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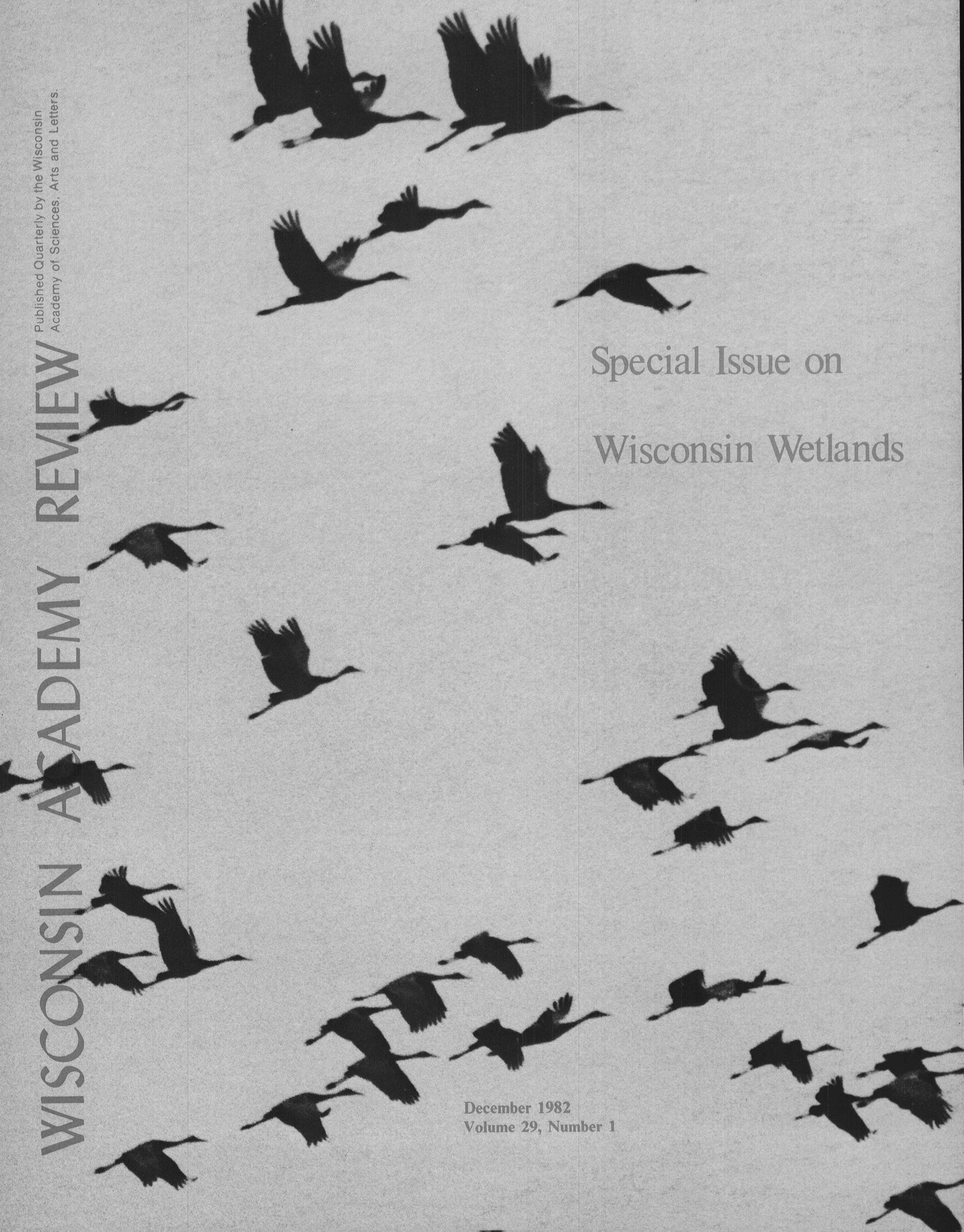

WISCONSIN ACADEMY REVIEW

Published Quarterly by the Wisconsin
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Special Issue on Wisconsin Wetlands

December 1982
Volume 29, Number 1

Editorial

This Issue's Issue

After the December 1981 mining issue appeared, we received mail from members saying how much they liked the idea of special issues on Wisconsin issues. One letter went further and proposed a similar treatment of Wisconsin wetlands. After talking to the letter writer, I agreed it would be a fascinating—and timely—topic to explore.

Enthusiasm about wetlands is contagious. After reading papers, looking at slides, and receiving a tour of Goose Pond with my family, I'll admit I'm a convert: I see the Wisconsin landscape with new eyes. The particular key to my conversion was learning about wetland birds. As Scott Freeman of ICF said, "Everyone is moved by the sight of a sandhill crane." He might have added, "or a flock of Canada geese passing overhead or a rare glimpse of a bald eagle." But as I was drawn into the landscape, I was moved by the beauty in other bird species and in wildflowers and prairie grasses.

But, of course, as our agricultural advocates point out, there is beauty also in a cranberry bog or a bountiful harvest of vegetables.

This may be an issue on which our hearts can lead, but it is far too complex an issue to leave to the heart. Since this is the most important land-use issue facing Wisconsin, we must learn as much as we can about the requirements of wildlife species and of all biotic communities. How much more land can we appropriate for building cities, for growing crops, for dumping waste before we lose the plant and animal species we value?

But it is not just man against nature. It is, as Jim Zimmerman points out, too many people wanting too much from the land. Not everyone's desires can be satisfied. We must make choices in the coming years and must do so with knowledge and understanding, for our decisions may well be irrevocable.

This issue is an introduction to the problems. We urge you to use this as a starting point for your own discoveries.

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On the cover: Sandhill cranes by Steven Landfried

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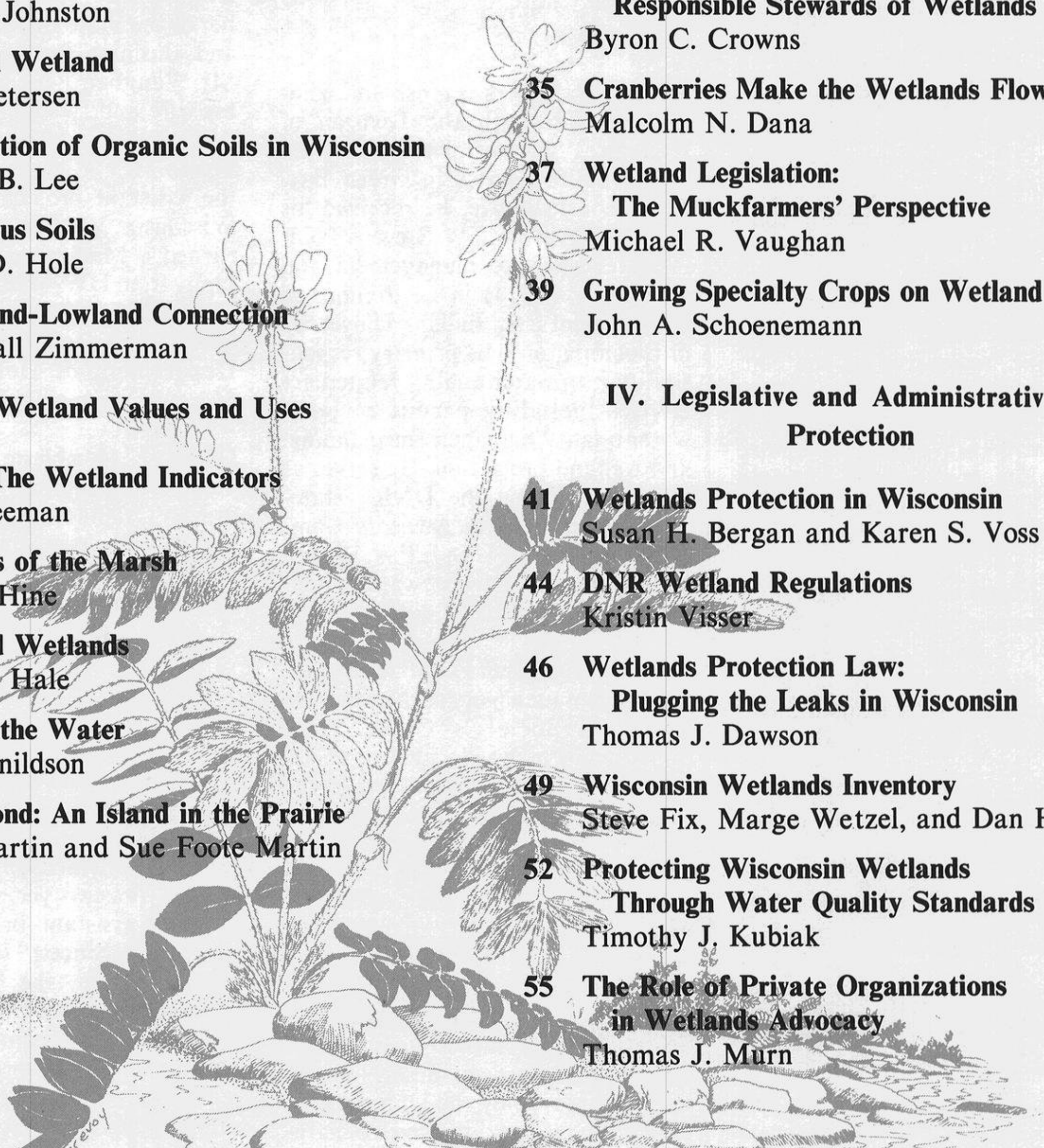

