ***wetland vegetation also impede the movement of flood waters and distribute them more slowly over floodplains*** (Figure 18 and figure 19 on the next page). This combined water storage and slowing action ***lowers flood heights and reduces erosion downstream and on adjacent lands.*** It also helps ***reduce floods and prevents waterlogging of agricultural lands***. Wetlands within and downstream of urban areas are particularly valuable in this regard, counteracting the greatly increased rate and volume of surface-water runoff from pavement and buildings.

Figure 18 **Photo credit: Bill Sipple**

Preserving and restoring wetlands, together with other water retention, can often provide the level of flood protection otherwise provided by expensive dredging operations and levees. The

Figure 19 **Photo credit: Bill Sipple**

preservation of wetlands also results in many other benefits to society, such as the protection of ecologically significant fish and wildlife habitat. A good example of this is the Mississippi River's bottomland hardwood-riparian wetlands, which once stored at least 60 days of floodwater and represented significant fish and wildlife habitat. They now store only 12 days of floodwater because most have been filled, leveed, or drained, with substantial loss of fish and wildlife habitat. Another good example is Minnesota, where the cost of replacing the natural flood control function of 5000 acres of drained wetlands was found to be $1.5 million annually.

To quote Henry Wessman, the mayor of Grand Forks, ND: "The total cost of flood damage is born by taxpayers again and again as the flood waters come. I offer as a suggestion to compensate farmers within the area to actually retain natural wetlands. If you look at the costs of compensating farmers for such activities as opposed to the almost annual cost of flood protection and flood fighting within a city such as Grand Forks, you would realize that over the long haul, you are doing yourself a much greater service by retaining that water rather than by continually paying for flood damage."

Therefore, ***in addition to their fish and wildlife values, wetlands reduce the likelihood of flood damage to homes, businesses, and crops in agricultural areas***. They also help ***control increases in the rate and volume of runoff in urban areas***. *This protection results in* ***less monetary flood damage (and related insurance costs), as well as protection of human health, safety, and welfare***.

Shoreline Erosion

Because of their position on the landscape, wetlands at the margins of lakes, rivers, bays, and the ocean help ***protect shorelines and stream banks against erosion***. Wetland plants ***hold the soil in place with their roots, absorb the energy of waves, and break up the flow of stream or river currents***. The ability of wetlands to control erosion is so valuable that some states (e.g., Florida) are restoring wetlands in coastal areas to buffer the storm surges from hurricanes and tropical storms by dissipating wave energy before it impacts roads, houses, and other man-made structures (Figure 20).

Economic Benefits of Wetland Resources

We use many natural products from wetlands, including mammals and birds, fish and shellfish, and timber. For example, ***wetlands supporting timber totals about 55 million acres***, two-thirds of which occurs east of the Rocky Mountains. Similarly, various ***plants like blueberries, cranberries, mints, and wild rice, are produced in wetlands. We also derive medicines from wetland soils and plants***.

Figure 20 **Photo credit: Kelly Drake**

Figure 21 **Photo credit: Steve Delaney**

Many of the nation's ***fishing and shellfishing industries harvest wetland-dependent species (e.g., striped bass and brown shrimp)*** (Figure 21). In fact, the fish and shellfish that depend on wetlands for food or habitat constitute more than 75% of the commercial and 90% of the recreational harvest (Figure 22). In the Southeast, fish and shellfish species dependent upon coastal and estuarine wetlands comprise almost all of the commercial catch. The coastal marshes of Louisiana alone produce a commercial fish and shellfish harvest amounting to 1.2 billion pounds annually, which was worth $244 million in 1991. In this region, 96% of the commercial harvest and more than 50% of the recreational catch are estuary-coastal wetland-dependent fish and shellfish. The United States commercial fisheries harvest is worth more than $2 billion annually. This harvest is the basis for a $26.8 billion fishery processing and sales industry. Overall, including commercial and recreational endeavors, seafood is a $50 billion industry.

Figure 22

Wetlands are habitats for commercial fur-bearers like muskrat, beaver, otter, and mink, as well as reptiles such as alligators (Figure 23). The nation's harvest of muskrat pelts alone valued at over $70 million annually, while the alligator industry is valued at $16 million.


