Wisconsin
Wetland Resources

Wetlands cover more than 5 million acres of Wisconsin. Although once regarded as wastelands, wetlands are now recognized as ecologically and economically valuable ecosystems. The preservation of wetlands is important for the continued survival of much of Wisconsin's plant and wildlife resources. Many fish and wildlife species, including endangered and threatened species, depend on wetlands for survival at one time or another during their life cycles. Animals that depend on wetlands include muskrats, ducks, water snakes, and leopard frogs. Ducks, geese, and other migratory birds depend on wetlands for resting and feeding during migration. Fish, including northern pike, walleye, and muskellunge, use wetlands for spawning and feeding.

Wetlands (such as that shown in figure 1) help maintain water quality by acting as filters that trap suspended sediments and organic and inorganic contaminants suspended or dissolved in the waters that reach them. These trapped pollutants are stored in the wetland soils and plants. Wetlands help to regulate streamflow by temporarily storing floodwater and then slowly releasing it to the stream or river, reducing the magnitude of flooding downstream. Flood peaks in watersheds (drainage basins) containing a large area of wetlands can be as much as 80 percent lower than in watersheds that have few or no wetlands (Novitzki, 1982). Wetlands also protect the shorelines and banks of lakes and rivers from erosion by absorbing wave energy, decreasing water velocity, and increasing soil stability.

Wetlands are productive ecosystems, yielding a large amount of plant material for wildlife and human consumption. Products that are harvested from wetlands include cranberries, wild rice, and sphagnum moss. Wisconsin's tourist industry benefits from the recreational opportunities that wetlands provide, including hunting, fishing, boating, hiking, camping, and bird watching. Many wetland areas throughout the State also provide educational opportunities for schools and the general public.

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 Wisconsin is shown in figure 2A; only wetlands are discussed herein.

Figure 1. Constructed wetland near Tomah in southwestern Wisconsin. *(Photograph by Randall J. Hunt, U.S. Geological Survey.)*

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 Wisconsin are described below.

System	Wetland description
Palustrine	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	Wetlands within an intermittently to permanently flooded lake or reservoir. Vegetation, when present, is predominantly nonpersistent emergent plants (nonpersistent-emergent wetlands), or submersed and (or) floating plants (aquatic beds), or both.
Riverine	Wetlands within a channel. Vegetation, when present, is same as in the Lacustrine System.

About 15 percent (5,300,000 acres) of Wisconsin's land surface is covered by wetlands (fig. 2A) (Wisconsin Department of Natural Resources, 1992a). The Wisconsin Department of Natural Resources completed an inventory of Wisconsin's wetland locations, sizes, and types in 1984. The information from the inventory is being used by the FWS as part of its National Wetlands Inventory project. Currently, this information is available only in map form, and the statewide total acreages for specific wetland types have not yet been computed.

The classification system used by the Department of Natural Resources to map Wisconsin wetlands recognizes seven major classes of wetlands: aquatic bed, moss (moss-lichen wetland), wet meadow (emergent wetland), scrub-shrub, forested, flats/unvegetated wet soils (unconsolidated-shore wetland), and open water (Wisconsin Department of Natural Resources, 1992b). Common types of wetlands in Wisconsin include swamps, marshes, and peatlands. Swamps and marshes are most common in southern Wisconsin, and peatlands are most common in northern Wisconsin (Yanggen and others, 1976). Swamps are palustrine forested wetlands. Marshes are palustrine emergent wetlands dominated by grass, rush, and sedge species. Peatlands, including bogs and fens, are wetlands that accumulate organic material owing to limited inflow and outflow. Peatlands can be forested, scrub-shrub, or emergent wetlands. Scrub-shrub wetlands (wetlands dominated by woody vegetation less than 20 feet tall) are common in Wisconsin and include both deciduous and evergreen vegetation. Many Wisconsin wetlands are riparian (streamside) wetlands adjacent to rivers or streams that periodically flood.

Wetland distribution in Wisconsin is related to the extent of the most recent glaciation. The southwestern part of the State (fig.

2*B*) was not affected by the latest glaciation, and wetlands are uncommon there except in stream valleys filled with glacial drift (Novitzki, 1982). The rest of the State contains glacial deposits and numerous wetlands.