Authors and Artists

Karen Voss filled a one-year position from the spring of 1981 through the end of the legislative session in mid-1982 with the Wetlands Task Force, building public and legislative support for wetland protection. She completed both her undergraduate and Master's degree in zoology at the UW-Madison, with a thesis on the behavior of sandhill cranes. She helps coordinate the annual Wisconsin sandhill crane count. Karen and her family have recently settled in the Eau Claire area, where she plans to continue her involvement in wetlands protection and public education about conservation issues.

Susan Hundt Bergan has been involved in the wetland protection effort since attending the 1978 Environmental Agenda Conference at Poynette and hearing the gospel of environmental activism preached by Peter Anderson. A member of the Wetlands Task Force, Susan completed her Master's degree in land resources at UW-Madison, writing her thesis on the Ag-DNR compromise wetlands bill of the past legislative session. She has served as the conservation chairperson for the Madison Audubon Society. Born and raised on a dairy farm in Wisconsin's Coulee region, Susan now lives in Madison with her husband Hal and children Lars and Kate.

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An Introduction to Wisconsin's Wetlands

By James Hall Zimmerman

We tend to alter wetlands into dry land or deep water because we are not adapted for living in soggy places. Although seldom living in them, man has always loved wetlands, as seen in the location of Indian mounds, the reports of Gard and Lamm (see bibliography), and the wetland scenes hung on the walls of motels built on fill. Today concern grows, as wetland services once taken for granted are lost, and we see in the neglected lowland resource hope of easing the pain of pollution and shortage of land and energy. And Walt Kelly showed us that living in the swamp fosters a gentle but keen perspective; witness Pogo's environmental epitome: "We have met the enemy and he is us!"

I. The wetland resource

For the contributed articles in this wetland sampler the introduction should provide the perspective of context. Among authors in this inventory section we see a sharp contrast in approach. Specialist **Lee** carefully describes the organic soils with yardsticks measuring origins and suitability for use of peat as fuel or in agriculture. Generalist **Johnston** and the DNR wetland mapping staff have the unenviable task described by **Fix** of defining and classifying all our unconverted wetlands for the full span of uses and users and methods of protection and management. Definition is easy by exclusion: wetlands are all places that are neither consistently dry land nor permanently deep water. While wetland vegetation is the most obvious indicator, the straying of emergents into upland ditches and submergents into lakes and streams leads us to apply a second exclusion: wetlands start where it's too soggy for upland plants and end where it's too deep for emergent wetland plants.

Much confusion over wetland values and uses arises from their bewildering diversity. Although some of the authors use wetland terminology loosely, we will try to follow John Curtis's attempts to be precise: A *swamp* is any forested wetland. Among open (treeless) lowlands, those with emergent aquatic plants in standing water are (wet) *marshes* while those with grasses and sedges ("dry marshes" in summer) are (wet) *meadows*, flooded only in spring if at all. The peatlands can be described as forming a continuum between two extreme types, both of which may be forested or not: the *fen*, fed by calcareous groundwater, and the *bog*, fed only by the slightly acid direct precipitation (or similar very low-nutrient ground and surface input). Open areas dominated by shrubs, like alders, dogwoods, pussywillows, bog birch, and button bush are called (wet) *carrs*. (Carr is a British term for a shrub community.) Swamps come in four types in Wisconsin: *bog* (black spruce and tamarack), *fen* (white cedar and sometimes tamarack), *northern mixed forest* (red maple and associates), and *southern floodplain* (silver maple and associates). The first two are often called conifer swamps, the latter two deciduous swamps or wet forest (northern and southern). The wet marsh and southern floodplain types have little peat; the open peatlands (bog and fen) have respectively moss and sedge peat; and the forested peatlands (bog, fen, and red maple swamps) have woody peat. (Europeans refer to peatlands as *mires*.)

Since no classification, simple or complex, will please everybody, we need an organismic approach based on intrinsic attributes and processes. By demonstrating the diverse influences on wetlands, **Hole** and **Johnston** introduce the concept that wetlands are systems of water, soil, and life in *dynamic equilibrium* with geologic, climatic, and biotic forces both recent and historic; the "Upland-lowland Connection" continues this theme. The hydrologic input-output approach of Novitzki cited by **Johnston** paves the way for my tentative classification of Wisconsin's wetlands into just four basic types (Table I). This classification has evolved in my course in wetland ecology. These are extreme types in the patchwork of environmental gradients.