American alligator

Figure 23

Recreation, Education, and Research

Wetlands provide many recreational, educational, and research opportunities. In the United States, more than half of all the adults (98 million) ***hunt, fish, birdwatch or photograph wildlife,*** annually spending a total of $59.5 billion in the process (Figures 24 and 25). Coastal areas themselves attract at least 100 million Americans each year. At least $18 billion in economic activity is generated annually from coastal wetland-dependent recreational fishing by 17 million Americans.


Waterfowl hunting in a marsh

Figure 24
Photo credit: Texas Parks and Wildlife Department

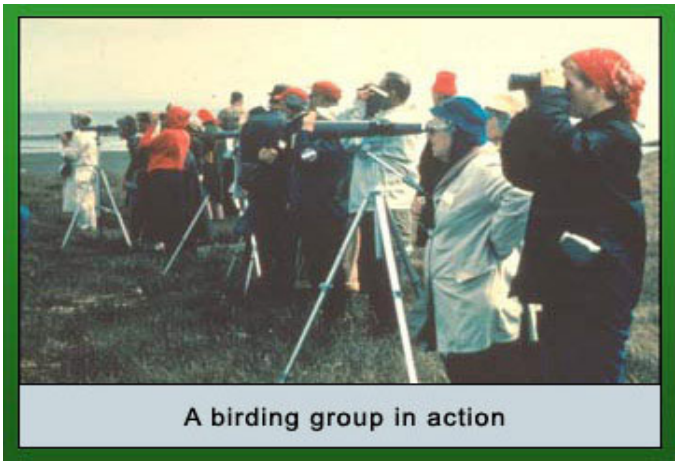

A birding group in action

Figure 25

Nature-related recreation is the fastest growing activity of the tourism industry – with an annual increase of about 30% since 1987. In 1996, 160 million Americans spent $29.2 billion to observe, photograph or feed wildlife. Much of this ***nature-based tourism involves birds, many of which are wetland-dependent***. Each year, about $20 billion are spent on seed, travel and equipment by birders. Birding has increased more quickly than other outdoor recreation activities, such as biking, pleasure walking, skiing and golf.

In fact, participation has tripled from 1982-83 (21 million) in to 1997 (63 million in 1997). The birding public is quite active – 24.7 million people took trips away from home to partake in birding, spending $5.2 billion in goods and services in 1991. This high level of participation by Americans in bird-related recreation is a clear indicator of the societal value of birds. An inordinate amount of this recreational birding is associated with wetlands and aquatic habitats. This undoubtedly relates to the fact that birds in particular tend to gravitate towards wetlands and aquatic habitats, which in turn attracts natural history and outdoor enthusiasts.

Nationally, economic activity directly associated with non-consumptive enjoyment of birds generated 191,000 jobs and more than $895 million in sales and income tax revenues in 1991. In addition, ***3 million migratory bird hunters generated $1.3 billion in retail sales***, with a total economic multiplier effect of $3.9 billion, associated with 46,000 additional jobs and sales and income tax revenues of $176 million (Figure 26).

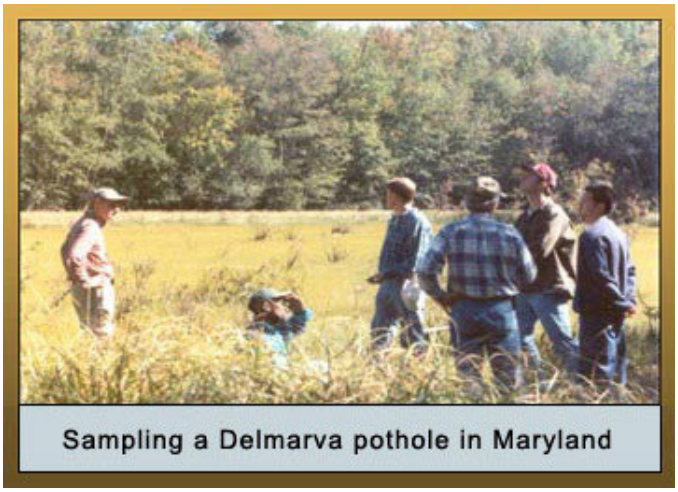

Sampling a Delmarva pothole in Maryland

Figure 26

Regional statistics on birding activity are also impressive. A prime example is the Delaware Bay shore and Cape May peninsula of New Jersey, which realizes more than $40 million annually from birders.