HYDROLOGIC SETTING

Hydrology is the single most important determinant for establishing and maintaining wetlands (Mitsch and Gosselink, 1986). Wetland formation is determined by the balance among the inflows and outflows of water, surface contours of the land, soil type, geology, and ground-water conditions. Topographic depressions caused by glacial and erosional processes, areas underlain by impermeable substrates that prevent infiltration of water into the ground, and areas where the water table is near the land surface provide ideal conditions for wetland formation.

Wisconsin's wetlands generally are in depressions, poorly drained areas, and, rarely, on slopes. All receive surface water, but a large proportion also receive ground water. Wisconsin's wetlands can be divided into four hydrologic classes: surface-water depression, surface-water slope, ground-water depression, and ground-water slope (Novitzki, 1982).

Surface-water-depression wetlands form where overland flow and precipitation collect in a depression. Water leaves this type of wetland by infiltrating through the substrate, evaporating, or being transpired by plants. The water level in surface-water-depression wetlands can fluctuate greatly, depending on surface-water flow.

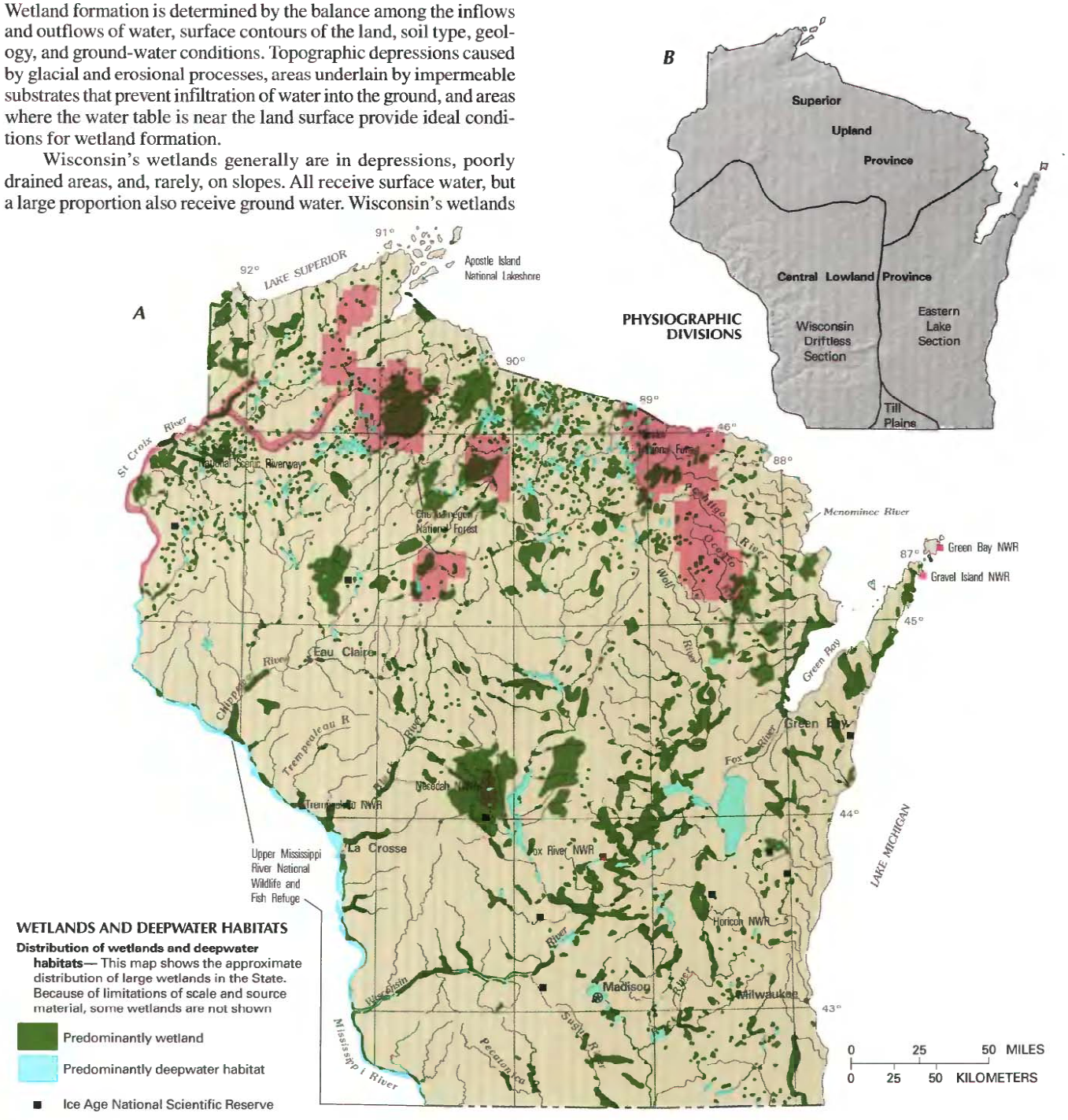

Figure 2. Wetland distribution in Wisconsin and physical features that control wetland distribution in the State. ***A***, Distribution of wetlands and deepwater habitats. ***B***, Physiography. *(Sources: A, T.E. Dahl, U.S. Fish and Wildlife Service, unpub. data, 1991. B, Physiographic divisions from Fenneman, 1946; landforms data from EROS Data Center.)*

Water levels rise during periods of high streamflow and fall during low streamflow. The bottom of the wetland is above the local water table most of the time (Novitzki, 1982). Surface-water depressions typically support ponds, marshes, swamps, and wet meadows (emergent wetlands).

Surface-water-slope wetlands form on or near the margins of lakes and streams. Included in this type of wetland are the shallow part of a lake or river and the bank to the point that is subject to flooding. This type of wetland is generally above the local water table, and floodwaters from the lake or river drain quickly. These wetlands are fed by precipitation, overland flow, and flooding from lakes and rivers (Novitzki, 1982). Surface-water-slope wetlands typically support shrub swamps (scrub-shrub wetland) and shallow marshes.

Ground-water-depression wetlands are located where a depression is below the water table. Water enters the wetland as precipitation, overland flow, and ground-water discharge. There generally is a lack of surface drainage away from this type of wetland. Although ground-water flow can be a small part of the total inflow, it can be an important water source during drought (Novitzki, 1982). Ground-water-depression wetlands typically support forested and shrub bogs, fens, and marshes.

Ground-water-slope wetlands form at ground-water-discharge sites, such as springs and seeps, typically on hillsides or at the bottom of hills where the water table intersects the land surface. These wetlands receive continuous ground-water inflow, but drainage away from the site reduces the ponding of water. The drainage commonly is the headwater of a small stream (Novitzki, 1982). Ground-water-slope wetlands typically support marshes, swamps, and wet meadows.

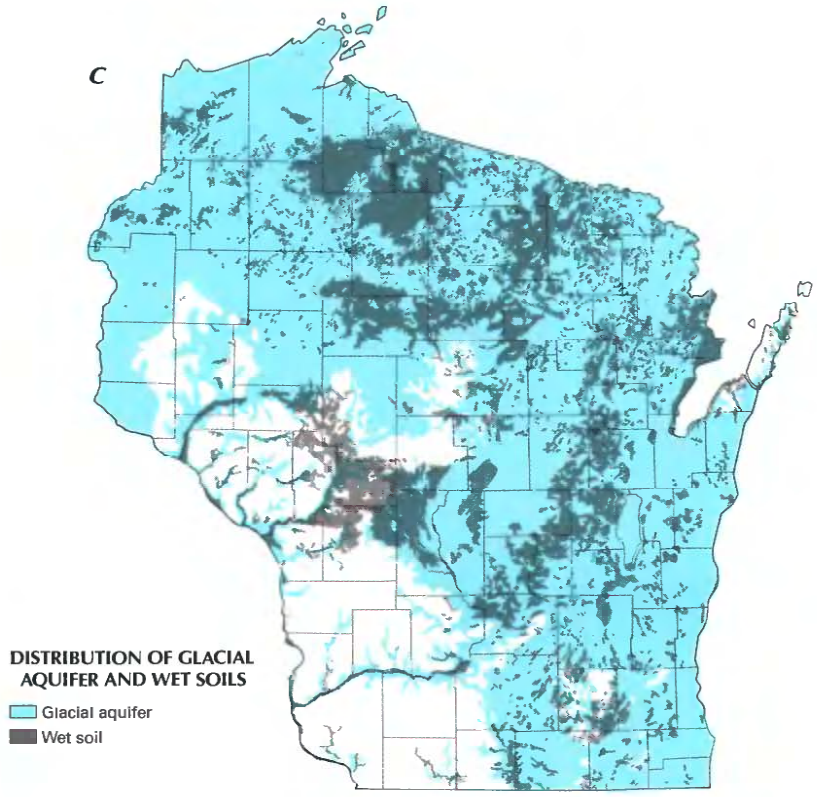

Figure 2. Continued. Wetland distribution in Wisconsin and physical features that control wetland distribution in the State. ***C***, Distribution of glacial aquifers and wet soils. *(Sources: C, Wet soils map from Frazier and Kiefer, 1974; limit of glacial aquifer from Devaul, 1975.)*

Wetlands are most numerous in areas that were covered by glaciers during the most recent glacial period (fig. 2*C*). Glacial erosion and deposition commonly create surface depressions and deposits of impermeable tills (sediments of glacial origin) that are ideal for wetland development (Bushnell, 1989). The unglaciated part of southwestern Wisconsin contains rugged terrain that is conducive to overland runoff, leaving little water for wetland development. Wetlands in the unglaciated areas are most commonly in riparian areas where glacial sediments have been deposited. Riparian wetlands develop either as lateral erosion widens a river valley or as deposition fills and flattens a valley. In riparian wetlands, a depositional substrate of silt, mud, and clay combines with the shallow water table near a river to create ideal conditions for the formation of small lakes and swamps (Bushnell,1989).

Wisconsin has about 43,000 miles of streams and about 15,000 lakes. Statewide, the annual average precipitation is 31 inches and annual evapotranspiration is 20 inches (Krohelski and others, 1990), so there is a moisture surplus on an annual basis. Many of Wisconsin's wetlands are supported by precipitation, either directly by surface-water runoff or indirectly by ground-water flow (Novitzki, 1979). A wetland's water supply is determined by the balance between precipitation and evapotranspiration. In northern Wisconsin, precipitation exceeds evaporation, whereas in the southern and western parts of the State, precipitation and evaporation are about equal (Novitzki, 1982). Therefore, more water is available for wetland formation in northern Wisconsin than in the southern and western parts of the State.

Annual and seasonal variations in precipitation can affect the amount of water available for wetlands. In years when snowmelt produces surface runoff and rain is frequent during the summer, surface-water wetlands have large quantities of water available. If the snowmelt recharges the ground-water system, ground-water wetlands have large amounts of water available to them. In general, water levels are highest in the spring and early summer when snowmelt has collected; levels then decline throughout the rest of the summer when evapotranspiration is at its highest. Ground-water wetlands are more stable than surface-water wetlands during drought because ground-water flow replaces some of the water lost to evapotranspiration (Novitzki, 1982). These natural fluctuations in precipitation quantity cause wetland vegetation to change in response to changes in moisture availability. Natural climatic changes are cyclical, whereas manmade changes, such as draining, cause a more permanent change in hydrology and vegetative types (Novitzki, 1979).

In most of the State, except the southwestern part, basement rocks are covered by unconsolidated glacial deposits, in which formed the kettles and potholes that contain many of the lakes and wetlands in the State. The Wisconsin Driftless Section in the southwestern part of the State is a region over which the most recent continental ice sheets did not pass. This region differs from the surrounding areas in topography and soil (Atwood, 1940). The topography is rugged, and few wetlands exist.

Wisconsin is in the Central Lowland and Superior Upland physiographic provinces (fig. 2*B*). The major surface-water drainage basins in the Central Lowland province are the Trempealeau–Black, Central Wisconsin, Lower Wisconsin, Fox–Wolf, Rock–Fox, and Pecatonica–Sugar River Basins, and the Lake Michigan Basin. The Wisconsin River, the largest in the State, drains the central part

of the State from its headwaters at the Michigan border to its confluence with the Mississippi River. The Rock–Fox River Basin drains the southern part of the State and contains a large number of wetlands, including the 30,000-acre Horicon Marsh, which is located in the headwaters of the Rock River. The marsh is on a major flyway and provides habitat for large numbers of migrating geese and ducks. Flooding is reduced along the Rock River because of runoff detention by the large number of wetlands in the basin (Gebert, 1986). The Upper Mississippi River Basin drains west-central Wisconsin and includes numerous wetlands associated with the headwaters of the Trempealeau and Black Rivers. The area drained by tributaries to Lake Michigan contains wetlands that are the headwaters for the streams that flow into the lake (Gebert, 1986).

The major surface-water drainage basins in the Superior Upland province are the St. Croix, Chippewa, Upper Wisconsin, and Menominee–Oconto–Peshtigo River Basins, and the Western Lake Superior Basin. The St. Croix River drains northwestern Wisconsin. This area has numerous wetlands, many of which are cranberry bogs. The Chippewa River Basin in north-central Wisconsin contains wetlands around the headwaters of most streams. The Upper Wisconsin River Basin has one of the largest concentrations of lakes in the world (Gebert, 1986). The Western Lake Superior Basin contains many small streams, many inland lakes, and the Lake Superior shore, all of which support wetlands.

Wisconsin has coastal wetlands along the Lake Michigan and Lake Superior shorelines. Most of the coastal wetlands are just landward of the shoreline in shallow depressions called lagoons or flood ponds. Barriers created by multiple cycles of deposition and erosion reduce wave energy and allow sediments to accumulate and vegetation to become rooted. The upland boundaries of these wetlands are formed by glacial features (Geis, 1985). Water-level fluctuations in coastal wetlands increase the area and diversity of shoreline vegetation. Periods of high water prevent woody plants from establishing and also prevent aggressive plants, such as cattails, from overtaking a site. When the high water drains away, emergent plants regenerate from buried seeds, creating a wetland high in vegetative diversity (Keddy and Reznicek, 1985).

TRENDS

Dahl (1990) estimated that from the 1780's to the 1980's, wetland acreage in Wisconsin decreased from 9.8 million acres to 5.3 million acres—a 46-percent loss of the State's original wetlands. Wetlands were converted to upland or to other types of wetlands primarily for agricultural, residential, commercial, and industrial development. Agricultural development in wetlands was the major cause of wetland losses. Agricultural uses of Wisconsin wetlands include cranberry cultivation, sphagnum moss harvesting, and feed-crop production. Cranberry cultivation and sphagnum moss harvesting severely alter wetlands but do not drain them. Feed-crop production necessitates wetland drainage.

Urban development also destroyed or altered many wetlands in Wisconsin. Many cities were established in and around wetlands because of a reliance on water for transportation. Milwaukee was built over what was a large, marshy river delta. Riverbanks were established and the wetland was filled as the city grew (Wisconsin Department of Natural Resources, undated).

Two studies of wetland losses were conducted by the Department of Natural Resources. One study tracked wetland losses in seven counties in the southeastern part of the State from 1970 to 1985 (Wisconsin Department of Natural Resources, 1992a). The area is highly developed, so study results cannot be extrapolated to the entire State. Losses were 154 acres per year during 1970–75, 320 acres per year during 1975–80, and 328 acres per year during 1980–85. The Department of Natural Resources also conducted a study of wetland losses associated with projects that received U.S. Army Corps of Engineers (Corps) section 404 permits. A review of permit decisions from 1982 to August 1990 indicated that permitted wetland losses were about 11,800 acres statewide. Annual losses during 1989–90 increased by 220 percent over annual wetland losses during the period 1982–89. That figure understates actual losses because it does not include activities preauthorized by general or nationwide permits or activities not regulated by section 404 (Wisconsin Department of Natural Resources, 1992a).

The Partners for Wildlife Program administered by the FWS is working to reverse these losses by restoring wetlands on private lands and providing technical assistance to Federal and State agencies and private landowners. As part of the program, 1,071 wetland restorations totaling 3,580 acres took place in Wisconsin in 1992 (Moriarty, 1992).

CONSERVATION

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

Federal wetland activities.—Development activities in Wisconsin 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

Table 1. Selected wetland-related activities of government agencies and private organizations in Wisconsin, 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	•	•	...	...	•	•
Rural Economic and Community Development	•	•	...	...	...	•
Department of Commerce						
National Oceanic and Atmospheric Administration	...	•	...	...	•	...
Department of Defense						
Army Corps of Engineers	•	•	•	•	...	•
Department of the Interior						
Fish and Wildlife Service	•	...	•	•	•	•
Geological Survey	...	...	...	...	•	...
National Biological Service	...	...	...	...	•	...
National Park Service	•	...	...	...	...	•
Environmental Protection Agency	...	•	...	...	...	•
STATE						
Department of Natural Resources						
Bureau of Water Regulation and Zoning	•	•	•	•	•	•
Department of Transportation	•	...	•	•	•	•
Regional planning commissions	...	•	...	...	•	•
State universities	...	...	...	...	•	...
SOME COUNTY AND LOCAL GOVERNMENTS	•	•	...	•	...	...
PRIVATE ORGANIZATIONS						
Audubon Society	...	...	•	...	...	...
Ducks Unlimited	...	...	•	...	...	...
Pheasants Forever	...	...	•	...	...	...
The Nature Conservancy	•	...	•	•	•	•
Wisconsin Waterfowl Association	...	...	•	...	...	...
Wisconsin Wildlife Federation	...	...	•	...	...	...

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 (EPA), 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 (NRCS) (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 Wetlands 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 and Great Lakes States that adopt coastal-zone management programs and plans approved by the National Oceanic and Atmospheric Administration (NOAA) are eligible for Federal funding and technical assistance through the Coastal Zone Management Act.

Federal agencies are responsible for the management of wetlands on public lands under their jurisdiction. There are approximately 300,000 acres of wetlands in federally managed forests and wildlife refuges in Wisconsin. The FWS manages seven sites in Wisconsin: the Trempealeau, Necedah, Upper Mississippi, Horicon, Fox River, Green Bay, and Gravel Island National Wildlife Refuges. The FWS also has two wetland-management districts that cover about 11,000 acres. The U.S. Forest Service manages more than 1 million acres of land in the Chequamegon National Forest and almost 1 million acres of land in the Nicolet National Forest. Both National Forests contain numerous wetlands. The NPS has jurisdiction over wetlands in the Apostle Island National Lakeshore, St. Croix National Scenic Riverway, and Ice Age National Scientific Reserve, which is administered by the Department of Natural Resources. Apostle Island National Lakeshore is made up of 21 islands and 12 miles of shoreline that support many coastal wetlands. The St. Croix National Scenic Riverway flows through undeveloped parts of northwestern Wisconsin. The Ice Age National Scientific Reserve is made up of nine units spread across the State. The Rural Economic and Community Development service manages farms that the Federal Government has acquired by loan default. Wetlands on these lands are delineated, and the land is sold with wetland easements on it. These wetland easements are then managed by the FWS. The EPA is involved in wetlands planning projects including the Green Bay Special Wetlands Inventory Study and Advanced Identification wetland projects in southeast Wisconsin.

State wetland activities.—Wisconsin has about 400,000 acres of wetlands in county forests and 300,000 acres of wetlands in State forests, parks, wildlife areas, and natural areas. The Department of Natural Resources is the principal State agency responsible for wetland management and regulation. Applications for section 404 permits are reviewed by the Department. Permit applications approved by the Department are then reviewed by the Corps. Approval of both the Department and the Corps is required for a section 404 application to be approved. In August 1991, Wisconsin became the first State to adopt water-quality standards for wetlands. Wisconsin's wetland water-quality standards allow the State to control wetland development under section 401 of the Clean Water Act. The Department of Natural Resources maintains an antidegradation policy to ensure that no adverse effects will occur from human activities. Projects must be water dependent and have no practicable alternatives. The project must also have no significant adverse effect on wetland function, values, or water quality or have other environmental consequences (Wisconsin Department of Natural Resources, 1992a).

The Department of Natural Resources, in cooperation with the FWS, has restored 1,252 acres of historic wetlands on Conservation Reserve Program lands. The Department also is working in cooperation with the FWS, the EPA, and NOAA on an Advanced Identification Project in the Green Bay area.

The Wisconsin Department of Transportation follows a policy of avoiding wetlands in its construction projects. When a wetland is disturbed, the Department mitigates the impacts of the road construction by enhancing and creating additional wetlands.

County and local activities.—Local governments are required to protect wetlands that are within 1,000 feet of navigable lakes and 300 feet of navigable streams. Wetland protection is achieved through shoreland-wetland zoning ordinances overseen by the Department of Natural Resources. All counties currently have shoreland ordinances to protect their wetlands. Adoption of shoreland-wetland ordinances is taking place in cities and villages.

Private wetland activities.—Private organizations in Wisconsin participate in wetland activities that include policy planning, land acquisition and management, restoration and creation, research, and public education. Some of the organizations active in Wisconsin are The Nature Conservancy (land acquisition and management), the Sierra Club, Wisconsin Wetland Association, and Wisconsin Environmental Decade (policy planning and education). Organizations including Ducks Unlimited, the Audubon Society, Pheasants Forever, Wisconsin Waterfowl Association, and the Wisconsin Wildlife Federation, in cooperation with the FWS, the NRCS, and the Department of Natural Resources, are involved in projects that create, restore, and enhance wetlands.

References Cited

Atwood, W.W., 1940, The physiographic provinces of North America: Boston, Ginn and Company, 536 p.

Bushnell, Kent, 1989, Geology of Pennsylvania Wetlands, *in* Majumdar, S.K., and others, eds., Wetlands ecology and conservation—Emphasis in Pennsylvania: Easton, The Pennsylvania Academy of Science, p. 39–46.

Cowardin, L.M., Carter, Virginia, Golet, F.C., and LaRoe, E.T., 1979, Classification of wetlands and deepwater habitats of the United States: U.S. Fish and Wildlife Service Report FWS/OBS–79/31, 131 p.

Dahl, T.E., 1990, Wetlands—Losses in the United States, 1780's to 1980's: Washington, D.C., U.S. Fish and Wildlife Service Report to Congress, 13 p.

Devaul, R.W., 1975, Probable yields of wells in the sand-and-gravel aquifer, Wisconsin: Madison, Wisconsin Geological and Natural History Survey map.

Fenneman, N.M., 1946, Physical divisions of the United States: Washington, D.C., U.S. Geological Survey special map, scale 1:7,000,000.

Frazier, B.E., and Kiefer, R.W., 1974, Generalized land cover interpreted from ERTS—1 satellite imagery: Madison, University of Wisconsin, Institute for Environmental Studies, LRAP Map No. 7.

Gebert, W.A.,1986 Wisconsin surface-water resources, *in* U.S. Geological Survey, National water summary 1985—Hydrologic events and surface-water resources: U.S. Geological Survey Water-Supply Paper 2300, p. 485–492.

Geis, J.W., 1985, Environmental influences on the distribution and composition of wetlands in the Great Lakes Basin, *in* Prince, H.H., and D'Itri, F.M., eds., Coastal wetlands: Chelsea, Mich., Lewis Publishers, Inc., p. 15–27.

Keddy, P.A., and Reznicek, A.A., 1985, Vegetation dynamics, buried seeds, and water level fluctuations on the shorelines of the Great Lakes, *in* Prince, H.H., and D'Itri, F.M., eds., Coastal wetlands: Chelsea, Mich., Lewis Publishers, Inc., p. 33–51.

Krohelski, J.T., Ellefson, B.R., and Rury, K.S., 1990, Wisconsin water supply and use, *in* U.S. Geological Survey, National water summary 1987—Water supply and use: U.S. Geological Survey Water-Supply Paper 2350, p. 531–538.

Mitsch, W.J., and Gosselink, J.G., 1986, Wetlands: New York, Van Nostrand Reinhold Company, 539 p.

Moriarty, M.E., 1992, Partners for Wildlife Program—Region 3 final report, fiscal year 1992: Washington D.C., U.S. Fish and Wildlife Service, 11 p.

Novitzki, R.P., 1979, An Introduction to Wisconsin wetlands—Plants, hydrology and soils: Wisconsin Geological and Natural History Survey Educational Information Series 22, 19 p.

_____1982, Hydrology of Wisconsin wetlands: Wisconsin Geological and Natural History Survey Information Circular 40, 22 p.

Wisconsin Department of Natural Resources, 1992a, Wisconsin water quality assessment report to Congress 1992: Madison, Wisconsin Department of Natural Resources, 220 p.

_____1992b, Wisconsin Wetland Inventory Classification Guide: Madison, Wisconsin Department of Natural Resources Publication W2–W2023, 3 p.

_____undated, Wisconsin wetlands priority plan—An addendum to Wisconsin's 1986–91 statewide comprehensive outdoor recreation plan: Madison, Wisconsin Department of Natural Resources, 22 p.

Yanggen, D.A., Johnson, C.D., Lee, G.B., Massie, L.R., Mulcahy, L.F., Ruff, R.L., and Schoenemann, J.A., 1976, Wisconsin wetlands: University of Wisconsin, Extension Publication G2818, 28 p.

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