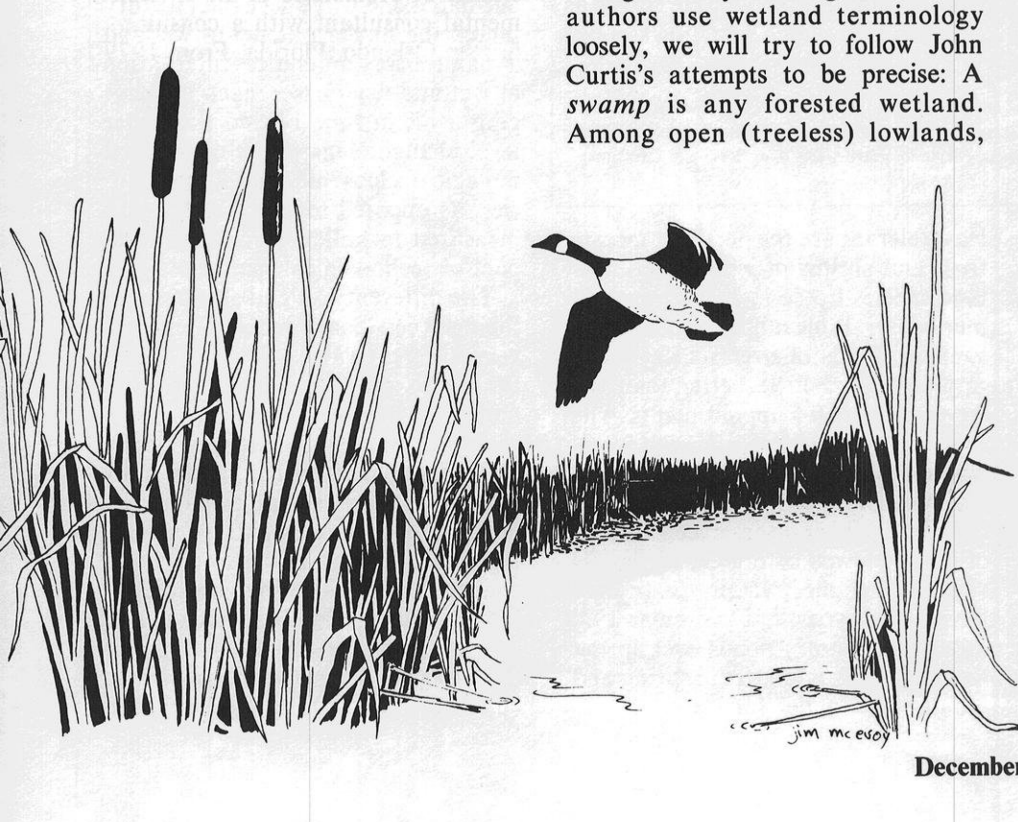

Table I. A Tentative Classification of Wisconsin Wetlands

Hydrology[1]	Vegetation Type in Two Climates[2]	
Water sources levels, chemistry	Prairie-oak Region (S&W) Warm summers Sporadic droughts	Conifer-hardwood Region (N&W) Cool summers Steady humidity
Shallow Basin Surface or groundwater depression or bay. Standing clean shallow water. Occasional drydowns in late summer.	Wet Marsh Dry Phase: emergent cattails and bulrushes following drydown. Wet Phase: open water with submerged plants. Little peat or muck.	Mixed Forest Swamp Red maple, ash, elm, birch, pine, hemlock all recolonize emergent fallen logs. Woody peat from submerged logs.
Floodplain Surface water slope. Immersed in spring; damp soil in summer with brief floods. Shifting fertile silt with erratic water levels from large watershed.	Southern Deciduous Swamp Silver maple, elm, ash, swamp oak, hackberry, cottonwood, willow, vines, nettles, all recolonize alluvium and eroding banks. Little peat or muck.	Alder-Willow Thicket Sometimes also ash, elm, cedar, sedges. Beaver cause cycles of wet marsh, sedge meadow, carr, & forest on smaller streams.
Bog Peats Surface or groundwater depression or bay. On groundwater divide, with small surface watershed low in mineral nutrients. Acid (pH 5) moss peat tints water brown.	Relic Sphagnum Bog Glacial relic with fewer species than in north. Often in frost pockets protected from fires. Very sensitive to impacts.	Sphagnum Bog Dry Phases: Ericad carr, and black spruce, tamarack. Wet Phases: Wiregrass sedge mats and peat floatups, with insectivorous plants.
Fen Peats Groundwater slope and shallow shore. Sedge peat, often accumulates lime (pH 8). Steady moisture, as in bog.	Sedge Meadow[3] Dry Phase: Willow-dogwood carr, and tamarack, poison sumac, alder. Wet Phase: Diverse sedges, grasses, and forbs, e.g., tussock sedge.	Forested Fen White cedar, tamarack, ash, birch, alder, all recycle after windthrow, rarely burn.

Footnotes

[1] Novitzki system (see citation in Johnston article).

[2] Separated by a transition belt extending between Twin Cities and Milwaukee called the "tension zone" by John Curtis.

[3] Also in north, persisting after fire. Diverse because any of four floral elements may be emphasized: shore, prairie, bog, and high-lime-tolerant plants. With drainage, pasturing, peat fires, and siltation, monotypes of aster-goldenrod, nettle, giant ragweed, reed canary grass, purple loosestrife, aspen, or floodplain forest may invade.

The outdated Fish and Wildlife Service "Circular 39," so handy in its simplistic reference to water depth and permanence, may have hit upon the primary factor which sorts out vegetation, namely oxygen supply to roots. Since the organic producers (green plants) and the organic decomposers (bacteria and fungi) share a need for oxygen, the degree of retarding of gas circulation in waterlogged soil or peat and stagnant water will regulate both plant growth and peat accumulation. The plants most tolerant of root anoxia are the deep water emergents with their snorkellike air tubes in stem and leaf. The plants least tolerant are the north temperate trees and shrubs of which even lowland species tiptoe in above the summer water table and are killed by summer floods of over six days' duration—only a little better than the six-hour limit for upland plants. The secondary factors of chemistry and climate then further sort out the vegetation as shown in Table I. One plant community is omitted since so much of it was plowed before Curtis did his vegetation studies: wet prairie (it may have been "type 1" of "Circular 39," around temporary ponds over spring ice or clay pans, too wet in spring and too dry in summer for trees.)

Similarly, the degree of oxygen penetration sorts out the peat types, again with a little help from soil and water chemistry. Wet marsh and floodplain have little peat (highly oxidized muck) because alternating flood and drought often give the microorganisms access to oxygen as well as minerals. Among the more evenly soggy wetlands, bog peats are fibrous because the absorbent sphagnum mosses remove what little mineral was available for the microorganisms while releasing acid, which is anathema to bacterial action (as we know when pickling silage and sauerkraut). The more fertile fen peats are more decayed (humified), but they, too, accumulate because artesian flow maintains waterlogging while lime accumulation skews the mineral nutrition balance.

We can also see why peat doesn't build up forever: the higher it builds, the more likely it will decay or burn in time of drought. The periodic recycling of vegetation, peat, and mineral nutrients comprises the "pulse" theory of wetlands proposed by ecologist Eugene Odum. Animals assist in the recycling: muskrat "eat-outs" as well as high water periodically destroy marsh emergents; beaver dams temporarily replace forest with marsh and meadow. In place of the out-dated one-way succession to "dry land," the modern model of wetland dynamics sees an endless alternation of wet and dry phases, each one lagging a bit in time behind the water level change. This is a climatic and biological clock measured in centuries, as opposed to geological clocks measured in millennia until the impact of technological man was felt.

The different wetland systems and their successional phases each have very different values for us. To take the biotic products, for example, a mossy floating bog on a lake, with its wiregrass meadow, leatherleaf carr, and forest phases, is one of our most esthetic wetlands, as its unusual three-dimensional complementary vegetation patterns of color and shape change through the four seasons; it also produces loons (but not ducks). The bog gave us the cranberry and the wiregrass sedge (formerly used as rug-backing), while the southern floodplain forest gave us most of our city trees (toughened by alternating flood and drought for the rigors of urban life). Muck farms use only the "sweet" (limey) peats of fen-sedge meadows, whereas the acid-absorbent bog mosses find universal use in packing nursery stock. Tamarack was the ideal rot-proof fence post of all early farmers, while white cedar bark today makes durable wood-chip trails. Wet marshes (when clean and not too deep or too shallow) produce our waterfowl, muskrats, and northern pike, as well as American wild rice and the giant reed used for thatch everywhere except in North America. Fen-meadow mice feed many of our hawks and owls while the sedge-grass mixture (unless replaced by unsuitable reed canary grass) winters our corn-fed pheasants and provides marsh hay. Shrub-carrs produce rabbits and deer (until unpalatable alien species of buckthorn and honeysuckle take over). White cedar swamps get the deer through the winter in the north (unless over-consumption by too many deer allows invasions by unpalatable fir and spruce).

The parenthetical comments indicate that a third descriptor is needed for wetlands besides type and phase: *condition*. Since structure determines the capability of an organism, the landscape structure or pattern within and beyond the wetland is germane to assessment. For example, the well-known correlation of amount of "edge" between vegetation types and wildlife production applies especially well to wetlands, as seen in the relative permanence of the wetland boundary (water being more dependable than fire in limiting carrs and forest) as well as in the interspersion pattern of open water, emergent aquatics, meadow, carr, and swamp. The gradualness of the natural upland-wetland-water continuum promotes species diversity and permanence of the biota. The natural occurrence of wetlands in clusters and corridors (**Johnston**) enhances animal use because of migratory, territorial, and social needs and because all needed wetland phases are more likely to be maintained within home range.