In addition, ***artists and writers capture the beauty of wetlands on canvas and paper, or through cameras, and video and sound recorders. Others appreciate wetlands by hiking, boating, and other recreational activities***. Almost everyone likes being on or near the water; part of the enjoyment is the varied, fascinating life forms (Figure 27) found in these biologically rich areas.

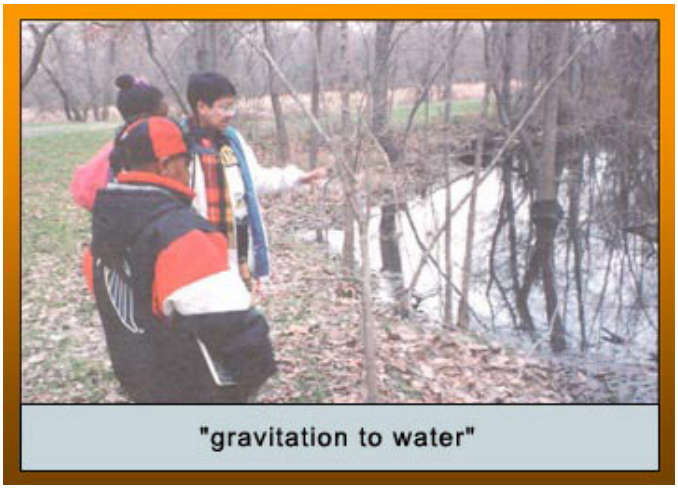

"gravitation to water"

Figure 27 **Photo credit: Jennifer Matchett**

The recreational benefits associated with wetlands, of course, also serve to educate. ***Wetlands are studied in conjunction with environmental programs*** at adult continuing education facilities and at environmental centers. Furthermore, many school systems at the grammar, middle, and high school levels use these valuable ecosystems as out-of-door laboratories for environmentally-related courses, since they serve as ***excellent study sites to learn about vegetative structure (e.g., the density and cover of the vegetation) and ecological functions (e.g., nutrient cycling) , natural ecological processes***

(e.g., plant succession), biodiversity, and plant-animal interactions. For more advanced students, particularly those at the high school and college levels, and professionals seeking to learn more about wetlands, they serve as ***excellent research sites***.

Summary

Wetlands provide many societal benefits: food and habitat for fish and wildlife, including threatened and endangered species; water quality improvement; flood storage; shoreline erosion control; economically beneficial natural products for human use; and opportunities for recreation, education, and research (Figure 28).

Now that you have successfully completed the module, you can evaluate your understanding by taking the test on page 19.

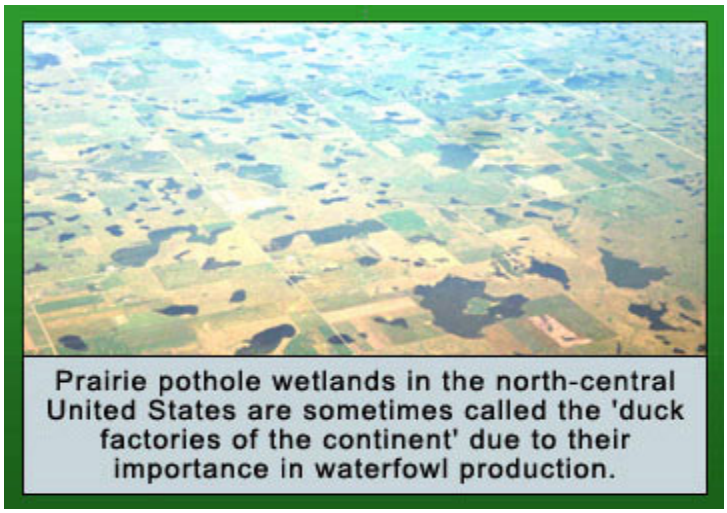


Figure 28

Acknowledgments

The text of this module was derived, with substantial modifications and additions, from two EPA publications, *America's Wetlands: Our Vital Link Between Land and Water* (1995) and *Wetlands Fact Sheets* (1995). Other References and World Wide Web sources used are given on the following pages.

The author appreciates the review of drafts of this module by Donna An, Rachel Doughty, George Loeb, John McShane, John Meagher, Tracie Nadeau, Douglas Norton, Sean Sipple, Lynne Trulio and Alan Wright.

Appreciation is also expressed for the use of figures and photos from *America's Wetlands: Our Vital Link Between Land and Water* (USEPA, 1995). Photo credits are listed under each photo in the module.

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List of all the wetland functions and values in this module

➤ ***fish,wildlife and plant habitats***

- ***source of substantial biodiversity***
- ***produce great quantities of food***
- ***development of organisms that form the base of the food web***
- ***birds and mammals rely on wetlands for food, water, and shelter, especially while migrating and breeding***
- ***breeding and egg deposition areas (fish, amphibians and reptiles)***
- ***estuaries and their coastal marshes serve as important fish nursery areas***
- ***some wetlands release cooler water to salmon-bearing streams and rivers***
- ***43% of the federally threatened and endangered species rely directly or indirectly on wetlands for their survival***

➤ ***natural water quality improvement and biogeochemical cycling***

- ***wetlands provide the conditions needed for the removal of both nitrogen and phosphorus from surface water***
- ***improve water/drinking water quality by -***
  - ***- intercepting surface runoff***
  - ***- removing or retaining inorganic nutrients***
  - ***- processing organic wastes***
  - ***- reducing suspended sediments***
- ***wetlands also reduce environmental problems such as algal blooms, dead zones, and fish kills, that are generally associated with excess nutrients.***

➤ ***atmospheric maintenance***

- ***wetlands world-wide help moderate global climatic conditions***
- ***store carbon within their live and preserved (peat) plant biomass instead of releasing it to the atmosphere as a greenhouse gas***

➤ ***hydrologic cycle roles***

- ***receive, store, and release water in numerous ways***
- ***some wetlands maintain stream flow during dry periods***
- ***some wetlands replenish groundwater***

➤ ***flood storage***

- ***store and slowly release surface water, rain, snowmelt, groundwater and flood waters***
- ***wetland vegetation also impedes the movement of flood waters and distributes them more slowly over floodplains***
- ***counteract the greatly increased rate and volume of surface-water runoff from pavement and buildings***

➤ ***shoreline erosion protection***

- ***protect shorelines and stream banks against erosion***
- ***hold the soil in place with their roots***
- ***absorb the energy of waves***
- ***break up the flow of stream or river currents***

➤ ***opportunities for recreation, education, research and aesthetic appreciation***

- ***used to hunt, fish, birdwatch or photograph wildlife***
- ***nature-based tourism involves birds, many of which are wetland-dependent***
- ***used for hiking, boating, and other recreational activities***
- ***studied in conjunction with environmental programs***
- ***excellent research and teaching sites to learn about vegetation, ecological functions and processes, biodiversity, and plant-animal interactions***

- ***artists and writers capture the beauty of wetlands on canvas and paper, or through cameras, and video and sound recorders***

➤ ***<u>economic benefits of natural services and products at little or no cost</u>***

- ***wetlands filtering function saves us a great deal of money***
- ***wetlands supporting timber totals about 55 million acres***
- ***blueberries, cranberries, mints, and wild rice, are produced in wetlands***
- ***medicines from wetland soils and plants***
- ***fishing and shellfishing industries harvest wetland-dependent species***
- ***habitats for commercial fur-bearers like muskrat, beaver, otter, and mink, as well as reptiles such as alligators***
- ***3 million migratory bird hunters generated $1.3 billion in retail sales***

➤ ***<u>reduce flood damage and protect our health and safety</u>***

- ***reduce the likelihood of flood damage to homes, businesses, and crops in agricultural areas***
- ***lower flood heights and reduce erosion downstream and on adjacent lands***
- ***reduce or prevent waterlogging of agricultural lands***
- ***less monetary flood damage (and related insurance costs), as well as greater protection of human health, safety, and welfare.***

Self Test for Wetlands Module

After you've completed the quiz, check your answers with the ones provided on page 23 of the document. A passing grade is 15 of 21 correct, or 70 percent.

1. Although wetlands are considered beneficial to society, this is only from a fish and wildlife perspective.

- ☐ A. True
- ☐ B. False

2. Wetlands are among the most productive ecosystems in the world and manifest substantial biodiversity.

- ☐ A. True
- ☐ B. False

3. Wetlands in Texas, North Carolina, and Alaska are quite similar.

- ☐ A. True
- ☐ B. False

4. All wetland animals spend their entire lives in wetlands.

- ☐ A. True
- ☐ B. False

5. Two types of food webs, the herbivore-carnivore food web and the detrital food web, are associated with wetlands.

- ☐ A. True
- ☐ B. False

6. The food component driving the detrital food web is dead or decaying plant material.

- ☐ A. True
- ☐ B. False

7. A very high percentage of federally endangered plants and animals rely directly or indirectly on wetlands for their survival.

- ☐ A. True
- ☐ B. False

8. Because of their low topographic position relative to uplands (e.g., isolated depressions, floodplains), some wetlands function to store and slowly release surface water, rain, snowmelt, groundwater, and flood waters.

- ☐ A. True
- ☐ B. False

9. Although wetlands function as indicated in question 8 above, this does little to lower flood heights and reduce erosion downstream and on adjacent lands.

- ☐ A. True
- ☐ B. False

10. Fish and shellfish that depend on wetlands for food or habitat constitute more than 75% of the commercial and 90% of the recreational harvest in the United States.

- ☐ A. True
- ☐ B. False

11. Wetland ecosystems are excellent study sites to learn about vegetative structure and the various ecological functions (e.g., nutrient cycling), natural ecological processes (e.g., plant succession), biodiversity, and plant-animal interactions.

- ☐ A. True
- ☐ B. False

12. The various benefits, or values, that wetlands provide to society arise from:

- ☐ A. the trees that inhabit almost all wetlands
- ☐ B. conversion of wetlands to non-wetlands
- ☐ C. the many ecological functions associated with wetlands
- ☐ D. the abundance of waterfowl found in peatlands

13. Wetlands are thought of as "biological supermarkets" because:

- ☐ A. they support microbes and insectivorous plants
- ☐ B. they produce great quantities of food that attracts many animal species
- ☐ C. they seldom have saturated or flooded soils
- ☐ D. they produce mostly birds and mammals, some of which are directly consumed by man.

14. An example of an animal that travels from uplands to vernal pools to breed and lay eggs is:

- ☐ A. muskrat
- ☐ B. black rat snake
- ☐ C. chain pickerel
- ☐ D. tiger salamander

15. Biogeochemical cycling involves:

- ☐ A. the conversion of wetlands to uplands
- ☐ B. the transportation of suspended sediments to estuaries and the subsequent transformation of these sediments into rock formations over the eons through pressure and compaction.
- ☐ C. the biologic, physical, and chemical transformations of various nutrients within the biota, soils, water, and air.
- ☐ D. a shift from the herbivore-carnivore food web to the detrital food web in estuaries.

16. Which of the following are released from wetlands in the gaseous form:

- ☐ A. phosphorus and iron
- ☐ B. oxygen and phosphorus
- ☐ C. nitrogen and sulfur
- ☐ D. carbon dioxide and manganese

17. Estuaries and their coastal marshes serve as important nursery areas for the young of many recreational (game) and commercial fish and shellfish because:

- ☐ A. they produce so much plant biomass and invertebrate life
- ☐ B. of the extreme range of tides associated with these areas
- ☐ C. of the abundant mammal populations found in coastal marshes
- ☐ D. they support abundant insect populations

18.Two examples of fish that subsist in freshwater wetlands that have natural low dissolved oxygen concentrations are:

- ☐ A. flounder and menhaden
- ☐ B. pickerel and northern pike
- ☐ C. sea trout and spot
- ☐ D. mud minnow and brown bullhead

19. Wetlands are important to humans because:

- ☐ A. they function in flood protection by storing and slowly releasing surface water
- ☐ B. they help improve water quality, including drinking water
- ☐ C. they trap suspended sediments before they reach open water
- ☐ D. all of the above
- ☐ E. none of the above

20. Two major recreational activities associated with wetlands are:

- ☐ A. hunting and birding
- ☐ B. camping and hiking
- ☐ C. swimming and canoeing
- ☐ D. mineral collecting and fishing

21. Coastal estuaries and their associated wetlands are particularly important to the following commercial industries:

- ☐ A. housing and golf
- ☐ B. fish and shellfish
- ☐ C. forestry and cranberry
- ☐ D. waterfowl and agriculture

Answers for Wetlands Module Self Test

Q1: B	Q2: A	Q3: B	Q4: B	Q5: A	Q6: A	Q7: A	Q8: A
Q9: B	Q10: A	Q11: A	Q12: C	Q13: B	Q14: D	Q15: C	Q16: C
Q17: A	Q18: D	Q19: D	Q20: A	Q21: B			