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Nontidal Wetland Functions And Values

Maryann Wohlgemuth

Introduction

Approximately 750,000 acres or 85% of Virginia's wetlands are nontidal (Odum, 1988). Nontidal wetlands include marshes, swamps, bogs, and low-lying areas along the margins of rivers, streams and lakes. They can also be found in isolated upland depressions or areas where the water table stays near the land surface (Figure 1). They are characterized by wet soils and by plants that are adapted to grow in the wet conditions. Vegetation found in nontidal wetlands may include grasses, herbaceous plants (non-woody), shrubs, and trees. They are not influenced by daily tides like tidal wetlands. Nontidal and tidal wetlands share many of the same values and both are important in maintaining the health of the Chesapeake Bay and its living resources.

Nontidal Wetland Types

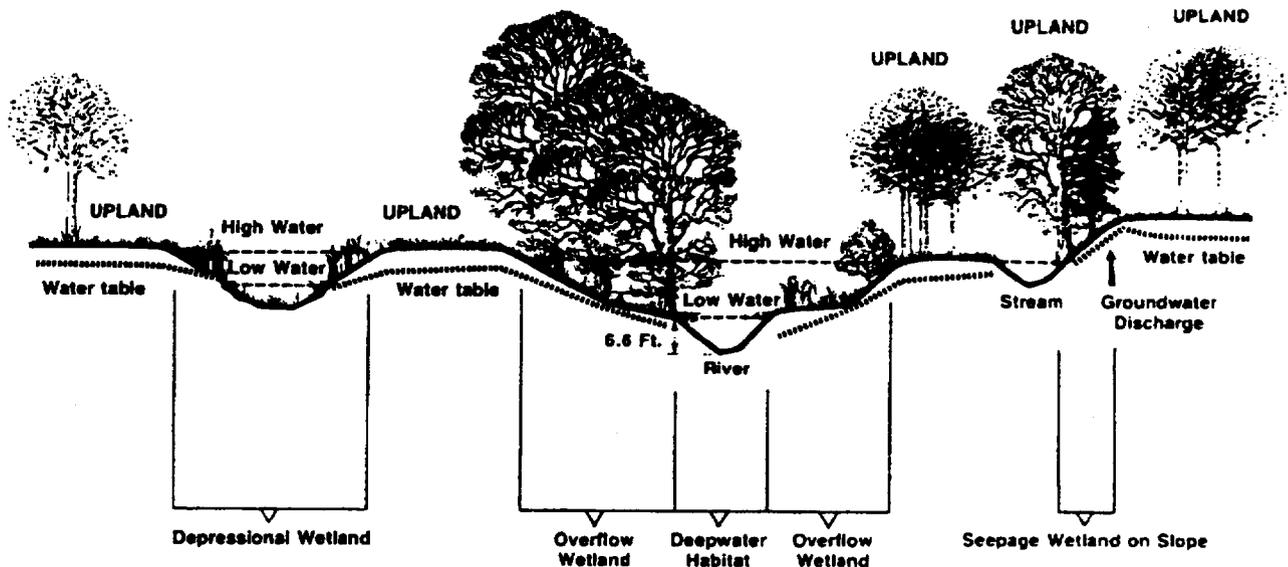
Forested, palustrine emergent, and lacustrine are the most prevalent types of nontidal wetlands in Virginia (Odum, 1988). Forested wetlands are the most extensive including bottomland hardwood forests, riparian wetlands, and bottomland hardwood swamps. Forested wetlands can occur as broad flood plains along rivers, as fringes along streams, or in upland depressions. Trees common to forested wetlands in Virginia include red maple, green ash, black gum, sweet gum, American elm, river birch, black willow, loblolly pine and alder (Odum, 1988). Palustrine emergent wetlands occupy depressions, ditches or stream banks and are characterized by emergent herbaceous plants such as sedges, rushes, and grasses. Cattails are a familiar plant found in these wetlands. Lacustrine wetlands are found along shorelines of lakes and are identified by grasses, sedges, rushes, shrubs, and trees. Other nontidal wetlands in Virginia include scrub-shrub wetlands, bogs, fens, and interdune swale wetlands (Odum, 1988).

Wetland Values

Ecological processes are usually described by function, such as wildlife habitat support. The further classification of a function by its value connotes usefulness to humans. The location of the wetland, the human population pressures on it, or the extent of the wetland may indicate the value of a functional ecologic process (Mitsch and Gosselink, 1986). For example, wildlife habitat may be important to humans because it provides wildlife for hunting, or

(continued)

Figure 1. Schematic diagram showing wetlands, deepwater habitats, and uplands on landscape. Note differences in wetlands due to hydrology and topographic location (adapted from Tiner, 1984).



nature study. Wetlands provide many ecological and socio-economic benefits including water quality improvement, stormwater treatment, food sources, fish and wildlife habitat, shoreline erosion control, flood protection, potable water supplies, economic resources such as timber, and recreation. Wetlands have traditionally been considered unproductive wastelands, which has led to their elimination by artificial draining or filling. This view has changed significantly as the connection between wetlands, wildlife, water quality, and other ecological and economic values have been studied. Hunters, fishermen, trappers, and loggers have always benefited from the abundant supply of mammals, fish, waterfowl, and lumber.

Nontidal Wetland Values to the Chesapeake Bay

In considering the values of nontidal wetlands, it is important to understand the coupling of wetlands with adjacent ecosystems, such as streams, rivers, lakes, bays, uplands, and floodplains. Of particular concern is the function Virginia's nontidal wetlands may play in protecting the water quality of the Chesapeake Bay. The entire Bay watershed should be considered in evaluating the cumulative function of nontidal wetlands (Figure 2). A *watershed* can

be defined as all the area that drains by surface or subsurface flow into the water body being considered (Figure 3). The Chesapeake Bay watershed extends north through parts of New York State and west to the Appalachian mountains covering approximately 64,000 square miles (Chesapeake Bay Program, 1983). Any substance that is added to the land or the waters within this area has the potential to impact the water quality and ecology of the Bay system. For example, agricultural or lawn fertilizers applied in western Virginia or New York have the potential to impact the Bay either through surface flow or groundwater flow (Figure 3). Nontidal wetlands throughout this watershed have the potential to improve or maintain many ecological values in waters flowing toward the Bay, especially water quality.

Nontidal wetlands are diverse and cover a wide range of habitats. Because they do not all provide the same values or functions, generally it is difficult to determine the functions a wetland provides without site specific analysis. Variables to consider in assessing the functional values of a wetland may include: wetland type, soil characteristics, hydrology, size, and surrounding upland land use. This report gives an overview of nontidal wetland functions and values.

Water Quality

Located at the interface between terrestrial and aquatic systems, wetlands often intercept pollutants and nutrients in upland runoff before they reach an adjacent waterway (Figure 4). Substances that can affect water quality include nutrients, dissolved gases, heavy metals, pesticides, pathogens, and industrial wastes. The nutrients of most importance in wetland and aquatic systems are nitrogen and phosphorous. In excessive quantities, they can cause nuisance algal blooms and subsequent low oxygen levels; however, they are essential for growth of wetland plants. Dissolved oxygen is produced by plants and is necessary for aquatic animals to survive. The processes occurring in wetland systems that impact water quality are plant uptake and cycling, filtering, sedimentation, reduction in shoreline erosion, soil adsorption, and soil microbial activity.

Nutrient Uptake and Cycling

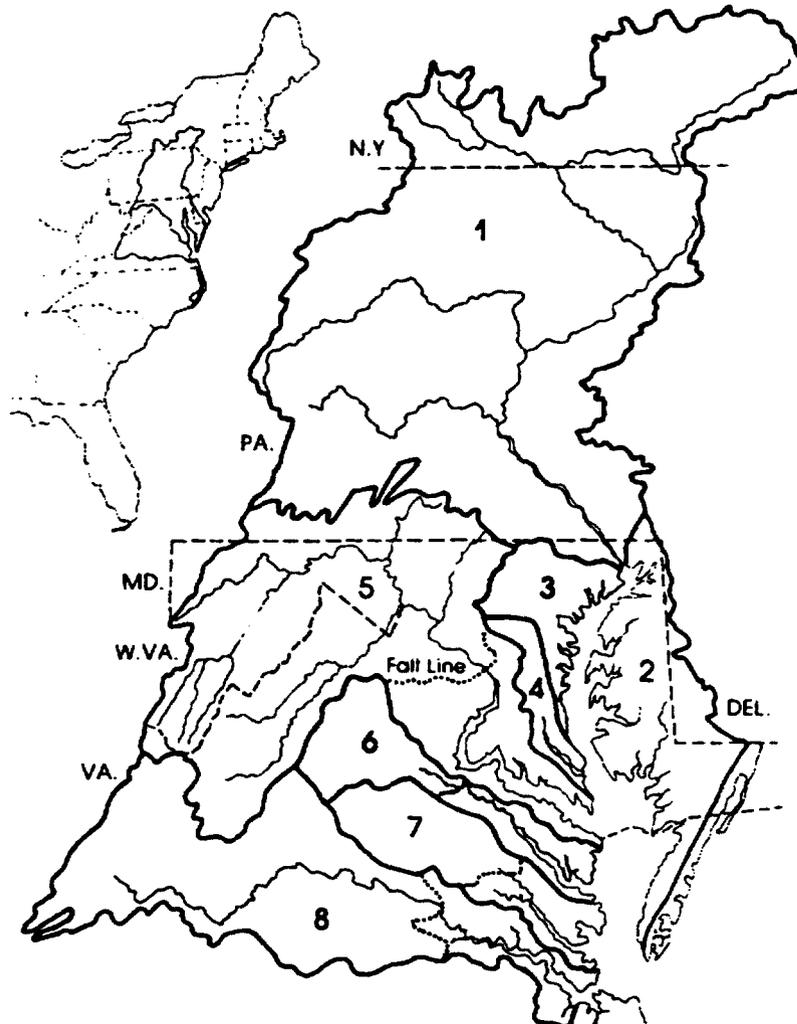
As wetland plants grow and die, they take up *inorganic* nutrients (nitrogen, phosphorous) and release *organic* or *detrital* forms (decaying plant material) of nutrients. The result is a valuable cycling and transformation of nutrients in the ecosystem. The transformation from inorganic to organic forms of nutrients reduces potential problems from excessive nutrient loadings, while providing organic forms of nutrients that are more useful to aquatic animals (Figure 5). Excessive nutrients may come from septic system leakage, sewage effluent, runoff from fertilized lawns and farms, and stormwater outflows. The organic forms of nutrients provide the base of the detrital food web, which may support many commercially important fish, crabs, and shellfish (Elder, 1985). A *food web* is the set of complex feeding interactions that occur in an ecosystem.

Some wetlands function as nutrient sinks in which the net

output of nutrients is less than the net input. Most wetlands are at least seasonal sinks for nutrients, taking them up during the growing season. A review by Van der Valk et al. (1979) of 17 studies showed that freshwater wetlands trapped nutrients during the growing season. This wetland function can be very important in managing urban and agricultural runoff with high concentrations of nutrients which may degrade downstream water quality. Even a slight increase in the amount of wetlands in an agricultural watershed reduced the amount of nitrogen leaving the watershed (Jones et al., 1976).

Plants may also take up heavy metals, and other chemical pollutants and incorporate them into their leaves, roots, and stems (Kadlec and

Figure 2. Chesapeake Bay watershed and major drainage basins (adapted from Chesapeake Bay Program, 1983).



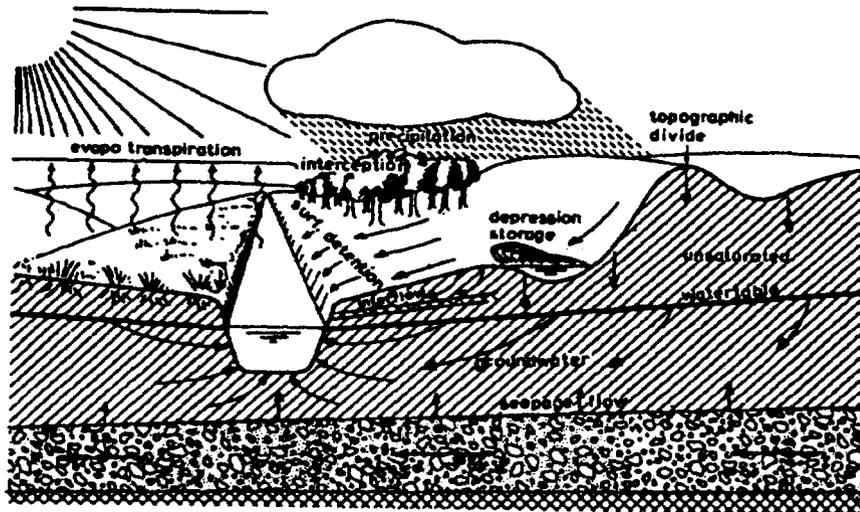


Figure 3. The riverine hydrologic cycle, note the subsurface flows (adapted from Clark, 1983).

Kadlec, 1979; Boto and Patrick, 1979). As the plant dies, the pollutants may be buried and removed from the system or returned to the water column. If the plant is consumed by an animal the pollutants may be passed up the food web.

Wetland Soil Processes

Wetland soils have been shown to be more important at removing nutrients from the overlying water than plant uptake. Sather et al. (1990) states that chemical adsorption by detritus and precipitation appear to remove more phosphorus than plant uptake. Bacteria at the water sediment interface remove significant amounts of nitrogen from the water column (Sather et al., 1990). Soil microbes such as bacteria are also important in degrading pesticides, resulting in reduced potential risk even if the soils are disturbed (Boto and Patrick, 1979).

Filtering and Sedimentation

Wetlands are sites of increased sedimentation, which improves water quality by reducing suspended solids and increases bank stabilization through the accumulation of sediment. As overlying waters pass across wetlands, water velocities are slowed by the increased friction between the water and the sediment interface and the presence of vegetation. As the water is slowed, suspended particles fall out, reducing turbidity and improving water quality. Riparian areas have been shown to retain 80 percent of sediment runoff from adjacent agricultural lands (Richardson, 1989). Wet-

lands located in depressions may retain all the sediment entering them (Novitzki, 1979). This is valuable in reducing siltation in downstream areas such as fish spawning areas and ship channels.

As sediments are removed from the water column, so are attached nutrients, heavy metals, and other toxins. Mitsch et al. (1979) found that large amounts of phosphorous were deposited

Nontidal Wetland Values

ENVIRONMENTAL QUALITY VALUES

Water Quality Improvement

- Pollutant removal (heavy metals, pathogens)
- Sediment trapping
- Nutrient uptake and recycling
- Oxygen production
- Wastewater treatment
- Stormwater treatment

Aquatic and Terrestrial Productivity

Fish and Wildlife Habitat

- Spawning and nesting sites
- Nursery areas for young
- Shelter from predators
- Foraging areas

SOCIO-ECONOMIC VALUES

- Shoreline Erosion Control
- Flood Protection
- Groundwater recharge and discharge
- Natural products (timber, fish, waterfowl)
- Recreation (boating, fishing, hunting)
- Aesthetics

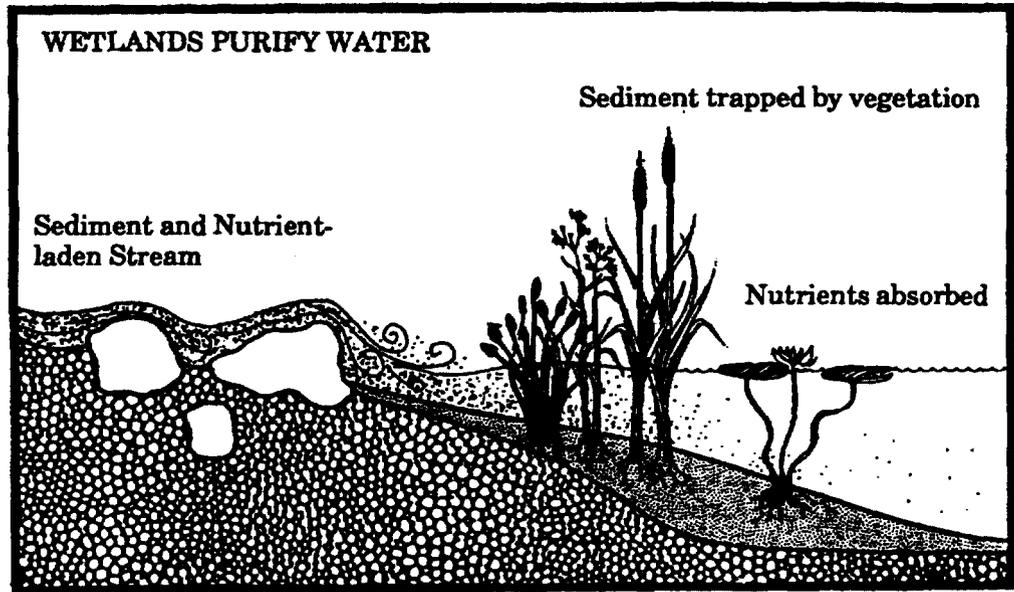


Figure 4. Wetlands help purify water by filtering out nutrients, wastes, and sediment from runoff and floods (adapted from Kusler, 1983).

with river sediments during river flooding in a swamp. Most wetland sediments accumulate faster than they are removed. This accumulation rate allows the wetland to retain a significant portion of the nutrients and other pollutants buried in the soil (Sather et al., 1990). Heavy metals and other toxic substances attached to sediment particles will become immobile through burial in sediments until they become disturbed through dredging or lowering of the water table (Boto and Patrick, 1979).

Wastewater Treatment

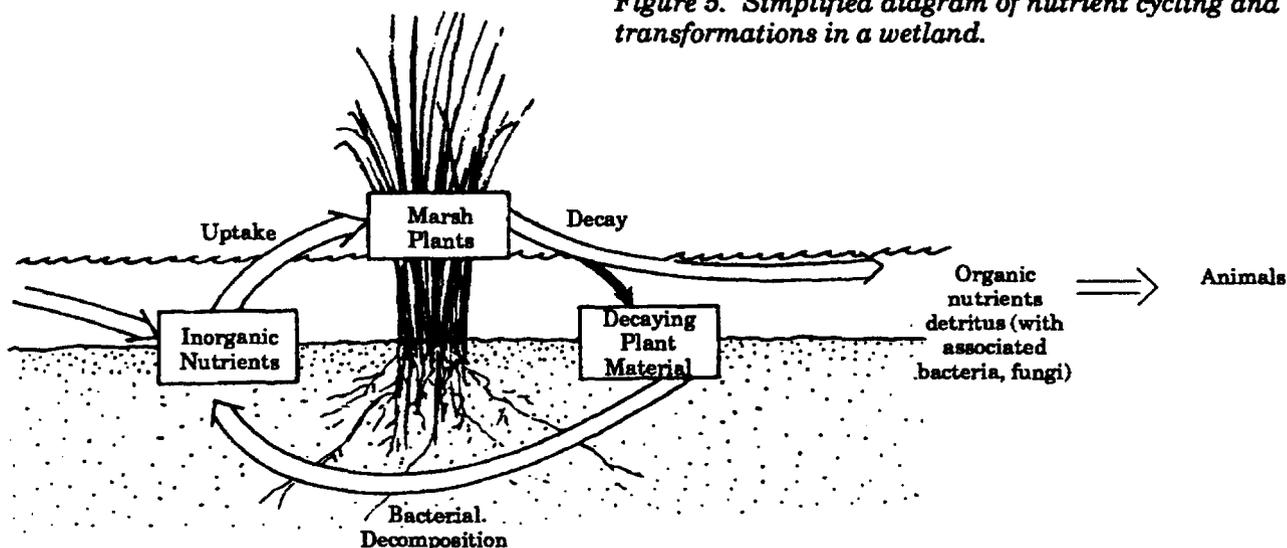
Some wetlands are so successful at removing nutrients that they have been utilized in treating wastewater. Freshwater wetlands filter 60 - 90 percent of the suspended solids from wastewater addition studies (Richardson, 1989). Boyt et al. (1976) studied a hardwood swamp that had been receiving sewage effluent for 20 years and reported a 98 percent reduction in phosphorous and 90 percent reduction in nitrogen in the outflow waters. Coliform bacteria may also show significant reductions in sewage effluent after passing through a wetland (Spangler et al., 1976). *Coliforms* are an indicator of human fecal matter which may contain pathogens. However, some studies have questioned the ability of a wetland to remove pathogenic microorganisms (Bender and Correll, 1974) and have shown that some wastewater heavy metals that are incorporated in plant tissue can be passed up the food web (Windom, 1976; Roman, 1981).

Stormwater Management

Stormwater runoff is becoming widely recognized as a significant contributor to water pollution problems. Stormwater runoff may contain many pollutants, among them are fuel and chemical spillage, lawn fertilizers and herbicides, vehicle drippings (oil, gas, antifreeze), sediment from erosion or construction activities, and sewage from failing systems. Urban areas are beginning to implement natural methods of reducing these pollutant loads, including vegetated drainage ways and detention basins with their associated wetland border. The Commonwealth's Best Management Practices (BMP) Manual for urban areas suggests using wetlands for natural biological treatment of stormwater (Virginia State Water Control Board, 1979b). Directing stormwater runoff through a wetland can be considered a filtering process analogous to running dirty water through a coffee filter. The filtering process is accompanied by complex biological and chemical reactions that occur in the wetland, resulting in significant reductions in total pollutants.

In summary, establishment or maintenance of wetland buffer zones may significantly improve water quality in the adjacent and downstream water bodies. Wetlands can improve water quality by five mechanisms: 1) plant nutrient uptake and cycling, 2) chemical adsorption and precipitation, 3) bacterial processes, 4) sedimentation, 5) reduction in shoreline erosion (discussed later in this paper).

Figure 5. Simplified diagram of nutrient cycling and transformations in a wetland.



Primary Production

Wetland productivity provides the source of many wetland functions, including nutrient recycling, fish and wildlife food and habitat, and food web support. All life is ultimately dependent on the photosynthetic production of plant material by primary producers. **Primary producers** include grasses, shrubs, trees, macro-algae, and floating microscopic plants (phytoplankton). **Photosynthetic production** of organic matter converts the sun's energy into a form which can be used by living organisms. In this process, nutrients and carbon dioxide are taken up and oxygen is released. Wetland plants produce more plant material than some of our most productive cultivated farm fields (Figure 6). Numerous wetland plant adaptations allow for maximum growth rates that are less common or impossible for terrestrial plants, which may be water or nutrient limited (Wetzel, 1989). Watersheds which drain wetland regions export more organic material than do watersheds that do not have wetlands (Mitsch and Gosselink, 1986). Wetzel (1989) compared the productivity rates across a wetland gradient beginning on the uplands and moving into the open water. He reported that the photosynthetic production of organic matter was greatest in the wetland area. The upland forest and plants produced less than half the amount of organic matter that the wetland produced. A portion of this production in wetlands is directly consumed by mammals, birds, and insects. The most significant portion is consumed as *detritus* which is decaying plant material that is colonized by microorganisms (bacteria, protozoa, and fungi). The attached

microbes increase the nutritional content of the plant material, resulting in a highly nutritious and readily available food source for many aquatic organisms including fish, crabs, shellfish, and zooplankton (microscopic animals). The fungi and bacteria in swamps produce vitamin B12, which is necessary for aquatic invertebrates and fish growth (Burkholder, 1956). Floodplain swamp forests are among the most productive ecosystems due to periodic flooding that supplies organic matter, water, nutrients, and clay (Bates, 1989).

Fish and Wildlife Habitat

Nontidal wetlands provide food and habitat for many terrestrial and aquatic animals including fish, birds, mammals, and invertebrates (Figure 7). Among the most valued food items in wetlands are plant leaves, detritus, tubers, seeds, snails, clams, worms, frogs, and insects. Mitsch and Gosselink (1986) reported that virtually all of the freshwater fish and shellfish are partially dependent on wetlands. Freshwater fish depend on wetlands for food, nursery grounds, and spawning. Almost all recreational fishes spawn in the aquatic portions of wetlands, often spawning in marshes bordering lakes or in riparian forests during flooding (Peters et al., 1979, Mitsch and Gosselink, 1986). Common fish that utilize freshwater wetlands include pickerel, sunfishes, bass, crappies, bullheads, carp, herring, white perch and American shad. Several anadromous fish (those which migrate from saltwater to freshwater to spawn) spawn in wetlands of the freshwater portions of rivers. For example, the blueback herring spawns on

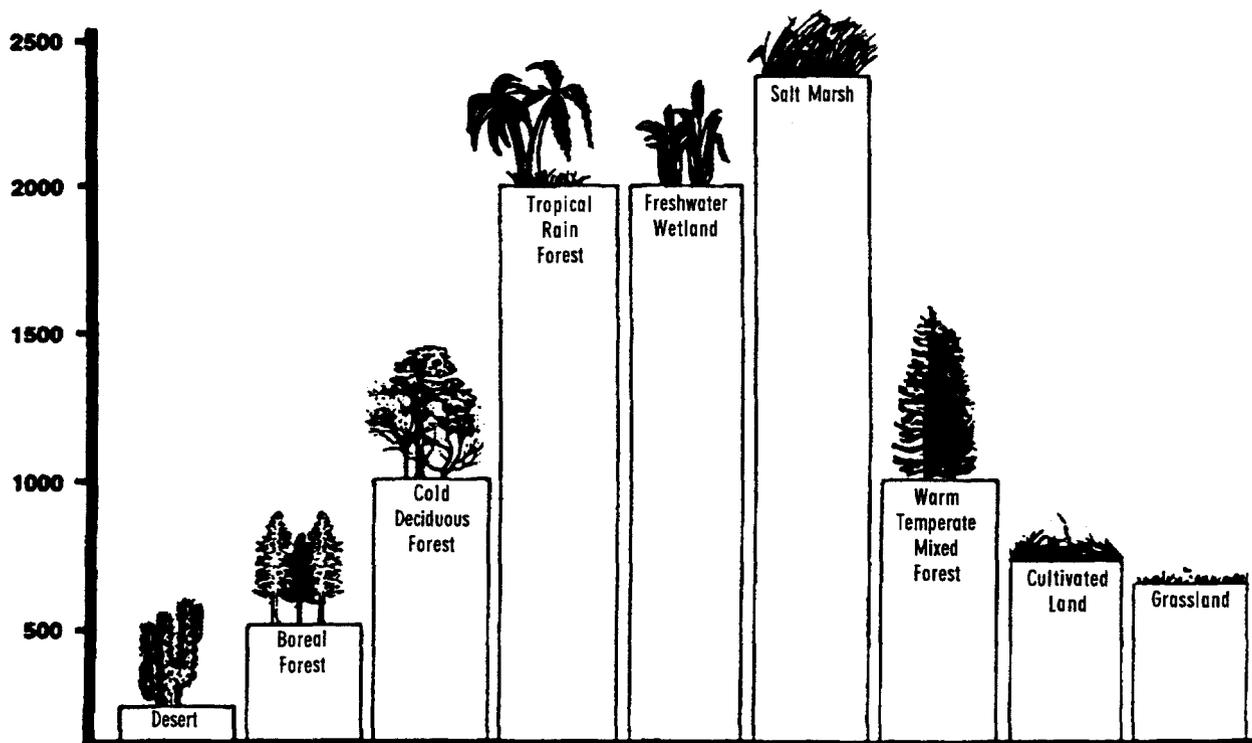
the hardwood forest floor during flooding (Adams, 1970), and the American shad spawns in freshwater streams (Tiner, 1985). Bottomland hardwoods of the southeastern U.S. are important to fish that use them for spawning, feeding, and hiding (Sather et al., 1990). Estuarine and marine fish and crabs have been reported to migrate into freshwater wetlands for food, spawning, and nursery areas (Conner and Day, 1982).

Wetlands provide a critical habitat for many birds including waterfowl, migratory songbirds, and shorebirds. Some species may utilize wetlands year round while others use them seasonal-

Bottomland forested wetlands are primary wintering grounds for waterfowl, as well as important breeding areas for wood ducks, herons, egrets, and wild turkeys (Tiner, 1984).

Muskrats, beavers, rabbits, river otters, raccoons, mice, and white-tailed deer are among the furbearers utilizing nontidal wetlands. Muskrats may feed on plant parts including belowground tubers; they may also feed on invertebrates found in wetlands such as clams and mussels. Muskrat lodges are often made of tall robust plants such as cattails. White-tailed deer depend on wetlands for winter shelter, food, cover and breeding (Tiner, 1985).

Figure 6. Net primary productivity of selected ecosystems ($g/m^2/year$) (adapted from Lieth, 1975 and Teal and Teal, 1969).



ly for breeding, feeding, resting, or overwintering. Wetland nesting birds include redwinged blackbirds, green herons, least bitterns, mallards, black ducks, wood ducks, and Virginia rails (Tiner, 1985). Other birds utilizing nontidal wetlands may include towhees, chickadees, titmouses, warblers, tanagers, vireos, flycatchers, and sparrows (Tiner, 1985). Predaceous birds such as hawks, bald eagles, ospreys, and owls also feed and nest in wetlands. Wetland seeds and tubers provide essential winter food for ducks and geese (Weller, 1979).

Another major component in wetland wildlife populations are the reptiles (turtles, snakes) and amphibians (frogs, salamanders). Almost all amphibians depend on wetlands for breeding. They lay eggs in water where their larvae develop and feed on algae as well as other foods (Weller, 1979). Frogs often found in wetlands include green, bull, and leopard frogs, and spring peepers (Tiner, 1985). Amphibians are numerous in some wetlands; 1,600 salamanders and 3,800 frogs and toads were found in a gum tree pond less than 100 feet wide in Georgia

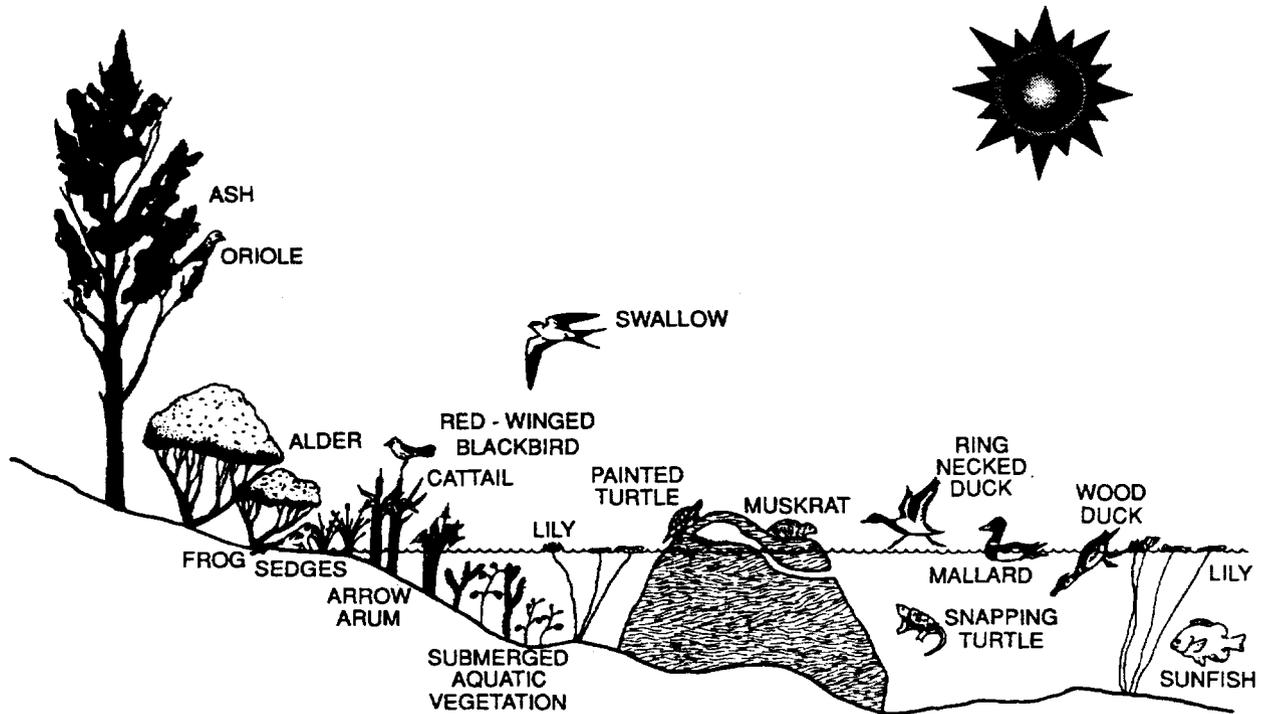


Figure 7. Simplified diagram of the plants and animals of a nontidal wetland and adjacent aquatic habitat.

(Wharton, 1978). Amphibians are a prime food source for larger animals such as raccoons, herons, mink, bitterns, and fish (Weller, 1981). Turtles and snakes use freshwater wetlands for food and cover and move to drier land to deposit eggs. Turtles are most common in freshwater marshes and ponds, the most common being box, snapping, painted, pond, and mud turtles (Clark, 1979). Water snakes are the most abundant snake in wetlands, though cottonmouths, garter, and mud snakes are also found.

Wetlands are also important in maintaining species diversity which is critical to ecosystem balance. Diversity is a measure of the variety of species present in an ecosystem. High species diversity provides resilience to potentially catastrophic events such as disease or environmental disturbance. Of the nation's endangered and threatened species, 50 percent of the animals and 28 percent of the plants are dependent on wetlands for their survival (Niering, 1988). Preservation of wetland plants is also important for maintaining direct potential benefits in the fields of agriculture and medicine (Niering, 1988). As Ehrlich and Ehrlich (1981, in Niering, 1988) state:

"The natural ecological systems of Earth, which supply these vital services, are analogous to the parts of an

aeroplane that make it a suitable vehicle for human beings. But ecosystems are much more complex than wings or engines. Ecosystems, like well-made aeroplanes, tend to have redundant subsystems and other 'design' features that permit them to continue functioning after absorbing a certain amount of abuse. A dozen rivets, or a dozen species, might never be missed. On the other hand, a thirteenth rivet popped from a wing flap, or the extinction of a key species involved in the cycling of nitrogen, could lead to a serious accident".

For the survival of many fish and wildlife, it is critical to preserve not only the wetland habitat in which the species is most common, but also a portion of the adjacent areas. Maximum wildlife usage may be dependent on preservation of upland buffer areas adjacent to wetlands (Adamus, 1990). Certain species are dependent on adjacent upland or aquatic areas for some part of their life history such as breeding, feeding, protection, or raising young. For example, trees and shrubs along a wetland edge make valuable nesting sites, song perches, and cover for birds. The upland adjacent to a wetland may be favored by wildlife for feeding, den-

ning, nesting, cover, roosting, or breeding (Porter, 1981). Upland buffers in urban areas may provide the necessary shield and concealment from human activities to allow for wildlife usage (Porter, 1981). The combination of the wetland and upland fringe provides an abundance of food close to good cover.

Shoreline Erosion Control

Wetlands located at the interface between upland and aquatic habitats have the potential to reduce upland erosion. As water moves across the reduced slope of shallow waters and wetlands, the energy dissipates. As friction or drag from the bottom increases the erosive force declines. This action occurs in nonvegetated as well as vegetated wetlands. Vegetated wetlands can reduce shoreline erosion by several mechanisms. The complex root system binds and stabilizes the sediment; as a wave propagates through vegetation additional frictional drag reduces wave energy and current velocity (Dean, 1979). Wetland vegetation also increases deposition of sediment which helps build the shoreline channelward of the uplands. Bulrushes and reed grass have been reported as the most successful herbaceous vegetation in erosion abatement (Seibert, 1968; Kadlec and Wentz, 1974). Trees stabilize banks of streams and rivers with their deep penetrating roots (Siebert, 1968; Virginia State Water Control Board, 1979a). Shoreline erosion control with vegetation has its limitations depending on many factors such as: potential wave energies, current velocities, flood magnitude, vegetation type, soil type, and slope.

Flood Storage

Wetlands within drainage basins attenuate flood peaks and total stream flows by temporarily storing surface water in slope wetlands or retaining them in depressional wetlands (Carter et al., 1979; Novitzki, 1979). These processes desynchronize peak flows by temporarily slowing and storing water, which results in a non-simultaneous, gradual release of peak waters, minimizing flow downstream (Figure 8) (Zacherle, 1984). Flood flows in watersheds with wetlands may be 80 percent lower than in

basins without wetlands (Novitzki, 1979). The U.S. Army Corps of Engineers found that protection of natural wetland systems along the Charles River basin in Massachusetts was the most cost-effective solution to controlling flood waters (U.S. Army Corps, 1972; Carter et al., 1979). Wetlands are able to store or remove water through several mechanisms, which include: maximum water storage resulting from soil properties specific to wetlands, plant uptake and evapotranspiration, and open water surface evaporation (Carter et al., 1979). The predominantly organic soils of wetlands have better water retention capabilities than mineral soils (Novitzki, 1979). Plant evapotranspiration is the loss of water vapor by plant parts. Flood storage may be reduced when soils are already saturated or in winter when plant uptake is lower (Carter et al., 1979). The increased friction caused by contact with wetland vegetation and roughness of the ground reduce flood current velocities. Mitsch et al., (1979) observed floodwaters being slowly returned to the river from a swamp months after maximum runoff occurred. This action results in reduced flood water heights because water levels have subsided in the river channel as these floodwaters are slowly released. Flood control has become increasingly important in urban areas where the rate and volume of stormwater runoff have increased with nonporous surfaces, such as roads, parking lots, and buildings.

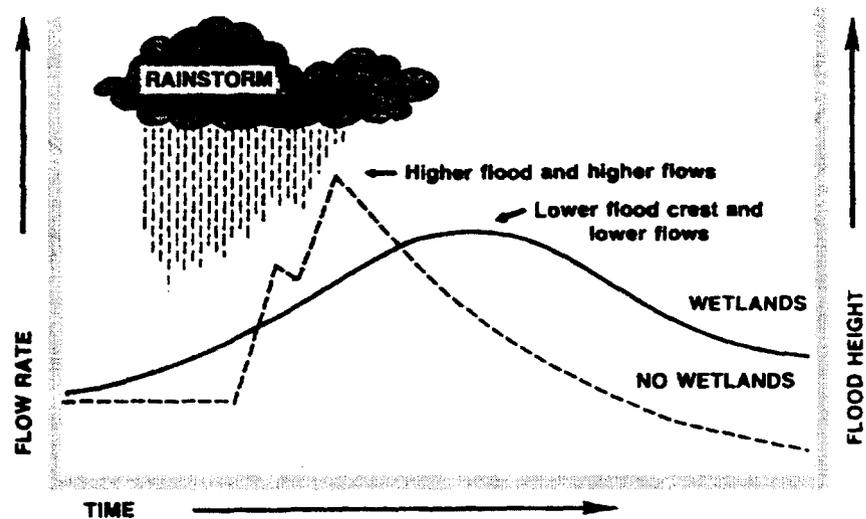


Figure 8. Wetland value in reducing flood crests and flow rates after rainstorms (adapted from Kusler, 1983).

Groundwater Discharge and Recharge

Some wetlands have been shown to be sites for groundwater recharge while most have been identified as areas of groundwater discharge. *Groundwater recharge* is the movement of water into a potential drinking water supply or aquifer. Wetlands located at sites of *groundwater discharge* occur where the groundwater table meets the surface of the land and discharges as springs or seeps. Most wetlands are discharge areas and may be used to supply drinking water. At least 60 municipalities in Massachusetts have public wells in or near wetlands (Motts and Heeley, 1973). In riverine wetlands, groundwater aquifers are recharged during floodplain inundation (Ward, 1989). Recharge potential varies according to wetland type, geographic location, season, soil type, water table location and precipitation (Tiner, 1984). May (1989) observed that the freshwater wetlands on Hilton Head Island, South Carolina are important recharge reservoirs for the aquifer that supplies potable water. Nontidal wetlands have the potential to impact the quantity and quality of potable water supplies as recharge or discharge areas.

Economic and Recreational Values

The economic benefits of wetlands are realized in natural products, shoreline erosion control, stormwater treatment, flood protection, water supply, livestock grazing, and recreation. Natural products include timber, fish, shellfish, waterfowl, furbearers, peat, and wild rice. Wetland grasses are also used for livestock grazing or are harvested for hay. Recreational activities in wetlands include boating, swimming, fishing, hunting, and nature study. All of these activities and products derived from wetlands bring direct and indirect economic benefits to the adjacent communities.

Economic benefits from hunting and fishing are significant. In 1980 furs from muskrats yielded approximately \$74 million; in 1980 5.3 million people spent \$638 million on hunting waterfowl and other migratory birds; and in 1975 sport fishermen spent \$13.1 billion to catch wetland dependent fishes in the U.S. (Burke et al., 1988). In 1980, 47 percent of Americans spent \$10 billion observing and photographing waterfowl and other wetland birds (Burke et al., 1988).

The ability of wetlands to control flood waters reduces property damage from flooding, and reduces costs for flood control structures.

Property damage from floods for 1975 in the U.S. was estimated to be \$3.4 billion (U.S. Water Resources Council, 1978). Wetlands provide perpetual values, whereas economic benefits from wetland destruction are finite (Mitsch and Gosselink, 1986).

Wetland Losses

Human threats to wetlands include drainage, dredging, filling, construction of shoreline structures, groundwater withdrawal, and impoundments. Wave reflection from shoreline defense structures may erode an adjacent wetland. As wetlands are lost so are their associated benefits. The short term economic gains acquired through wetlands destruction are relatively easy to measure and therefore have received a great deal of emphasis in the past. However, the long term economic and environmental costs of wetland destruction may well outweigh the short term gains.

Regulation of Nontidal Wetlands

Presently Virginia does not have a state nontidal regulatory program. The Commonwealth's Chesapeake Bay Preservation Act includes nontidal wetlands that are connected by surface flow and are contiguous to tidal wetlands or tributary streams as part of Resource Protection Areas. These areas and an upland buffer bordering the wetland will be subject to land disturbance restrictions. The land management practices will be implemented by local governments. The intent of the Act is to protect water quality in the Chesapeake Bay, through managing lands that have the potential to impact water quality in the Bay and its tributaries.

The U.S. Army Corps of Engineers is the lead federal agency responsible for regulation of wetlands as described under Section 404 of the Clean Water Act. The Corps' decisions are overseen by the U.S. Environmental Protection Agency. Concerned citizens can assist in wetland protection through various activities including: attending Wetlands Board public hearings, locating and monitoring wetlands in their area, supporting wetland legislation, informing neighbors and developers of the values of wetlands, and encouraging them to minimize their impact on wetlands. It is important for citizens to consider that any substances such as fertilizers, auto fluids, and pesticides that are distributed or disposed of within the Bay watershed (Figure 2)

may potentially impact the waters of the Chesapeake Bay and drinking water supplies.

Economic development and wetland protection are not mutually exclusive. Many commercial activities and economic growth depend on the productivity and aesthetic values of the Chesapeake Bay. Without wetlands and their attendant values, expensive alternative methods would be required to prevent flooding, control erosion, improve water quality, and provide fish and wildlife habitat and recreational opportunities. Our wetlands resource, if properly managed, will provide these services far into the future. We risk much more than just the wetlands if we allow their loss in favor of short term economic gain.

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