The context or setting is part of the essential pattern; for example, for trout habitat, beaver are a boon in a cool climate but a bane in a warm one. For scenic value, topography provides essential backdrop, vista, and vantage. Impacts impair wetland function by altering the landscape structure at all scales: roads or buildings interrupt essential animal traffic to or from uplands; steepened shores bring in floodplain trees which exclude waterfowl and erode; alien species like carp and purple loosestrife alter vegetation patterns; silt deltas make water too shallow to hold oxygen; altering surface or groundwater levels has regional impact.

The pertinent ecological factors can be summarized in four principles vital in all three realms of wetland assessment (physical, biotic, and esthetic): (1) upland-lowland unity (wetlands can't stand alone); (2) endurance through change (the types and their recycling phases seek equilibrium with environmental conditions); (3) appropriate function (each type and phase has unique values and sensitivity to impact); (4) structure in health (the furniture arrangement of landscape features—water, soil, peat, vegetation—determines how much potential is realized).

II. Wetland values and uses

In this even larger subject we have selected contributions in the "noneconomic" category to make three points. (1) Wisconsin leads in conservation ethics with its public water doctrine (**Dawson**), the nation's first soil conservation district, and having imported Leopold to head the nation's first university wildlife department and the Hamerstroms to devise a landscape pattern wherein prairie chickens and agriculture could coexist. Today we also host many important private groups such as the International Crane Foundation and the Nature Conservancy's most active chapter. (2) Protecting threatened species demands environmental monitoring—the kind of periodic medical checkup we accept for maintaining human health and must now apply to the land. (3) The "underdog" (a species in trouble) focuses public attention whereas the total landscape is too diffuse and complex.

Effort to perpetuate our wild cranes saves many other wetland values at the same time, as **Freeman** points out. Our DNR has paralleled the crane counts with frog counts (**Hine**) and informative alerts and curriculum materials on nongame wildlife (**Hale**) and plants (**Brynildson**). The endangered species serve as an early warning system to involve citizens and youth in landscape diagnosis and therapy to maintain our heritage.

The reader interested in the full catalogue of wetland services will find a good cross section of current understandings in the four recent symposia edited respectively by DeWitt, Good, Greeson, and Richardson and their collaborators. Wisconsin researchers are well represented in all four.

It is important to distinguish between natural, managed, and consumptive functions (from the wetland's point of view). From the few unaltered examples we can recognize three types of services provided by *natural* wetlands: physical, biotic, and cultural. Physical services include the buffering of uplands against damage by fire, human vandals, and wave action, and of downstream waters against pollutants and floods. As usual where the crises have come before the understandings, some people claim too much for wetlands and others too little. When employed as sponges and filters, wetlands in headwaters do lower (spread) flood peaks and augment low flows and do trap sediment, although doing so soon alters the structure of all types of wetlands to the floodplain system which may soon pass the silt downstream. Detention or storage of mineral nutrients may be seasonal, selective, temporary, and too slow to handle added loads. (Loading requires intensive management to preserve the structure and clean the filter.) Groundwater recharge appears to be an uncommon wetland function in Wisconsin, with the possible exception of Cedarburg Bog. (Many wetlands are "perched" over aquatards through which water moves slowly and only when under pressure.)

The biotic functions include the food, fiber, fur, fish, fowl and considerable upland game resources re-counted earlier, on which Wisconsin's large recreation industry depends. The biotic gene bank (full complement of species) has obvious potential in medicine, agriculture, and chemistry as more species, including microorganisms, become better known. The largest wetland contribution to mankind, rice, has ensured that most of the world's agricultural soil has been conserved by terracing. Discoveries among nearly extinct species, like the perennial teosinte which might be crossed with corn, may be expected to continue indefinitely since the 4 percent of our national landscape still in wetlands harbors over a quarter of our flora and fauna.

Cultural services include many educational and scientific benefits unique to wetlands. For example, the attractiveness of water, mud, and accessible small animals to children and the unusually long food chains make wetlands the ideal place to introduce ecological understandings at the only age when they can easily become part of one's life style. If we do not convert all our peat to cropland and fuel, its data bank—the unique historical record stretching back to glacial times—may yield further secrets such as better understanding of climatic cycles. Recent tools as yet insufficiently used in peat analysis include the scanning electron microscope and the fallout marker, cesium 137.

With landscape alteration we replace natural values with a further set of values. One level of alteration is *management* of "natural" wetlands, which means favoring one service or product at the expense of others with minimal disturbance of the system. Ducks, wild rice, fish, or cranberries can be produced in greater quantity than before by reducing or eliminating the normal complement of plants and animals that compete for space, nutrients, and solar energy. Waterfowl management is a major business prompted by the drastic decline in North American duck populations as agriculture has displaced their breeding, wintering, and migration territory with equal thoroughness. We hope other wetland types will someday rate parallels to Weller's excellent new book on wet marsh ecology and management.

Experimental management of wetlands to trap heavy metals, nutrients from sewage and canning plants, and sediment may lead to the devising of special systems which might also produce certain useful wildlife, plant, or soil-conditioning products, but the system will probably have to be highly altered and intensive in money and environmental costs for frequent harvest of the materials trapped.

Consumptive uses of wetlands, in the sense of drastically altering or using up the system, include peat harvest, floodplain and muck farming, and flooding. Muck farming is defined and explained in Section III. Seasonal impounding of wetlands to store flood peaks eliminates important animals such as amphibians, turtles, fish, muskrats, and sometimes plants by preparatory winter drawdown (freezeout) and by sudden or prolonged summer high water (removing emergent cover) as well as by trapping silt and nutrients causing eutrophication and turbidity. Some wetlands are permanently flooded to make lakes for boating and fishing, or intermittently flooded by "dry" flood-control dams, or for hydroelectric power generation or the dissipation of heat from fossil-fuel power plants. In contrast to outright filling with dirt or waste materials to make upland, all these uses are classed as reversible since the basin is not destroyed but only borrowed.

Restoration of mined peatland, at least to the quickest and highly productive type, the wet marsh system, is theoretically possible once the peat is fully removed for fuel or by decay under agricultural drainage. Major obstacles to successful wetland restoration of any type are (a) insufficient knowledge, (b) extinction of species while too many wetlands are borrowed, and (c) external impacts. The Horicon Refuge, often cited as a successful restoration, has been disappointing as a producer (as opposed to attractor) of birds for so large an acreage. It probably owes much of its functional impairment to the "flood-mud-crud-and-carp" syndrome explained in the "Upland-lowland Connection" and the rest to conflicts of management objectives between those concerned respectively with fish, muskrats, game birds, nongame birds, flood detention, and crop damage. Some of the see-saw of special interest pressures on Horicon is documented by Hanson as well as by Gard. Encouragement of monitoring and research at Horicon is now a welcome trend.

III. The agricultural perspective

The environmental and agricultural positions comprise a healthy debate. To the defenders of lowland agriculture (**Schoenemann, Vaughan, Crowns,** and **Dana**) one must point out that damage to unfarmed wetlands by altered regional water tables and through ditches and to downstream waters by ditch effluent is a largely undocumented environmental cost to society. If it proves to be serious, it should be circumvented or, if not, then added into the economic equation.

While one could wish for a decision-making process based on facts and logic, it must be admitted that people like a fight and may need emotional prodding to be receptive to education. What is so often lacking is leadership which can channel aroused energy into constructive action; especially where neighbors, youth, and agencies can collaborate on, and accommodate interests in a *specific* local landscape system. The persistent initiative of a few individuals in the Dane County Conservation League over the years in gradually restoring the Sugar River System while maintaining private agriculture with some public access could serve as an important role model.

IV. Legislative and administrative protection

To those concerned with legal protection of the wetland resource against consumptive uses (**Bergan/Voss, Visser, Dawson,** and **Murn**) it must be pointed out that because regulation is by nature arbitrary and repugnant, it requires so much education to be enacted and effectively enforced that one is tempted to suggest putting all effort into education alone. Even the mapping program, advocated by the Muck Farmers Association (**Vaughan**) as a wise prerequisite to any action, has frightened many rural landowners unnecessarily because too little time and effort could be spent on explaining the need. However, the nonlegislative incentives documented by Harris and Sauey, especially pride in private land stewardship, can not be tested for effectiveness unless our education system (especially teacher training and selection) were thoroughly revamped and all landowners kept current on resource supply by requiring a conscientious periodic landscape inventory, at least every time a parcel changes hands. If an estate must be appraised and a will probated, why not have the same procedure for our priceless environmental inheritance?

The final point in this attempt at perspective is that the argument between preservationists, alterationists, and extractionists which surfaces each year in the legislature is unresolvable as long as there isn't enough wetland to satisfy the needs of all people. It appears to be a special case of a larger problem: human overpopulation, that is, more people than the land can support without strain on both people and the land. Less wasteful use of the landscape together with wetland restoration and creation might bring satisfaction, but only if the population ceases to grow. Better knowledge of both human and environmental needs may enable decisions to be made as to whose special interests society can best afford to deny in the long run.

In attaining a balance between human demands and the earth's life support system, we must not overlook the area of wetland services addressed in this issue only briefly by **Petersen**'s personal testimonial—the inspirational and therapeutic values of nature in which wetlands play a large role. They are quiet and unspoiled landscapes precisely because so few people go into them. It is of interest that wetland values are rated highest near centers of population regardless of condition or intrinsic worth: access breeds familiarity and appreciation. Ironically, to assess the societal importance of these values will require that crowds of people take to the wetlands via boardwalks, sneakers, or canoes. Perhaps, nevertheless, Pogo's world can be a beneficial influence on much more of mankind. Until the masses get their feet wet, we can refer to the eloquent testimony of a few individuals who did, like Henry David Thoreau, Paul Errington, and Aldo Leopold.

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Wetlands in the Wisconsin Landscape

By Carol A. Johnston
Wisconsin Department of Natural Resources

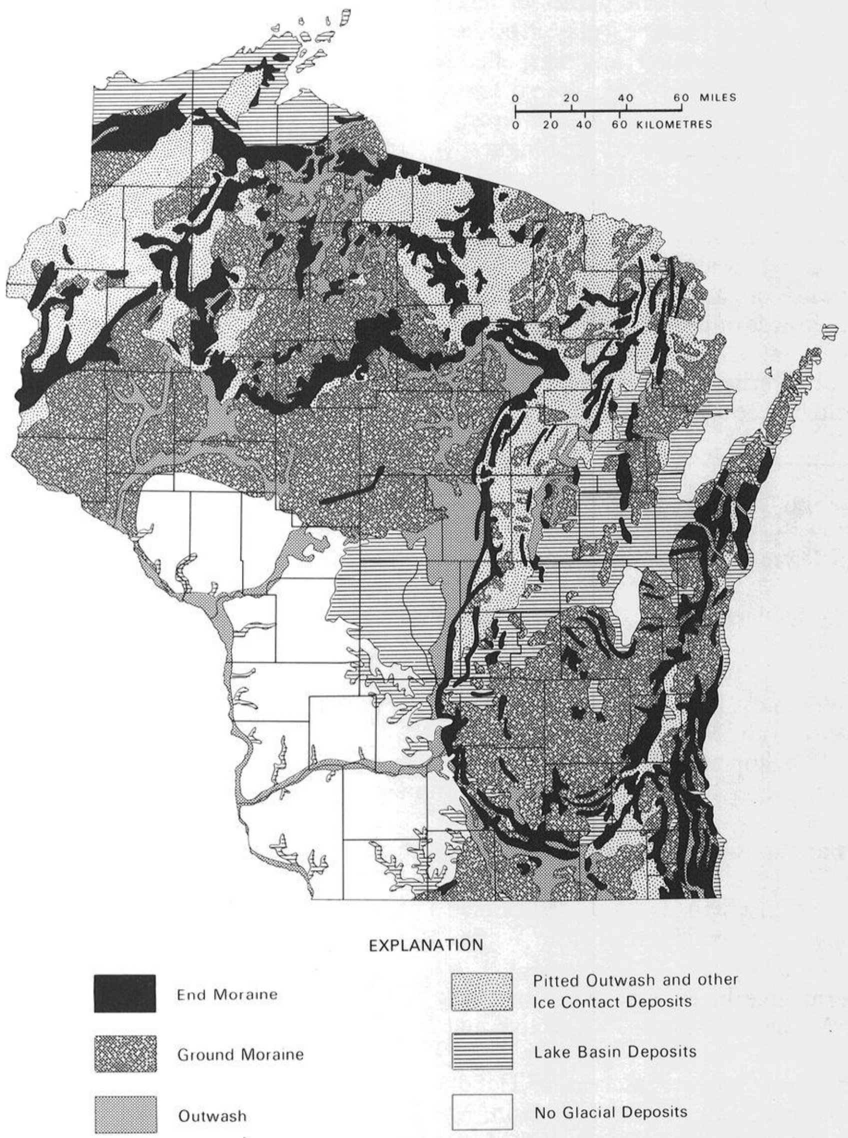


Fig. 1. Distribution and types of glacial deposits in Wisconsin. Courtesy of Wisconsin Geological and Natural History Survey.

Wisconsin's diverse landscape is largely the product of two geologic forces: stream erosion and glaciation. By shaping the land surface into hills, valleys, and plains these forces dictated where wetlands would form.

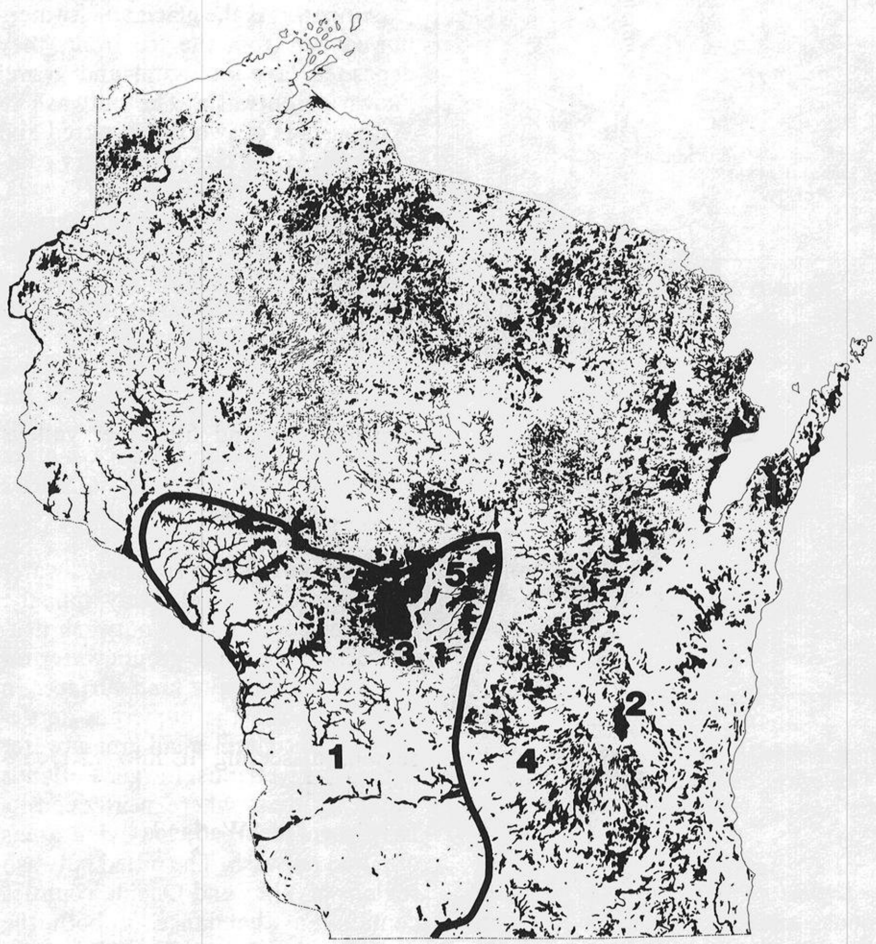
The glacial forces smoothed Wisconsin's hills and filled her valleys with tons of pulverized rubble some 12,000 years ago. Figure 1 shows the distribution and types of glacial deposits found in Wisconsin. Without this glacial legacy, the whole state would look like the driftless area of southwest Wisconsin, which most geologists believe was never glaciated. Streams have gradually eroded steep, narrow valleys into the bedrock of this region, dissecting it into interconnected ridges.

Driftless Area Wetlands

Wetlands cover only a small percentage of the driftless area landscape (Fig. 2), because it is so hilly. A 1955 inventory of wetlands by the U.S. Fish and Wildlife Service reported an average of only 12.5 acres of wetlands per square mile within the Fayette-Dubuque soil association of southwestern Wisconsin, as opposed to 154.8 acres of wetland per square mile in parts of northern and central Wisconsin.

Most wetlands in the driftless area are wet meadows on alluvial soils along streams. The peat and muck soils which are so common in wetlands elsewhere in Wisconsin rarely occur in the driftless area, so wetland plant communities which require organic soils, such as bogs and fens, are virtually nonexistent in southwest Wisconsin.

Fig. 2. Wisconsin's nineteenth century wetlands. It is believed that the area to the southwest of the solid line was never covered by glacial ice. Numbers identify the following features: 1. the driftless area, 2. Horicon Marsh, 3. wetlands left by Glacial Lake Wisconsin, 4. inter-drumlin wetlands, 5. Buena Vista Marsh. Wetland information compiled by Georgine Price, Wisconsin Department of Natural Resources after the Trygg and Finley composites of Wisconsin's original land survey.



Flooding by rivers and streams is the major source of water for many wetlands in the driftless area. These flood waters readily drain back into the stream as the flow returns to normal, resulting in drastic water level fluctuation. Richard Novitzki, a hydrologist with the U.S. Geological Survey, has termed these "surface water slope" wetlands because they slope gradually down to the surface water bodies which are their major source of water (Fig. 3).

Since level land is at a premium in the driftless area, floodplain wetlands there are frequently farmed. The streamside wet meadows have long been cut for marsh hay or grazed by livestock, uses which leave the native wetland vegetation and soils relatively intact.

Hillside seeps and springs are also common in the driftless area where the water table emerges at the ground surface, usually because of an impermeable layer of bedrock beneath it. In the years from 1958 to 1962 the Wisconsin Conservation Department counted 2,269 springs in Grant County alone. Although "groundwater slope" wetlands associated with springs and seeps receive some water from precipitation and overland flow, most of their moisture comes from groundwater (Fig. 3).

Wetlands in the Glaciated Landscape

The stream networks in the glaciated portions of Wisconsin are not as well developed as those in the driftless area because they are geologically much younger. The glaciers spread a great blanket of earth over the land surface, interrupting the drainage patterns which had existed before glaciation. Some preglacial river valleys were filled with over 300 feet of glacially transported materials, enough to bury a thirty-story building.

Glacial lakes. With so many stream valleys filled with glacial debris, there was often no way for the glacial meltwaters to flow out of the newly created basins. Lakes formed from the impounded waters. When the water level went down in these shallow lakes or when they became filled with organic matter from decomposing aquatic plants, vast wetlands were created.

Although the water level in these glacial lakebed wetlands is lower than it was after glaciation, the groundwater table is still at, near, or above the land surface in those that support wetland vegetation. Such a wetland is called a "groundwater depression" (Fig. 3).

One of the most famous of these wetlands which were formerly glacial lakes is Horicon Marsh (Fig. 2). The huge wetlands in parts of Juneau, Adams, Wood, Jackson, and Monroe counties owe their existence to another glacial lake. "Glacial Lake Wisconsin" formed when glacial deposits created a dam across the former channel of the Wisconsin River at Devil's Lake near Baraboo. When the river gradually eroded a new path to the east of its former channel, the lake level dropped, leaving wetlands behind (Fig. 2).

End Moraines. In other places the glacier created hills where there had been none before. End moraines are ridges of glacial debris which were deposited at the snout of the glacier where it paused in its retreat. Ice blocks commonly became trapped in these end moraines. When the ice blocks melted, the kettleholes which remained often filled with water and

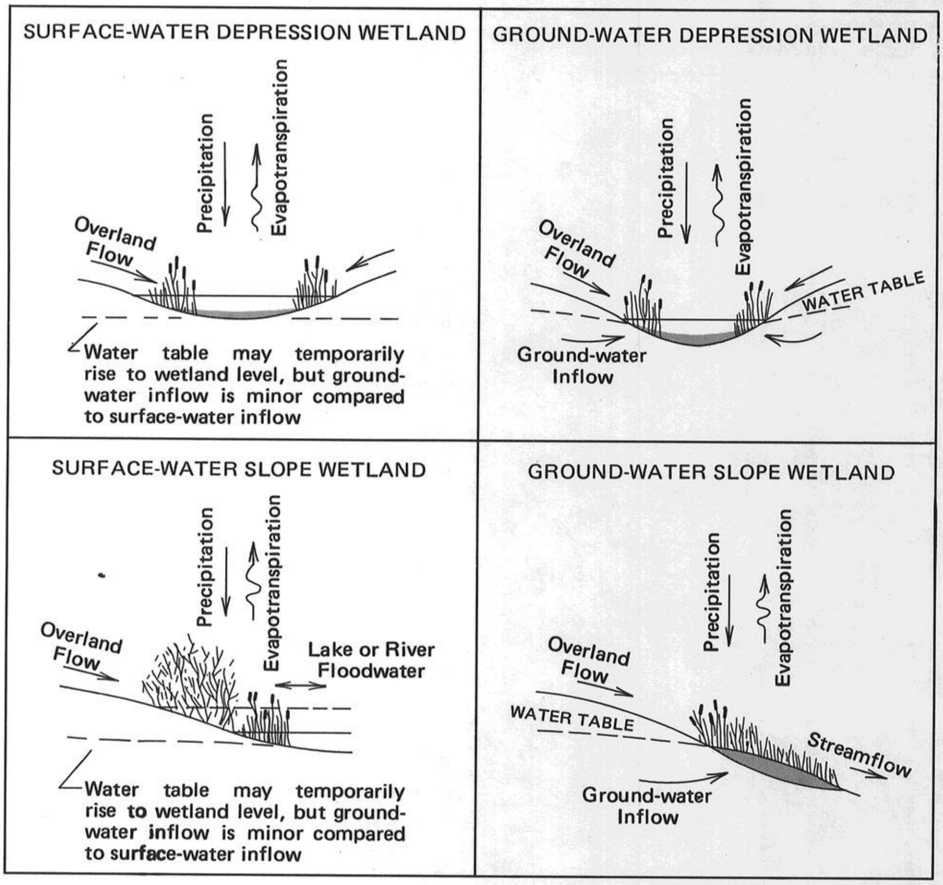


Fig. 3. Basic hydrologic characteristics of wetland sites. From "An Introduction to Wisconsin's Wetlands." Courtesy of Wisconsin Geological and Natural History Survey.

wetland vegetation. Some fine examples of kettlehole wetlands can be seen in the Chippewa Moraine of the Ice Age National Scientific Preserve near Bloomer.

Kettlehole wetlands are often perched above the regional groundwater table by an impervious bottom layer. Because they depend on rain and surface runoff for their moisture, the water levels in these "surface water depression" wetlands often fluctuate drastically (Fig. 3). Also, because they are independent of the groundwater, two adjacent wetlands could be at much different elevations.

Although kettlehole wetlands collectively cover a significant area, they tend to be ignored by wetlands inventories and regulations because of their small size.

Drumlins. Wisconsin is world famous among geologists for its drumlins, elongated hills which formed in special zones of compression under the glacial ice. Like a mirror image wetlands developed in the valleys between the drumlins. The long, narrow wetlands between drumlins in Dodge, Jefferson, and eastern Dane counties are clearly visible on the map of Wisconsin's nineteenth century wetlands (Fig. 2). Although that area has some of the most prominent drumlin fields in the state, drumlins are found at a number of sites in north-central and eastern Wisconsin (Fig. 4).

Many of the inter-drumlin wetlands in southeast Wisconsin have been drained for agriculture. A Wisconsin Conservation Department study showed that there was a loss of 30 percent of the wetland acreage in Dodge County between 1939 and 1960. About one half of the wetlands remaining undrained in that time in Dodge and Jefferson counties were used as pasture for livestock. Most inter-drumlin wetlands in northern Wisconsin are forested.

Outwash. As the glacial meltwaters flowed out from the ice front, they deposited layers of sand and gravel known as outwash. The outwash in Wisconsin is of two types: pitted and unpitted. Pitted outwash is very common in northern Wisconsin (Fig. 1). The kettleholes which give pitted outwash its irregular surface topography formed when stranded ice blocks melted, in the same manner as kettleholes formed in end moraines. Unpitted outwash is smooth and level and may cover broad plains, as in the Central Sands area of southwest Portage and northeast Adams counties, or filled old stream valleys, as in Price and southern Ashland counties (Fig. 1).

Since outwash is so sandy, water flows through it relatively quickly. Therefore, wetlands in outwash usually occur where the groundwater table is at or near the land surface. In pitted outwash the numerous kettleholes often contain small groundwater depression wetlands. Larger wetlands occur in areas where peat deposits have covered broad, low-lying areas of pitted outwash. The pitted outwash regions of Vilas and Oneida counties contain an abundance of both the small kettlehole and large bog wetlands.

Because they are flat and low-lying, many areas of unpitted outwash originally supported huge wetlands. One of the biggest was Buena Vista Marsh in southwest Portage County (Fig. 2). Prior to the 1870s the marsh was a hunting and food-gathering place for Indians and traders. Around the turn of the century the Bradley Polytechnic Institute of Peoria, Illinois, bought most of the 56,000 acres in the marsh and began to drain it. Nearly seventy miles of ditches had been dug by 1914, but peat fires and early frosts frequently killed the crops that were planted there. The land was abandoned, and it reverted to extensive wet

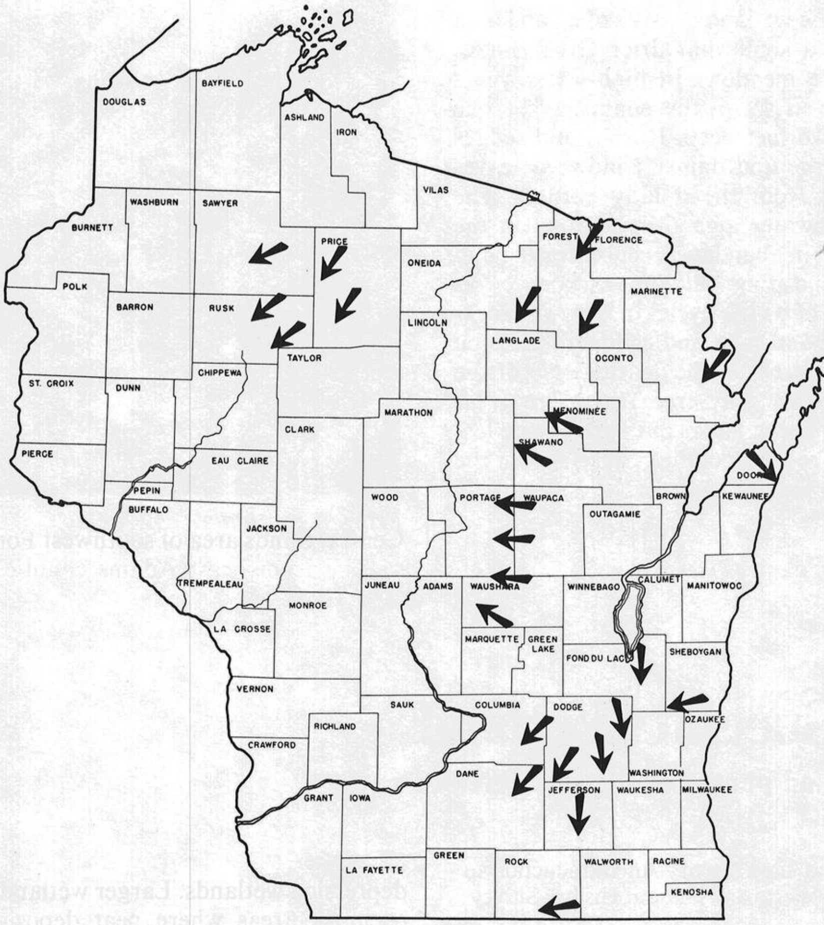


FIG. 4. Major drumlin fields in Wisconsin. Arrows show the direction of glacial ice flow, as indicated by the orientation of the major axis of the drumlins. After Thwaite's 1956 map of Wisconsin Glacial Deposits.

meadows. In time these wet grasslands became the last major refuge for prairie chickens in Wisconsin. The advent of improved drainage and irrigation systems within the last two decades has revived farming in the Central Sands area, however. Large scale intensive agri-business ventures have recently destroyed thousands of acres of prairie chicken habitat. Since the permeable outwash sands are relatively easy to drain, many other wetlands underlain by glacial outwash are falling to similar fates.

The torrential glacial meltwaters carried outwash far past the outermost limit of the ice which covered Wisconsin. The Chippewa, Black, and Wisconsin rivers all carried glacial meltwaters to the Mississippi and were subsequently filled with deep deposits of unpitted glacial outwash. Because of the broad, flat surface created by the outwash, extensive floodplains developed along the rivers. Today, the most extensive floodplain forests in the state are found in these four river valleys.

Ground moraine. Ground moraine is the most widespread type of glacial deposit in the state, covering the bedrock like a veneer. It is a mixed-up assortment of sand, silt, clay, and stones known as till. Because the topography, climate, soil permeability, and depth to water table varies so much in ground moraine areas, the occurrence and nature of wetlands in those areas is also highly variable. All four of the wetland hydrologies shown in Figure 3 are found in ground moraine areas. Surface water depression wetlands are most common in areas where the till is impermeable because of high clay content or a hard pan below the soil surface. Groundwater slope wetlands often occur at the base of hills in rolling ground moraine. Where the till is calcium rich, groundwater slope wetlands having organic soils may support distinctive plant communities: fens in southern Wisconsin and cedar swamps in northern Wisconsin. Groundwater depression peatlands in areas of acid till usually have bog vegetation. Wetlands along the geologically youthful lakes and streams in ground moraine areas may receive hydrologic inputs from either surface or groundwater sources, or both.

Geology alone clearly cannot explain the diversity of wetland types in the state. But by altering the surface topography and patterns of water flow so drastically, the glaciation of Wisconsin affected the size, shape, location, soils, hydrology, and nutrient status of most of the state's wetlands. Thousands of wetlands were created where there would otherwise have been a dry, hilly landscape.

Although glacial events that happened some 10,000 years ago seem staid when compared to the flashy geological fireworks of a Mount St. Helens, their effect on the Wisconsin landscape and its wetlands has been no less profound.■

What is a wetland? It can be described scientifically—or quite personally.

Carlin's Point lies on the northeastern shore of Washington Island in Door County. The postglacial lake levels and the climate have shaped this point in the following way: The cool northeast winds forced the waves to heap up a ridge of limestone cobbles on the outer edge of Jackson Harbor. The warm southerlies caused deposition of a sand beach and dune against the cobble ridge in a triangular arrangement with the eastern point reaching into the lake towards Rock Island. Inside this point exists a small wetland—four to five acres at most—that bounds in rare, unusual, and beautiful wild things.

The wetland consists of a pond area and a somewhat drier Great Lakes shore meadow. In high-water years such as 1974, the pond may be one to two feet deep. Rushes and sedges emerge and dainty pondweed leaves float from the muddy bottom. The freshwater alga *Chara* grows in the pond in abundance, concentrating and redepositing calcium carbonates as part of its life cycle. In May a searching hand may find caddisfly cases on the bottom or the floating eggs of the northern gray tree frog. The great blue heron hangs out here on one leg, and red dragonflies chase across the rush tops in summer.

Fringed gentian

A Special Wetland

Text and photos by Ursula Petersen

Lobelia kalmee

Indian paintbrush

Calamint

This year the lake level is down exposing the pond bottom and offering the mud-flat look with sparse whisps of rushes sticking up. The little pond comes up with a new surprise: In July it turns a bright golden color—thousands of tiny horned bladderworts standing in the sandy mud. This bladderwort has no leaves and is said to catch invertebrate prey by means of small bladders on the roots. The color, shape, and sheer quantity of these plants delight the human eye.

The outer edge of my special wetland comes into full glory during low water years. The wet sand is decorated by a complement of unusual sedges, rushes, wet mosses, and a colorful array of rare wildflowers throughout the season. The blooming begins in May when beds of miniscule Arctic primroses wave in the northerly breezes. An abundance of Indian paintbrushes overwhelms the eye in June. Then the stately false asphodel appears and sweet-smelling wild savory, the blue brook lobelia and later purple gerardia. The fold of Ohio goldenrod and the deep blue of the fringed gentian gentle us into autumn. This is the splendor of the Great Lakes shore meadow.

All wetlands are special, each in its own way. What makes this little spot memorable? To me this wetland embodies the essence of northern Lake Michigan: the fresh breezes and pounding surf proclaim both the presence and the majesty of the lake; the water level of the wetland reflects the ever-fluctuating Great Lakes levels; Chara and lime-loving wildflowers speak of ancient coral seas and reefs; the Arctic primrose evokes dreams of the splendor of tundra spring. The colors and creatures, the calls of migrating water birds resting on the point, the white silence of winter—they are all part of the wonder of northern Lake Michigan and of my special wetland.

The owners of the point live there for one or two months a year; they disturb the area little. Hikers stroll through in summer and fall and are gone again. The special quiet and peace at Carlin's Point let a person be at one with nature and feel disconnected from the human turmoil. There are rumblings of condominiums and marinas, but somehow this point must be kept in its pristine condition for the greatest benefit to wildlife and human beings.■

Primula mistassinica

The Classification of Organic Soils in Wisconsin

By Gerhard B. Lee
University of Wisconsin-Madison

Wetlands are in wet places. The water is usually from a high water table but may be lateral flow or in some cases precipitation which is held so tenaciously by the hyline cells of sphagnum plants that a very wet environment is created. The many glacial depressions of Wisconsin afford an ideal wet environment and consequently support a broad assemblage of wetlands.

Wetland soils may be comprised of either mineral or organic matter depending on the wetness of the site and the history of the area. Wet mineral soils form where the water table is at or near the soil surface most of the time, most years. Organic soils (Histosols) form where the water table is at or above the soil surface most of the time. These soils are commonly called peat or muck in this country. Peat refers to fibrous, relatively unhumidified organic material; muck is dark colored, well-decomposed material.

Histosols then, are the soils which collectively make up our peatlands. Most are saturated with water, or nearly so most of the time, unless they have been artificially drained. Some are floating mats over lakes or other bodies of water. Others border shallow lakes, or are in low places. This paper is about their classification by soil scientists.

Genesis of Histosols

Histosols form from organic debris. Processes involved include the accumulation of plant material in an anaerobic (waterlogged) shallow lake or wet depression. Here, where runoff collects, is an excellent site for diatoms, algae, bacteria and zooplankton to reproduce, grow, and die, settling to the bottom of the pond and forming "sedimentary" peat or limnic deposits (ghytta). Eventually the water becomes shallow enough so that sunlight penetrates to the oxygen-rich bottom, producing optimal conditions for the growth of a variety of submergent pond weeds. This depletes oxygen at the pond bottom and decomposition virtually ceases. Rushes, cattails, and, closer to the edge, sedges become established. As these plants live and die, their remains fall to the bottom and the pond begins to fill.

After being filled, the site supports a sedge meadow. Wisconsin, especially the southern part, has many sedge meadows. In the northern part of the state sedge meadows underlie sphagnum in many places. In some areas, trees such as black spruce, white cedar (arbor vitae), or tamarack may encroach upon the marsh and the water table drops slightly in response to their evapotranspiration.

Northeastern Wisconsin has many cedar swamps. Other trees such as black spruce, willow, swamp white oak, and tamarack are common. In northern Wisconsin, sphagnum grew over the sedge covering in many places, particularly after the forest fires of the late twenties and early thirties, forming a slightly convex dome which was largely isolated from the water table. Because of the acidity of the sphagnum, microbial decomposition was inhibited and the nutrient-rich, eutrophic marsh was converted into an acid, nutrient-poor, raised bog.

The result, in Wisconsin, is that we have basically three kinds of peat, based on origin. That derived from sphagnum is fibrous and mainly undecomposed; that derived from woody materials, particularly white cedar, which is partially to fully decomposed; and that derived from sedges, and associated plants which is partially to fully decomposed. In a general sort of a way, the sedge peats are best expressed in the southern part of the state, while those derived from white cedar are in the northeast. Sphagnum bogs are mainly in the north but may extend south in some places.

When peat is exposed to aeration, it rapidly undergoes disintegration and biochemical decomposition ("ripening") resulting in destruction of fiber and original structure, and formation of dark colored amorphouslike materials that with time are aggregated into pedogenic structure. While some of these processes occur under anaerobic conditions, they are vastly accelerated under aerobic conditions. The extent of development that occurs and the speed with which development takes place is also dependent on botanical composition, e.g. sedges decompose more rapidly than sphagnum moss.

Classification of Histosols

Because fiber content is strongly related to soil characteristics and behaviour, fiber has been used as a means of classifying peat, at high levels. In 1936, the Swedish geologist Lenhart von Post developed a ten part scale that makes use of fiber content in classifying peat soils. The International Peat Society recognized three stages of peat decomposition (R_1), (R_2) and (R_3). These classes closely parallel those used in the present system of the USDA, namely (O_i) fibric, (O_e) hemic, and (O_a) sapric.

The present classification, as described in Soil Taxonomy (USDA Soil Conservation Service, 1975) is provisional, the result of efforts by interested individuals and regional and national committees. The following classes are recognized.

Fibrists are composed primarily of fibrous undecomposed vegetative debris. These are the saturated, raw peats, frequently straw-colored and matted. In a sense they are the parent material of Hemists and Saprists. Fibric material resists destruction by rubbing, it has low bulk density (<0.2 gm/cc) and usually a low ash content. In many cases it consists of sphagnum and associated plants, but may be, for example, undecomposed sedge material. In older systems this material was called peat. It is designated by the symbol O_i, indicating that it is fibrous organic matter. Six Great Groups of Fibrists are recognized, based on botanical composition, temperature, and special morphologic features: Sphagnofibrists (mainly sphagnum), Cryofibrists (over permafrost), Borofibrists (soil temperature less than 47° Fahrenheit), Medifibrists (soil temperature from 47° to 59°), Tropofibrists (soil temperature greater than 59°), and Luvifibrists (an illuvial horizon).

Hemists consist of partially decomposed vegetative materials often brown in color. *In situ* these may appear fibrous, but upon rubbing the fibers are partially destroyed. Other Hemists are decomposed enough so that the botanical origin of two thirds of the material making up the soil cannot be determined. Bulk densities are usually somewhat higher (0.1 to 0.2 gm/cc) than those of Fibrists. