Connecticut
Wetland Resources

Connecticut's diverse wetlands are valued for the environmental and economic benefits they provide, such as wildlife habitat, water-quality improvement, flood and erosion control, recreation, hunting, trapping, and esthetic beauty. Wetlands provide food, shelter, and breeding and nursery grounds for fish, shellfish, birds, and other wildlife, many of whose populations are threatened or endangered. The quality of water that passes through wetlands is typically enhanced by physical and biochemical processes. Undeveloped floodplain wetlands along the Connecticut River and other rivers in the State provide natural storage that helps regulate floodwaters. Because wetlands are valuable to the people of Connecticut, the Federal and State governments own and protect several wetlands, such as Robbins Swamp (fig. 1).

TYPES AND DISTRIBUTION

Wetlands are lands transitional between terrestrial and deepwater habitats where the water table usually is at or near the land surface or the land is covered by shallow water (Cowardin and others, 1979). The distribution of wetlands and deepwater habitats in Connecticut is shown in figure 2*A*; only wetlands are discussed herein.

Wetlands can be vegetated or nonvegetated and are classified on the basis of their hydrology, vegetation, and substrate. In this summary, wetlands are classified according to the system proposed by Cowardin and others (1979), which is used by the U.S. Fish and Wildlife Service (FWS) to map and inventory the Nation's wetlands. At the most general level of the classification system, wetlands are grouped into five ecological systems: Palustrine, Lacustrine, Riverine, Estuarine, and Marine. The Palustrine System includes only wetlands, whereas the other systems comprise wetlands and deepwater habitats. Wetlands of the systems that occur in Connecticut are described below.

System	Wetland description
Palustrine	Nontidal and tidal-freshwater wetlands in which vegetation is predominantly trees (forested wetlands); shrubs (scrub-shrub wetlands); persistent or nonpersistent emergent, erect, rooted herbaceous plants (persistent- and nonpersistent-emergent wetlands); or submersed and (or) floating plants (aquatic beds). Also, intermittently to permanently flooded open-water bodies of less than 20 acres in which water is less than 6.6 feet deep.
Lacustrine	Nontidal and tidal-freshwater wetlands within an intermittently to permanently flooded lake or reservoir larger than 20 acres and (or) deeper than 6.6 feet. Vegetation, when present, is predominantly nonpersistent emergent plants (nonpersistent-emergent wetlands), or submersed and (or) floating plants (aquatic beds), or both.
Riverine	Nontidal and tidal-freshwater wetlands within a channel. Vegetation, when present, is same as in the Lacustrine System.
Estuarine	Tidal wetlands in low-wave-energy environments where the salinity of the water is greater than 0.5 part per thousand (ppt) and is variable owing to evaporation and the mixing of seawater and freshwater.

According to a survey conducted in the early 1980's by the Connecticut Department of Environmental Protection on contract to the FWS National Wetland Inventory (Metzler and Tiner, 1992), wetlands covered about 172,500 acres, or about 5 percent, of Connecticut at that time. Wetlands were defined on the basis of aerial-photo interpretation of visible vegetation types and hydrology. Evaluations of the accuracy of the National Wetland Inventory maps for Vermont and Massachusetts, which were produced using the same techniques as for the Connecticut inventory, indicated that the 1:24,000-scale maps had accuracies of 91 percent and greater than 95 percent, respectively, in those States (Metzler and Tiner, 1992). Wetland area and density are greatest in the eastern part of the State (fig. 2*B*). Palustrine wetlands are by far the most common wetland type in the State, followed by estuarine wetlands (fig. 2*C*); together, they constitute about 99 percent, by area, of the State's wetlands. The combined area of lacustrine and riverine wetlands makes up the remaining 1 percent of wetland acreage. A description of Connecticut's most common wetland types follows.

Palustrine wetlands.—Vegetated palustrine wetlands in Connecticut include ponds and shallow lakes in which the dominant vegetation is floating or submersed (aquatic-bed wetlands); freshwater marshes, fens, and bogs dominated by herbaceous plants (emergent wetlands); and bogs and swamps dominated by shrubs or trees (scrub-shrub or forested wetlands). Palustrine forested wetlands constitute 54 percent of the State's wetlands (Metzler and Tiner, 1992) and consist primarily of red maple swamps with some evergreen forested wetlands. Red maple grows in most inland wetlands because it tolerates a wide range of flooding and soil-saturation conditions. The vegetation found with red maple, in the understory and intermixed or codominating in the canopy, differs according to nutrient conditions and water regime. Evergreen forested wetlands are commonly vegetated by Atlantic white cedar in eastern Connecticut (Metzler and Tiner, 1992) and hemlock or black spruce in western Connecticut (Messier, 1980).

Lacustrine and riverine wetlands.—Although present throughout the State, lacustrine and riverine wetlands comprise only a small percentage of Connecticut's wetland area. These freshwater wetlands generally are restricted to the channel or the shallow zone between the shore and deepwater habitat. If vegetated, they have only aquatic-bed or nonpersistent emergent vegetation. Riverine wetlands are most abundant in the freshwater tidal areas of the Connecticut and Housatonic River (Metzler and Tiner, 1992). Shallow wetlands ad-

Figure 1. Robbins Swamp, near Canaan. This 1,000-acre forested wetland is the largest inland wetland in Connecticut. The wetland provides wildlife habitat, outdoor recreation, and other benefits. Parts are owned by the State and The Nature Conservancy. *(Photograph by Ellen M. Ramsey, The Nature Conservancy.)*

jacent to rivers or lakes are classified as palustrine wetlands if there is persistent emergent vegetation present.

Estuarine wetlands.—Estuarine wetlands consist of salt and brackish marshes (emergent and scrub-shrub wetlands) that have developed in protected coves and embayments along the coast and estuaries adjacent to Long Island Sound. Sparsely vegetated estuarine flats and beaches, alternately flooded by tide or exposed to air, also are present.

HYDROLOGIC SETTING

Wetlands occur in geologic, topographic, and hydrologic settings that enhance the accumulation and retention of ground water, surface water, or both for extended periods of time. Hydrologic processes are the primary factors determining the existence of wetlands; even if the geologic and topographic settings are favorable for wetland formation, unfavorable hydrologic conditions can inhibit wet-

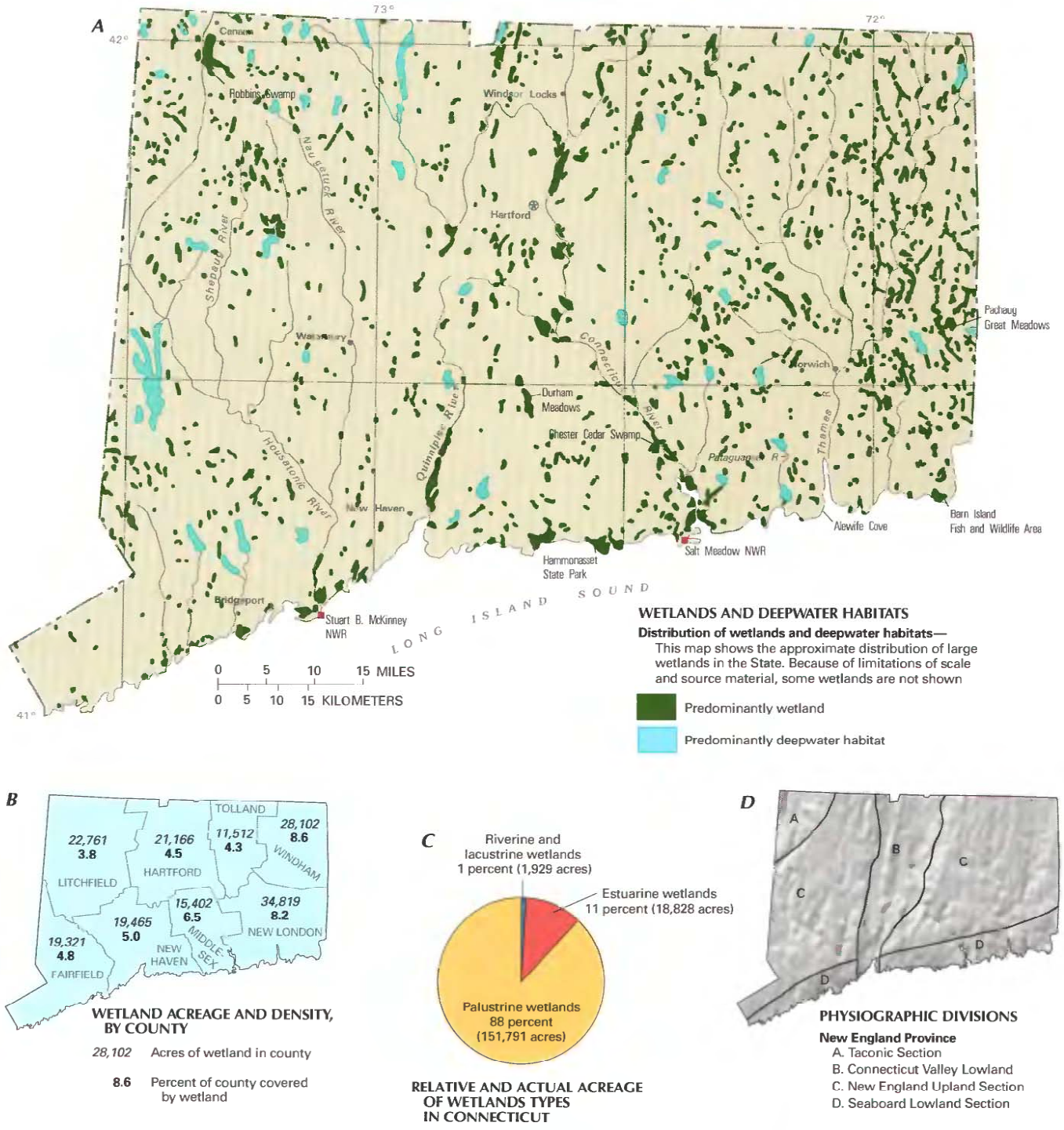

Figure 2. Wetland distribution in Connecticut and physical features that control wetland distribution in the State. ***A***, Distribution of wetlands and deepwater habitats. ***B***, Wetland acreage and density, by county. ***C***, Relative and actual acreage of wetland types in the early 1980's for Connecticut. ***D***, Physiography. *(Sources: A, T.E. Dahl, U.S. Fish and Wildlife Service, unpub. data, 1991. B and C, Data from Metzler and Tiner, 1992. D, Physiographic divisions from Fenneman, 1938; landforms data from EROS Data Center.)*

land formation (Winter, 1988). On an annual basis, precipitation exceeds evapotranspiration losses in Connecticut, resulting in an annual moisture surplus. Hydrology, therefore, favors the formation of wetlands throughout the State, and wetland location is determined primarily by geologic and topographic controls.

Connecticut's physical features—created by geologic forces over millions of years, erosion and deposition from recent glaciation, and human activities—combined with present-day hydrologic conditions, determine the distribution of wetlands in the State. Connecticut can be divided into four physiographic divisions based upon general topographic relief: the Taconic, the Connecticut Valley Lowland, the New England Upland, and the Seaboard Lowland Sections of the New England Province (fig. 2*D*). Topographic relief generally increases from the southeast to northwest corners of the State. Major lowland areas include the Seaboard Lowland, Connecticut Valley Lowland, and, in the New England Upland and Taconic Sections, deep valleys formed of weathered, calcareous bedrock. Connecticut was completely covered by ice during the last glaciation; the ice margin reached its maximum extent at Long Island, New York. Glaciation did little to change the preglacial, fluvially eroded bedrock topography except for locally deepening bedrock hollows and river valleys (Schafer and Hartshorn, 1965). Large quantities of sediment were produced and deposited over bedrock throughout the State. This sediment either was deposited on upland hilltops and slopes as till or was eroded and reworked by glacial meltwater and deposited as stratified drift (sorted and layered glacial sediments). Stratified drift was deposited in topographically low areas—major lowlands such as the Connecticut Valley Lowland and in stream and river valleys throughout the State. Many wetlands in Connecticut occur in the depressions, deepened valleys, and lowlands in which stratified drift was deposited.

Inland wetlands.—During deglaciation, a series of large glacial lakes occupied the Connecticut Valley Lowland, and smaller lakes occurred along many river valleys throughout the State (Schafer and Hartshorn, 1965). Extensive areas of flat, slowly permeable stratified drift were deposited on the bottom of these lakes. The generally low relief and poorly permeable substrate of these areas retain surface water or slow its drainage, leading to the formation and maintenance of wetlands. Owing to the low slope of these areas, small drainage obstructions can form large wetlands. Sources of water can be ground-water discharge, surface runoff, or direct precipitation.

Wetlands occur in small and large valleys throughout Connecticut. Some wetlands occupy the depressions, or kettles, left by melting ice blocks in stratified drift. Wetlands also have formed in areas modified by the recent erosion and deposition of rivers—in abandoned river channels, behind levees and overbank sediments adjacent to rivers, and in backswamp areas. In the New England Upland and Taconic Sections, the hilly topography of upland areas of till or bedrock generally does not retain surface runoff. Wetlands form primarily in isolated depressions where surface runoff and ground-water discharge collect. The depressions may have no outflow or have drainage controlled by bedrock sills, stratified drift, beaver dams, or manmade structures. Seepage wetlands may form where the water table intersects the land surface, such as on concave slopes and at breaks in slope; however, the wetlands are perennial only if ground-water discharge is perennial (Winter, 1988).

The position of a wetland in the landscape determines the nutrient status and vegetative characteristics of the wetland (Damman and French, 1987). Water that has moved through soil and subsurface materials carries nutrients that encourage plant growth. Wetlands in upland till and bedrock depressions are primarily areas of discharge from nutrient-poor, local ground-water flow systems, whereas wetlands in lowland stratified-drift valleys receive discharge from more nutrient-enriched ground-water flow systems (Winter, 1988). Wetlands in the New England Upland and Taconic Sections, which are underlain by metamorphosed calcareous rocks, are distinct from those in the more widespread acidic bedrock areas of the State. Soils and ground water derived from calcareous rocks are rich in nutrients, resulting in wetlands such as Robbins Swamp that support a lush and diverse flora (Dowhan and Craig, 1976).

As vegetation became established after glacial retreat and developed in response to the warming climate, open-water areas filled with sediment or organic matter to become wetlands or remained lakes with wetlands fringing open water. Studies of upland wetlands in northeastern Connecticut have shown that wetlands have developed over many divergent paths in the time since deglaciation (Thorson, 1990, 1992; Thorson and Harris, 1991). Postsettlement agricultural and industrial practices, rather than natural ecological factors, determined the present-day character of all previously existing wetlands. In addition, many wetlands were formed since settlement as a result of the effects of colonial land use and the construction of cattle-watering sites, ice ponds, and mill ponds for water-powered industries.

Tidal wetlands.—Wetlands in coastal areas of Connecticut have water-level fluctuations that are driven largely by ocean tides. Tidal wetlands form a continuum from estuarine to tidal riverine to palustrine wetlands. The effects of wave energy and salinity on the wetlands diminish along this continuum, although not necessarily at the same rate. Tidal effects are present in the Connecticut River as far as Windsor Locks near the Massachusetts border, whereas wetlands have graded from salt and brackish to freshwater before reaching Hartford. Tidal wetlands receive freshwater input from upland areas through ground-water discharge, stream overflow, and hillslope runoff. Regional ground-water discharge is greatest near the break in slope between upland and coastal areas, and intermediate and local ground-water flow systems increase in importance in low areas (Winter, 1988). Floodwater resulting from high tides or stormflows may be temporarily stored on the wetland surface. The drainage of floodwater and hillslope runoff from the wetland surface is slowed by the low slope of coastal areas. Major areas of tidal wetlands are shown along major portions of the Housatonic, Quinnipiac, and Connecticut Rivers in figure 2*A*.

The major factors affecting the development and persistence of tidal wetlands are the postglacial rise of sea level relative to the land, the tidal regime, the supply of sediments to the wetland, and the ability of plants to survive submergence by saltwater (Redfield, 1972). Unless the submergence of tidal wetlands by rising sea level is counteracted by the vertical accretion of the wetland by sediment deposition and plant accumulation, the wetland will drown and become a deepwater habitat. When the glaciers melted, the sea rose and encroached upon land, inundating many stream and river valleys to form estuaries. Tidal wetlands either have migrated inland along estuaries, river valleys, and coastal slopes or the wetlands have been completely inundated. Salt-marsh peats, as much as 12.5 feet thick, overlie freshwater peats in parts of the Pataguanset River valley and indicate the change in wetland type in response to changing sea levels 4,000 years ago (Orson and others, 1987). Presently, tidal wetlands exist in a narrow setting between rising sea level and expanding coastal development. As sea level continues to rise, the migration of these wetlands inland is hindered by historic alteration of coastal-margin wetlands and by present development.

TRENDS

The FWS has estimated that Connecticut lost 74 percent of its original wetlands over the 200-year period between the 1780's and the 1980's (Dahl, 1990). The FWS estimate is based on the assumption that Connecticut originally had about 670,000 acres of wetlands. However, Metzler and Tiner (1992) discuss some of the limitations of the methods used in the FWS inventory to estimate predevelopment

and recent wetland acreage when applied to Connecticut. They believe that statewide wetland losses of one-third to one-half are more realistic (Metzler and Tiner, 1992). The Connecticut Department of Environmental Protection estimates losses of 40 to 50 percent for freshwater wetlands and 65 percent for coastal wetlands.

Some tidal wetlands have been created through the effects of human activities. Barske (1988) describes the development of 700 acres of salt marsh at the mouth of the Housatonic River through the accumulation of sediment, the result of upstream deforestation and other activities. Often, however, human activities lead to the degradation of tidal wetlands. The elimination or restriction of tidal flow commonly results in reduced salinity, lowered water tables, subsidence of wetlands peats, and conversion of wetland vegetation to less salt-tolerant species (Roman and others, 1984; Rozsa, 1988). Roman and others (1984) estimate that 10 percent of Connecticut's salt marshes are subject to tidal-flow restriction. Loss of upstream freshwater wetlands, separation of watercourses and remaining upstream wetlands from downstream areas by a railroad right-of-way, and loss of downstream tidal marshes have all contributed to a reduction of productivity in Alewife Cove, an estuary on Long Island Sound (Welsh and others, 1976). Several degraded coastal wetlands in Connecticut are the site of restoration projects. The U.S. Army Corps of Engineers (Corps), in cooperation with the Connecticut Department of Environmental Protection, is working to identify and restore salt marshes that have been degraded as a result of tidal-flow restriction.

CONSERVATION

Many government agencies and private organizations participate in wetland conservation in Connecticut. The most active agencies and organizations and some of their activities are listed in table 1.

Table 1. Selected wetland-related activities of government agencies and private organizations in Connecticut, 1993

[Source: Classification of activities is generalized from information provided by agencies and organizations. •, agency or organization participates in wetland-related activity; .. , agency or organization does not participate in wetland-related activity. MAN, management; REG, regulation; R&C, restoration and creation; LAN, land acquisition; R&D, research and data collection; D&I, delineation and inventory]

Agency or organization	MAN	REG	R&C	LAN	R&D	D&I
FEDERAL						
Department of Agriculture						
Consolidated Farm Service Agency	..	•		.		
Forest Service	..		.		.	•
Natural Resources Conservation Service			•		•	•
Department of Commerce						
National Oceanic and						
Atmospheric Administration	•	•		.		
Department of Defense						
Army Corps of Engineers	•	•	•	•	•	•
Military reservations	•				.	..
Department of the Interior						
Fish and Wildlife Service	•		•	•	•	•
National Biological Service					•	.
Environmental Protection Agency		•			.	•
STATE						
Department of Environmental Protection	•	•	•	•	•	•
Department of Transportation	•	.	•	•	•	•
University of Connecticut					•	
TOWN AND CITY CONSERVATION COMMISSIONS	•	•			•	.
PRIVATE ORGANIZATIONS						
Connecticut Audubon Society	•		.	•	•	•
Ducks Unlimited				.	•	•
The Nature Conservancy	•			•	•	•

Federal wetland activities.—Development activities in Connecticut wetlands are regulated by several Federal statutory prohibitions and incentives that are intended to slow wetland losses. Some of the more important of these are contained in the 1899 Rivers and Harbors Act; the 1972 Clean Water Act and amendments; the 1985 Food Security Act; the 1990 Food, Agriculture, Conservation, and Trade Act; the 1986 Emergency Wetlands Resources Act; and the 1972 Coastal Zone Management Act.

Section 10 of the Rivers and Harbors Act gives the Corps authority to regulate certain activities in navigable waters. Regulated activities include diking, deepening, filling, excavating, and placing of structures. The related section 404 of the Clean Water Act is the most often-used Federal legislation protecting wetlands. Under section 404 provisions, the Corps issues permits regulating the discharge of dredged or fill material into wetlands. Permits are subject to review and possible veto by the U.S. Environmental Protection Agency, and the FWS has review and advisory roles. Section 401 of the Clean Water Act grants to States and eligible Indian Tribes the authority to approve, apply conditions to, or deny section 404 permit applications on the basis of a proposed activity's probable effects on the water quality of a wetland.

Most farming, ranching, and silviculture activities are not subject to section 404 regulation. However, the "Swampbuster" provision of the 1985 Food Security Act and amendments in the 1990 Food, Agriculture, Conservation, and Trade Act discourage (through financial disincentives) the draining, filling, or other alteration of wetlands for agricultural use. The law allows exemptions from penalties in some cases, especially if the farmer agrees to restore the altered wetland or other wetlands that have been converted to agricultural use. The Wetlands Reserve Program of the 1990 Food, Agriculture, Conservation, and Trade Act authorizes the Federal Government to purchase conservation easements from landowners who agree to protect or restore wetlands. The Consolidated Farm Service Agency (formerly the Agricultural Stabilization and Conservation Service) administers the Swampbuster provisions and Wetlands Reserve Program. The Natural Resources Conservation Service (formerly the Soil Conservation Service) determines compliance with Swampbuster provisions and assists farmers in the identification of wetlands and in the development of wetland protection, restoration, or creation plans.

The 1986 Emergency Wetlands Resources Act and the 1972 Coastal Zone Management Act and amendments encourage wetland protection through funding incentives. The Emergency Wetland Resources Act requires States to address wetland protection in their Statewide Comprehensive Outdoor Recreation Plans to qualify for Federal funding for State recreational land; the National Park Service (NPS) provides guidance to States in developing the wetland component of their plans. Coastal States that adopt coastal-zone management programs and plans approved by the National Oceanic and Atmospheric Administration are eligible for Federal funding and technical assistance through the Coastal Zone Management Act.

Federal agencies are responsible for the proper management of wetlands on public lands under their jurisdiction. The FWS protects and manages wetlands in two National Wildlife Refuges—the Stewart B. McKinney National Wildlife Refuge and the Salt Meadow National Wildlife Refuge. The Corps manages and conserves forests, water, fish, wildlife, wetlands, and recreation areas for multiple uses at dams, reservoirs, and parks located throughout the State.

State wetland activities.—Tidal wetlands are protected under the Tidal Wetlands Act of 1969 and the Coastal Management Act of 1979. Activities in tidal wetlands are regulated at the State level with exemptions for mosquito control, conservation, navigation, and emergency activities. Tidal wetlands are defined by the State as areas that border or lie beneath tidal waters and that contain certain plant species. About 15,000 acres of tidal salt marsh and 7,000 acres of

brackish and freshwater tidal wetlands are regulated under this statute (Lefor and Tiner, 1972).

Nontidal freshwater wetlands are protected under the Inland Wetlands and Watercourses Act of 1972. Inland wetlands are regulated according to State standards by local inland wetlands and watercourses commissions. Permits are required for all activities within wetlands with exemptions for agricultural activities, construction and maintenance of water-supply systems, certain conservation and recreation uses, and the enjoyment and maintenance of residential property. Inland wetlands are defined by soil type—poorly drained, very poorly drained, flood-plain, or alluvial soils as delineated by the National Cooperative Soil Survey. Rivers, streams, waterways, and other natural and artificial water bodies are regulated under this statute as watercourses. On the basis of the State's wetland definition, 15 to 20 percent of Connecticut's land is subject to regulation as inland wetlands (Metzler and Tiner, 1992).

Under section 401 of the Federal Clean Water Act, any activity that results in a discharge, including that of fill into wetlands or State waters that requires a federal permit, must also obtain a section 401 water-quality certification stating that the activity will not violate State surface-water-quality standards. Many activities exempted under the Inland Wetlands and Watercourses Act are in the Department of Environmental Protection's jurisdiction under the section 401 certification program; however, normal maintenance and improvement of agricultural lands remain exempt from State and Federal authority. Use of the antidegradation provisions of State surface-water-quality standards on wetlands provides enhanced wetland protection. Antidegradation provisions provide for the protection of existing wetland functions and the level of water quality necessary to maintain and protect those functions. No degradation is allowed in areas designated as "outstanding national resource waters," such as National Wildlife Refuges, National Parks, State parks, wildlife areas, and other areas of ecological significance. The Water Resources Division of the Department of Environmental Protection is responsible for section 401 certifications in Connecticut.

The Department of Environmental Protection is the primary environmental and conservation agency in Connecticut. The Department owns more wetland acreage in Connecticut than does the Federal Government (Metzler and Tiner, 1992). Numerous wetlands are protected in State parks, State forests, and wildlife-management areas throughout the State. Chester Cedar Swamp and Pachaug Great Meadows are partly State-owned wetlands and are designated as National Natural Landmarks by the NPS. The State owns significant portions of wetlands at Robbins Swamp, Durham Meadows, Barn Island Fish and Wildlife Areas, and Hammonasset State Park (Metzler and Tiner, 1992). Wetlands are acquired through the Recreation and Natural Heritage Act and sale of the new Connecticut Waterfowl Hunting Stamp. Funds derived from the stamp will be used solely for wetland acquisition or improvements.

Development projects that cause unavoidable wetlands degradation or loss are required to mitigate or compensate for wetland loss by replacing or providing a substitute wetland resource. The Connecticut State Department of Transportation has been involved in wetlands creation and mitigation projects as a way to offset the long-term effects of highway construction. Wetlands, created and restored as a part of the design, permit, and construction process, have provided lost wetland functions with varying success (Butts, 1988). The Department of Transportation has acquired about 200 acres of wetlands in compensation for wetlands lost through development projects; most of this land has remained under the Department's management. The Department provides funds for wetland-related research primarily at the University of Connecticut.

Local wetland activities.—Inland wetland and watercourse commissions and coastal-area zoning and planning commissions are responsible for planning and regulating wetland-related activities at the town or municipal level. Inland wetland and watercourse commissions regulate activities through permitting under the Inland Wetland and Watercourses Act. Coastal-area zoning and planning commissions balance development and the preservation of environmental values in coastal areas under the Coastal Management Act. The act provides commissions with planning, research, and permitting authority. Education, training, support, and final authority are provided to commissions by the Department of Environmental Protection's Wetland Program.

Private wetland activities.—Private organizations in Connecticut are active in land acquisition and management, research, education, and policy review and planning. The Nature Conservancy protects about 1,800 acres of wetlands within the 9,000 acres of land under its ownership. Ducks Unlimited provides technical and financial assistance to Federal and State agencies in order to protect waterfowl habitat in Connecticut.

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