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Chapter Twelve

WETLANDS OF THE DELAWARE RIVER BASIN

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The Delaware River Basin contains an estimated 762,000 acres of wetlands. This resource covers about 9% of the Basin's land surface area. Wetlands exist in a variety of types, largely due to the varied landscapes of the Basin. Estuarine wetlands associated with the brackish waters are found only in the lower part of the Basin along Delaware Bay. Palustrine wetlands or freshwater wetlands occur throughout the Basin in association with freshwater tidal and nontidal rivers and streams, lakes, ponds, and isolated upland depressions. The general extent, distribution, and characteristics of the major types of wetlands are presented along with discussions of wetland values, recent trends, and protection.

INTRODUCTION

Wetlands are one of the Delaware River Basin's most valuable natural resources in that they provide essential habitats for many fish and wildlife species, help to maintain and improve water quality and reduce flood damages, and produce other benefits. Yet, wetlands have been traditionally viewed by many people as mosquito-breeding, snake-infested wastelands whose best use could only be attained through drainage for agriculture or filling for urban development. Although these notions still persist in the minds of some people, more and more people are beginning to realize that wetlands in their natural unaltered state provide a wealth of benefits to society. The purpose of this paper is to present an overview of the wetlands of the Delaware River Basin, focusing on their variety, extent and distribution, values, recent trends and protection efforts.

WETLAND DEFINITION

Before discussing wetland types, a brief discussion of the definition of "wetland" is worthwhile. Wetlands have been defined in many ways to meet the needs of various groups or organizations, e.g., wetland regulators, waterfowl managers, flood control engineers and hydrologists. The federal government and numerous states have defined wetlands for regulatory purposes. Many of these definitions were developed in the late 1960s and early 1970s and do not reflect our current state-of-knowledge about wetlands. More recently, the U.S. Fish and Wildlife Service developed a multi-disciplinary definition for the main purpose of inventorying the nation's wetlands (Cowardin, *et al.* 1979). The Service's definition relies on the fields of hydrology, botany, and soil science for identifying wetlands, as follows: "Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: 1) at least periodically, the land supports predominantly hydrophytes; 2) the substrate is predominantly undrained hydric soil; and 3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year" (Cowardin, *et al.* 1979). Thus, the Service uses three key criteria for identifying wetlands: (1) hydrology -- the degree of flooding and/or soil saturation, (2) wetland vegetation or hydrophytes, and (3) undrained hydric soils. All areas considered wetland must have enough water at some time during the growing season to stress plants and animals not adapted for life in water or saturated soils. Most wetlands have both hydrophytes and hydric soils present. The Service (1982) has prepared a preliminary list of wetland plants and the U.S.D.A. Soil Conservation Service (1985) has published a national list of hydric soils. Updated regional wetland plant lists are now available.

WETLAND TYPES

The Delaware River Basin contains a wealth of wetlands within its 12,765 square-mile drainage area. The diversity of wetlands throughout the Basin is largely attributed to landscape diversity and climatic differences. At least five physiographic regions are recognized: (1) Coastal Zone of Delaware Bay, (2) Atlantic Coastal Plain, (3) Piedmont, (4) Ridge and Valley Region, and (5) Appalachian Highlands. These provinces create different environmental conditions for the establishment of wetland plant communities.

To simplify matters for discussion purposes, the Basin's wetlands can be divided into four systems according to the U.S. Fish and Wildlife Service's wetland classification system (Cowardin, *et al.* 1979): (1) estuarine, (2) riverine, (3) palustrine, and (4) lacustrine. The following paragraphs briefly summarize the

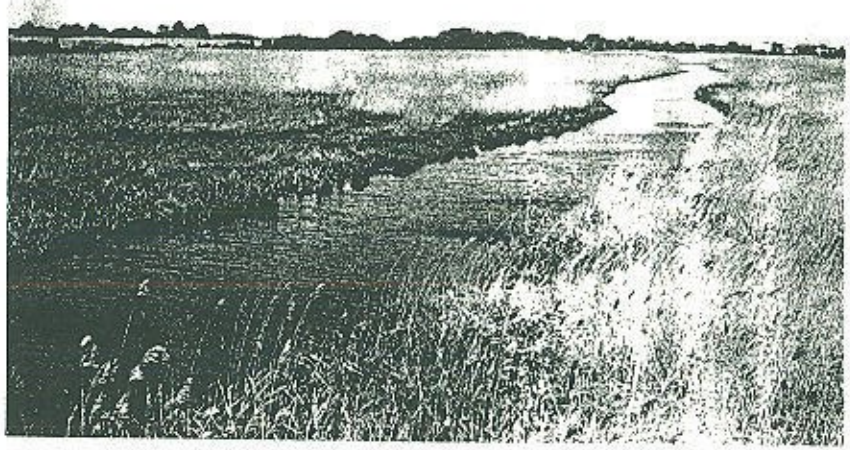

FIGURE 1. Common reed (*Phragmites australis*) dominates many of Delaware's estuarine wetlands.

major wetland plant communities based on existing National Wetlands Inventory field data and reports. For more detailed discussions on New Jersey and Delaware wetlands, the reader is referred to two U.S. Fish and Wildlife Service reports (Tiner 1985a and 1985b).

Estuarine wetlands include salt and brackish marshes and tidal flats associated with Delaware Bay and its brackish water tributaries (Figure 1). The salt marshes are characterized by numerous salt-tolerant grass and grasslike plants including smooth cordgrass (*Spartina alterniflora*), salt hay grass (*Spartina patens*), spike grass (*Distichlis spicata*), common reed (*Phragmites australis*), black grass (*Juncus gerardii*), and switchgrass (*Panicum virgatum*). A salt-tolerant shrub, high-tide bush (*Iva frutescens*), is also common along with numerous other flowering halophytes. Brackish marshes occur upstream of salt marshes where water salinity is reduced by freshwater influence. Here, other plants become abundant including narrow-leaved cattail (*Typha angustifolia*), big cordgrass (*Spartina cynosuroides*), Olney three-square (*Scirpus americanus* = *S. olneyi*), rose mallow (*Hibiscus moscheutos*), and water hemp (*Amaranthus cannabinus*). Smooth cordgrass, common reed, and salt hay grass are still among the dominant plants in many of these wetlands.

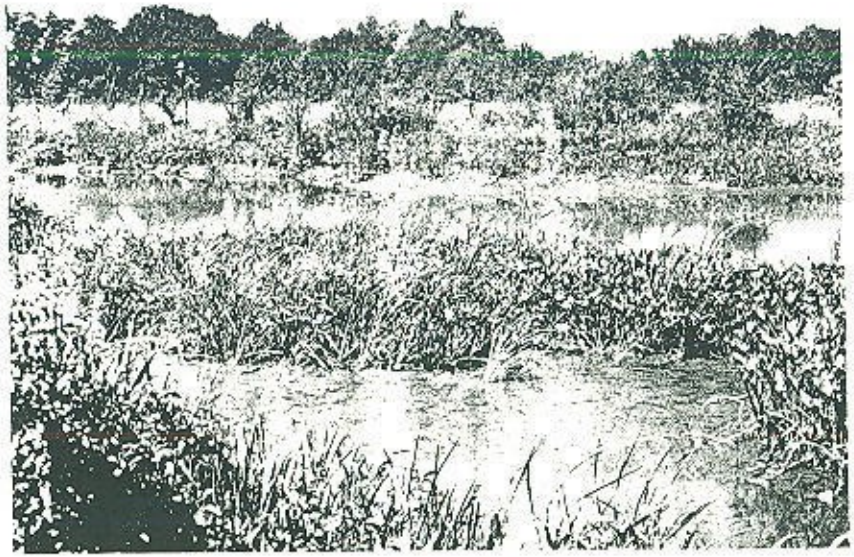

FIGURE 2. Tidal freshwater wetlands are common along the upper reaches of many coastal rivers in the Delaware River Basin, such as the Smyrna River in Delaware.

Riverine wetlands are limited by definition to aquatic beds, unvegetated periodically exposed areas, shallow water of rivers and streams, and streamside marshes dominated by nonpersistent plants, such as spatterdock (*Nuphar luteum*), wild rice (*Zizania aquatica*), arrow arum (*Peltandra virginica*) and pickerelweed (*Pontederia cordata*). These wetlands are most extensive in tidal freshwater areas along the Delaware River and its tributaries due to the exposure of vast acreages of mudflats at low tide (Figure 2). Dominant vegetation in these riverine tidal marshes are spatterdock, wild rice, arrow arum, pickerelweed, water smartweed (*Polygonum punctatum*), bur marigold (*Bidens laevis*), broadleaf arrowhead (*Sagittaria latifolia*), and water hemp. These plants generally dominate the zone flooded daily by tides and intermix with persistent emergent plants at higher levels to form large stands of palustrine tidal wetlands. Outside of the tidal areas, riverine wetlands may be represented by nonpersistent fringing marshes of burreeds (*Sparganium* spp.), arrow arum, pickerelweed, arrowheads (*Sagittaria* spp.), rice cutgrass (*Leersia oryzoides*), and smartweeds (*Polygonum* spp.) or by aquatic beds of spatterdock, pondweeds (*Potamogeton* spp.), and white water lily (*Nymphaea odorata*).

Palustrine wetlands are, by far, the most wide ranging types of wetlands in the Basin. They include freshwater marshes, bogs, swamps, bottomland hardwood forests, and many tidal fresh marshes (Figure 3). Due to climatic and

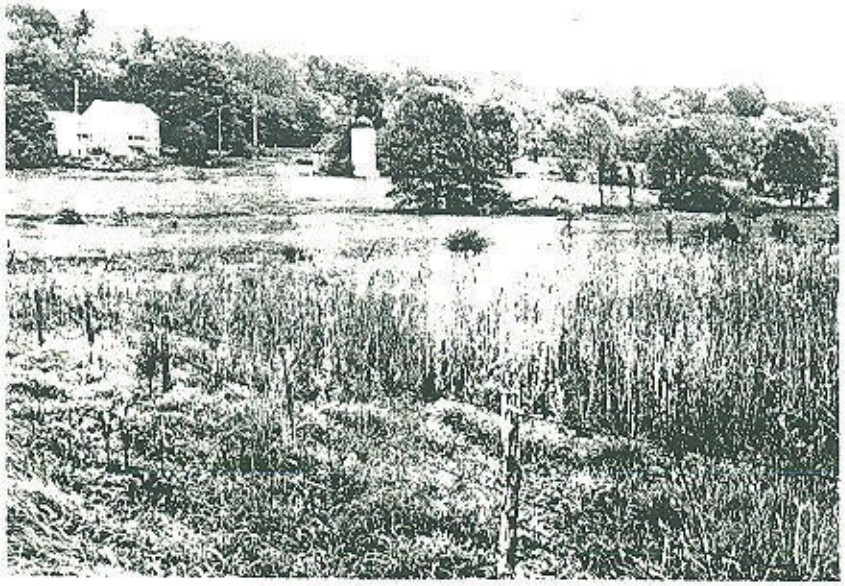

Figure 3a.

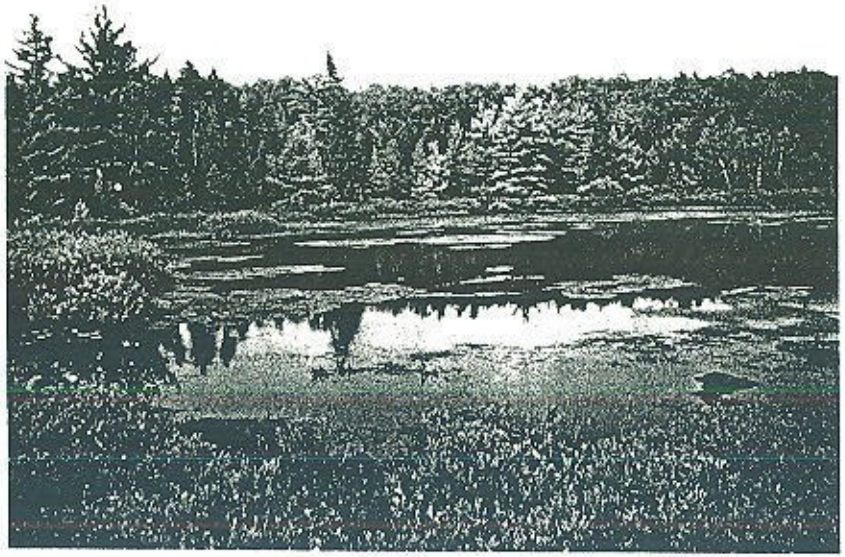

Figure 3b.

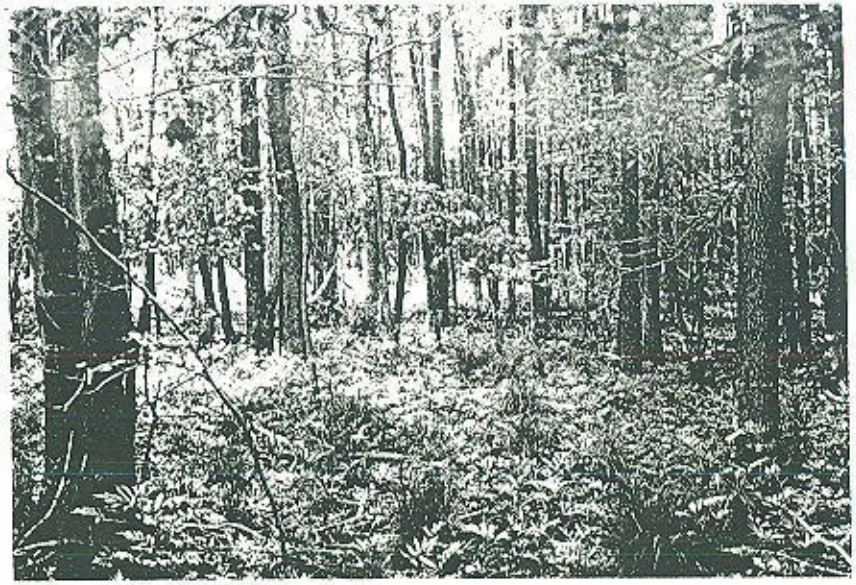

FIGURE 3. Palustrine wetlands are the most abundant types of wetlands in the Delaware River Basin. They are represented by three major vegetated types: (a) emergent wetlands dominated by cattails and other herbaceous plants, (b) scrub-shrub wetlands like leatherleaf bogs in the Pocono region of Pennsylvania, and (c) forested wetlands such as red maple swamps.

physiographic differences within the Basin, plant composition varies from north to south, with the northern wetlands having characteristics like the New England and Adirondack wetlands and the southern wetlands having coastal plain vegetation. While differences exist, there are also some great similarities throughout the Basin, such as the abundance of red maple (*Acer rubrum*) swamps. Freshwater marshes tend to be dominated by one or more of several species, including broad-leaved cattail (*Typha latifolia*), soft rush (*Juncus effusus*), tussock sedge (*Carex stricta*), bluejoint (*Calamagrostis canadensis*), rice cutgrass, reed canary grass (*Phalaris arundinacea*), sweet flag (*Acorus calamus*), broadleaf arrowhead, wool grass (*Scirpus cyperinus*), tearthumbs (*Polygonum sagittatum and P. arifolium*), willow-herbs (*Epilobium* spp.), and water willow (*Decodon verticillatus*). Common dominants of shrub swamps are buttonbush (*Cephalanthus occidentalis*), alders (*Alnus* spp.), swamp rose (*Rosa palustris*), willows (*Salix* spp.), silky dogwood (*Cornus amonum*), arrowwoods (*Viburnum* spp.), meadowsweet (*Spiraea latifolia and S. alba*), steeplebush (*Spiraea tomentosa*), highbush blueberry (*Vaccinium corymbosum*), sweet pepperbush (*Clethra alnifolia*), and saplings of trees, such as red maple. Wax myrtle (*Myrica cerifera*) forms shrub thickets in freshwater tidal areas in Delaware, while sweet gale (*Myrica gale*) and leatherleaf (*Chamaedaphne calyculata*) dominate low

shrub swamps in the northern part of the Basin. Forested wetlands are largely dominated by red maple throughout the Basin, with sweet gum (*Liquidambar styraciflua*), black gum (*Nyssa sylvatica*), loblolly pine (*Pinus taeda*), green ash (*Fraxinus pennsylvanica*), sweet bay (*Magnolia virginiana*) and river birch (*Betula nigra*) among the more common associates in southern areas and with white ash (*Fraxinus americana*), yellow birch (*Betula alleghaniensis*) and hemlock (*Tsuga canadensis*) in the north. Other northern forested wetlands may be dominated by hemlock with an understory of rose bay (*Rhododendron maximum*), or by black spruce (*Picea mariana*) and larch (*Larix laricina*). Southern forested wetland dominants include loblolly pine and sweet gum. In the central part of the Basin (the Piedmont), box elder (*Acer negundo*), sycamore (*Platanus occidentalis*), and silver maple (*Acer saccharinum*) are important species in temporarily flooded forested wetlands.

Lacustrine wetlands are largely restricted by definition to marshes dominated by nonpersistent vegetation and aquatic beds along the shores of lakes and reservoirs. The emergent marshes may be colonized by arrowheads, three-way sedge (*Dulichium arundinaceum*), spikerushes (*Eleocharis* spp.), burreeds, rushes (*Juncus* spp.), smartweeds, pickerelweed and arrow arum. The aquatic beds may be dominated by floating-leaved forms such as spatterdock, white water lily, and water shield (*Brasenia schreberi*), by free-floating forms like duckweeds (*Spirodela polyrhiza, Lemna* spp., and *Wolffia* spp.) and bladderworts (*Utricularia* spp.), or by submergent species including many pondweeds, naiads (*Najas* spp.), waterweeds (*Elodea* spp.) and coontail (*Ceratophyllum demersum*).

EXTENT AND DISTRIBUTION OF WETLANDS IN THE BASIN

The Delaware River Basin includes an estimated 762,000 acres of wetlands which comprise about 9% of the Basin's land surface area. About 48% of these wetlands are in New Jersey, with lesser amounts in the other states: 20% in New York, 18% in Delaware, 14% in Pennsylvania, and only a negligible amount in Maryland. Approximately 200,000 acres of estuarine wetlands are present in the southernmost portion of the Basin. These wetlands are associated with Delaware Bay and they occur in New Jersey (roughly 62%) and Delaware (about 38%). The Basin includes slightly more than a third of New Jersey's estuarine wetlands and roughly 85% of Delaware's estuarine wetlands.

The majority of the Basin's wetlands (roughly 562,000 acres) are freshwater wetlands, mostly palustrine nontidal wetlands, but a few thousand acres of tidal freshwater marshes and flats exist. New Jersey and New York account for nearly 70% of the Basin's freshwater wetlands, with New Jersey alone representing 43%. Pennsylvania has about 19% of these wetlands and Delaware 11%.

WETLAND VALUES

The Basin's wetlands have been traditionally used for many purposes, including hunting, trapping, fishing, timber, hay production, and livestock grazing. Many of these uses tend to preserve the wetland's integrity, although the qualitative nature of the wetland may be modified by salt hay production, timber harvest, and other intensive uses. Mining of peat from wetlands in the Pocono region of Pennsylvania, drainage of wetlands for agriculture, and filling for industrial and residential development are destructive and often irreversible actions that destroy all or nearly all of the values wetlands provide. In their natural condition, wetlands produce many benefits to society that can be divided into three groups: (1) fish and wildlife values, (2) environmental quality values, and (3) socio-economic values. The following discussion highlights the more significant values. For an indepth examination of wetland values, please refer to *Wetland Functions and Values: The State of Our Understanding* (Greeson, *et al.* 1979).

Fish and Wildlife Values

Fish and wildlife utilize wetlands in a variety of ways, with some spending their entire lives in wetlands and others using wetlands for various periods of time during their lives, such as nursery grounds or feeding. Wetlands are also essential for the majority of endangered plants and numerous rare and endangered animals.

Coastal and inland wetlands are important fish habitats, while coastal wetlands are also essential for shellfish, such as shrimp, crabs, oysters, and clams. Approximately two-thirds of the major U.S. commercial fishes depend on estuaries and associated marshes for nursery or spawning grounds (McHugh 1966). Some of the more familiar wetland-dependent fishes are menhaden, bluefish, fluke, white perch, sea trout, mullet, croaker, striped bass and drum. Nearly all freshwater fishes can be considered wetland-dependent because: (1) many species feed in wetlands or upon wetland-produced food, (2) many fishes use wetlands as nursery grounds, and (3) almost all important recreational fishes spawn in the aquatic portions of wetlands (Peters, *et al.* 1979). Alewife, blueback herring, and American shad are anadromous species that spawn in freshwater tributaries of the Delaware River.

Avian use of wetlands is widespread. Salt marshes are used for nesting by many birds, including laughing gulls, Forster's terns, sharp-tailed sparrows, seaside sparrows, clapper rails, black ducks, blue-winged teals, willets and marsh hawks. Wading birds like great blue herons, little blue herons, black-crowned night herons, glossy ibises, common egrets and snowy egrets feed in Delaware Bay's coastal marshes and nest in adjacent woody vegetation. Delaware Bay coastal marshes are also important feeding and stopover areas for migratin

greater snow geese, black ducks, brant, Canada geese, mallards, shorebirds and wading birds (Tiner 1985a and 1985b). Tidal freshwater wetlands along the Delaware River are used for nesting by at least 48 species of birds, including redwinged blackbirds, long-billed marsh wrens, least bitterns, clapper rails, American goldfinches, swamp sparrows, common yellowthroats, yellow warblers, wood ducks, green herons and common gallinules (Hawkins and Leck 1977). In Tinicum Marsh, outside of Philadelphia, 119 species of birds have been reported (McCormick 1970). Inland wetlands are also important nesting, feeding, and resting areas. From 40-45 nesting species were observed in hardwood swamps of southern New Jersey (Wander 1980). Songbirds, such as yellowthroats, towhees, great crested flycatchers, ovenbirds, and several types of warblers build nests in forested wetlands. American bitterns, various waterfowl, long-billed marsh wrens, redwinged blackbirds, swamp sparrows and song sparrows are also among the many birds nesting in freshwater wetlands.

Mammals also utilize wetlands within the Basin. Among the more important wetland-dependent species are muskrats and beavers. Muskrats are more abundant and wide-ranging, inhabiting both coastal and inland marshes, while beavers tend to be restricted to inland wetlands. Beaver are an important factor in creating wetland by damming up streams and creating impoundments that are important for wood ducks and other waterbirds. Other wetland-utilizing mammals include river otters, minks, raccoons, skunks, foxes, weasels, marsh and swamp rabbits, rice rats, numerous mice, meadow voles, bog lemmings, and shrew. Large mammals, i.e., white-tailed deer and black bear, frequently inhabit wetlands. Deer depend on evergreen forested wetlands for winter shelter and food, while black bear spend a majority of their time in forested and mixed forested-shrub swamps in the Pocono region.

Other animals, such as many reptiles (turtles and snakes) and nearly all amphibians (frogs and salamanders), also depend on wetlands. Among the more common species in the Basin are the painted turtle, spotted turtle, snapping turtle, northern water snake, bull frog, green frog, and spring peepers.

Environmental Quality Values

Besides providing habitat for fish and wildlife, wetlands play a less conspicuous but essential role in maintaining high environmental quality, especially in aquatic habitats. They do this in a number of ways, including purifying natural waters by removing nutrients, chemical and organic pollutants, and sediment, and producing food which supports aquatic life.

Wetlands help maintain good water quality or improve degraded waters in several ways: (1) nutrient removal and retention, (2) processing chemical and organic wastes, and (3) reducing the sediment load of water. Wetlands are particularly good water filters because of their locations between land and open water. Thus, they can both intercept runoff from land before it reaches the water and help filter nutrients, wastes and sediment from flooding waters. Clean waters are important to humans as well as to aquatic life.

Wetlands remove nutrients, especially nitrogen and phosphorus, and other waste products from flooding waters for plant growth and help prevent eutrophication or over-enrichment of natural waters. Sloey and others (1978) summarize the value of freshwater wetlands at removing nitrogen and phosphorus from the water and address management issues. Numerous scientists have proposed that certain types of wetlands be used to process domestic wastes and some wetlands are already used for this purpose (Sloey, *et al.* 1978; Carter, *et al.* 1979; Kadlec 1979). New Jersey's freshwater tidal wetlands may be valuable as tertiary treatment systems (Whigham and Simpson 1976). It is, however, possible to overload a wetland and thereby reduce its ability to perform this function. Every wetland has a limited capacity to absorb nutrients and individual wetlands differ in their ability to do so.

Perhaps the best known example of the importance of wetlands for water quality improvement is Tinicum Marsh (Grant and Patrick 1970). Tinicum Marsh is a 512 acre freshwater tidal marsh lying just south of Philadelphia, Pennsylvania. Three sewage treatment plants discharge treated sewage into marsh waters. On a daily basis, it was shown that this marsh removes from flooding waters—7.7 tons of biological oxygen demand, 4.9 tons of phosphorus, 4.3 tons of ammonia, and 138 pounds of nitrate. In addition, Tinicum Marsh adds 20 tons of oxygen to the water each day.

Recently, the ability of wetlands to retain heavy metals has been reported (Simpson, *et al.* 1983). Wetland soils have been regarded as primary sinks for heavy metals, while wetland plants may play a more limited role. Waters flowing through urban areas often have heavy concentrations of heavy metals (e.g., cadmium, chromium, coppper, nickel, lead, and zinc). The ability of freshwater tidal wetlands along the Delaware River in New Jersey to sequester and hold heavy metals has been documented (Simpson, *et al.* 1983). Additional study is needed to better understand retention mechanisms and capacities in these and other types of wetlands.

Wetlands also play a valuable role in reducing turbidity of flooding waters. This is especially important for aquatic life and for reducing siltation of ports, harbors, rivers and reservoirs. Removal of sediment load is also valuable because sediments often transport absorbed nutrients, pesticides, heavy metals and other toxins which pollute our nation's waters (Boto and Patrick 1979).

Wetlands are among the most productive ecosystems in the world and they may be the highest, rivaling our best cornfields. Wetland plants are particularly efficient converters of solar energy. Through photosynthesis, plants convert sunlight into plant material or biomass and produce oxygen as a by-product. Other materials, such as organic matter, nutrients, heavy metals, and sediment captured by wetlands are either stored in the sediment or converted to biomass. This biomass serves as food for a multitude of animals, both aquatic

and terrestrial. For example, many waterfowl depend heavily on seeds of marsh plants, while muskrat eat cattail tubers and young shoots. Although direct grazing of wetland plants may be considerable in freshwater marshes, their major food value to most aquatic organisms is reached upon death when plants fragment to form "detritus." This detritus forms the base of an aquatic food web that supports higher consumers, e.g., commercial fishes (Figure 4). Thus, wetlands can be regarded as the farmlands of the aquatic environment where great volumes of food are produced annually. The majority of non-marine aquatic animals also depend, either directly or indirectly, on this food source.

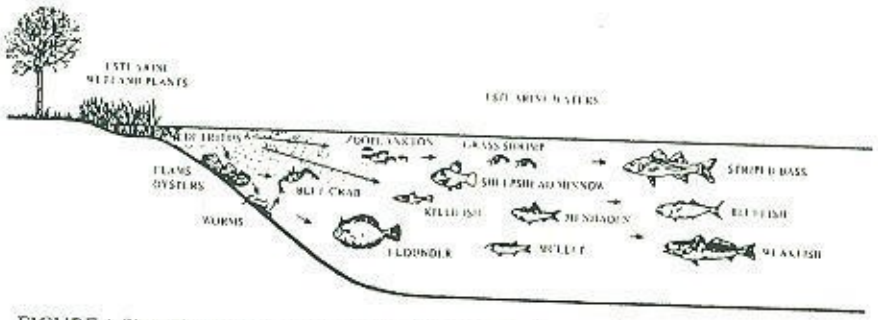

FIGURE 4. Simplified food pathways from estuarine wetland vegetation to commercial and recreational fishes of importance to people.

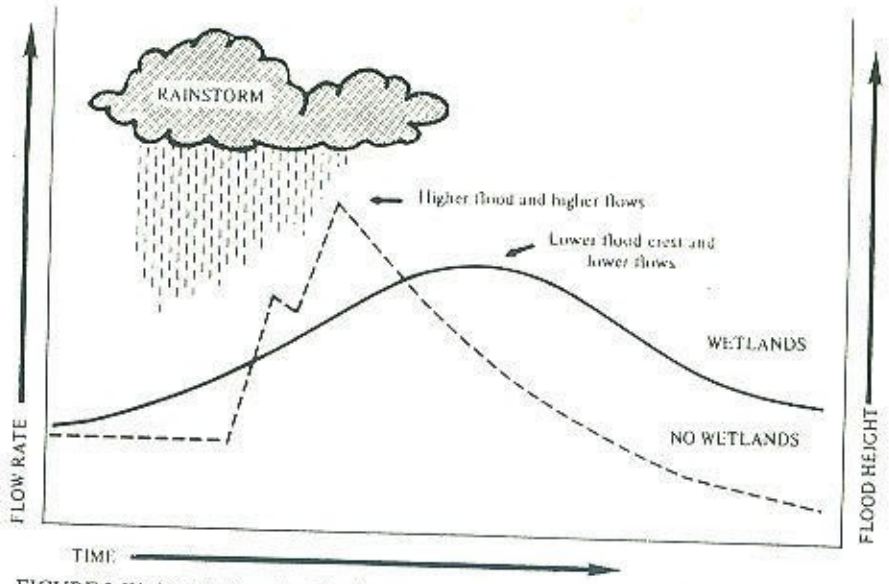

FIGURE 5. Wetlands help reduce flood crests and flow rates in rivers and streams, especially after rainstorms (adapted from Kusler 1983).

Socio-economic Values

The more tangible benefits of wetlands to society may be considered socio-economic values and they include flood and storm damage protection, erosion control, water supply and ground-water recharge, harvest of natural products, livestock grazing and recreation. Since these values provide either dollar savings or financial profit, they are more easily understood by most people.

In their natural condition, wetlands serve to temporarily store flood waters, thereby protecting downstream property owners from flood damage. This flood storage function also helps to slow the velocity of water and lower wave heights, reducing the water's erosive potential (Figure 5). Rather than having all flood waters flowing rapidly downstream and destroying private property and crops, wetlands slow the flow of water, store it for a period of time and slowly release stored waters downstream. This becomes increasingly important in urban areas where development has increased the rate and volume of surface water runoff and the potential for flood damage. Protection of wetlands is, therefore, an important means to minimizing flood damages in the future.

Located between watercourses and uplands, wetlands help protect uplands from erosion. Wetland vegetation can reduce shoreline erosion in several ways, including: (1) increasing durability of the sediment through binding with its roots, (2) dampening waves through friction, and (3) reducing current velocity through friction (Dean 1979). This process also helps reduce turbidity and thereby improves water quality.

There is considerable debate over the role of wetlands in ground-water recharge, i.e., their ability to add water to the underlying aquifer or water table. Recharge potential of wetlands varies according to numerous factors, including wetland type, geographic location, season, soil type, water table location and precipitation. In general, researchers believe that most wetlands do not serve as ground-water recharge sites (Carter, *et al.* 1979). A few studies, however, have shown that certain wetland types may help recharge ground-water supplies (Stewart and Kantrud 1972; Odum, *et al.* 1975; Klopatek 1978; Ballard 1979). In urban areas where municipal wells pump water from streams and adjacent wetlands, "induced infiltration" may draw in surface water from wetlands into public wells. This type of human-induced recharge has been observed in Burlington, Massachusetts (Mulica 1977). These studies and others suggest that additional research is needed to better assess the role of wetlands in ground-water recharge.

A variety of natural products are produced by wetlands, including timber, fish and shellfish, wildlife, cranberries, blueberries, and wild rice. Wetland grasses are hayed in many places for winter livestock feed. During other seasons, livestock graze directly in many wetlands. Along Delaware Bay, many tidal marshes have been impounded for producing salt hay. These and other products are harvested for human use and provide a livelihood for many people.

In the Pocono region, some wetlands are mined for peat which is used mainly for enriching garden soils. Unfortunately, peat mining destroys natural wetlands and most of their associated values.

Many recreational activities take place in and around wetlands. Hunting and fishing are popular sports. Waterfowl hunting is a major activity in wetlands, but big game hunting is also important locally. In 1980, 5.3 million people spent $638 million on hunting waterfowl and other migratory birds (U.S. Department of the Interior and Department of Commerce 1982). Saltwater recreational fishing has increased dramatically over the past 20 years, with half of the catch represented by wetland-associated species. Moreover, nearly all freshwater fishing is dependent on wetlands. In 1975 alone, sportfishermen spent $13.1 billion to catch wetland-dependent fishes in the U.S. (Peters, *et al.* 1979). Other recreation in wetlands is largely non-consumptive and involves activities like hiking, nature observation and photography, and canoeing and other boating. Many people simply enjoy the beauty and sounds of nature and spend their leisure time walking or boating in or near wetlands and observing plant and animal life. This aesthetic value is extremely difficult to evaluate or place a dollar value upon. Nonetheless, it is a very important one because in 1980, 28.8 million people (17% of the U.S. population) took special trips to observe, photograph or feed wildlife. Moreover, about 47% of all Americans showed an active interest in wildlife around their homes (U.S. Department of the Interior and Department of Commerce 1982).

WETLAND TRENDS

Nationally, only 99 million acres or 46% of the country's original wetlands remained in the mid-1970s (Frayer, *et al.* 1983; Tiner 1984). Between the mid-50s and mid-70s, annual wetland losses averaged 458,000 acres—an area half the size of Rhode Island. Agricultural conversion was responsible for 87% of these recent losses, while urbanization represented 8%.

For the Delaware River Basin, no specific basinwide data on wetland trends exist, however, recent data collected by the U.S. Fish and Wildlife Service point to a continued decline in wetland acreage. For example, Delaware has lost about 21% of its inland wetlands between the mid-50s and late 70s, mostly due to late agricultural conversion and associated channelization and ditching projects. Pennsylvania has recently lost about 6% of its vegetated wetlands, with the northern part of the Pocono region losing about 15% of its wetlands. Conversion of wetlands to ponds, lakes and reservoirs was responsible for 46% of the statewide losses, while agriculture and urban development made up 17% and 14% of the losses, respectively. These data leave little doubt that the Basin's wetlands continue to be under pressure for development.

WETLAND PROTECTION

While significant losses of wetlands have occurred in the Basin between the mid-50s and mid-70s, recent state and federal laws provide opportunities for improved wetland protection. All states within the Basin have some form of wetland protection. Delaware (1973) and New Jersey (1970) both have strong coastal wetland protection programs, but lack a statewide inland wetland regulatory program. New York (1975) regulates certain uses of wetlands 12.4 acres and larger in size, but exempts drainage for crop production. Pennsylvania (1978) has the most comprehensive regulatory program with no size limit to regulated wetlands and no agricultural exemption. The federal government's role in wetland regulation increased in the early 1970s with passage of the Federal Water Pollution Control Act (later amended as the Clean Water Act). This law requires that landowners obtain permits from the U.S. Army Corps of Engineers for discharge of dredged or fill material into wetlands, with exemptions for normal farming and silviculture including minor drainage. Although this law and the River and Harbor Act of 1899 have the potential to regulate all wetlands, Corps regulations have limited the scope of wetland regulation. While the existence of these federal and state laws provides improved protection of wetlands, wetlands will remain under intense pressure by agricultural and urban development interests.

Acquisition of individual wetlands by public agencies and private environmental groups is an important part of wetland protection, but such efforts will not be sufficient to adequately preserve our wetland resources. Wetland regulatory programs at local, state and federal levels must be strengthened to enhance other wetland protection efforts. Also, the general public must be better informed on wetland values and the consequences of continued losses. Public and private cooperation is crucial to protecting our remaining wetlands as ways must be found to achieve economic growth, while minimizing adverse environmental impacts. It is in the public's best interest to protect wetlands and the multitude of values they provide for themselves and for future generations.

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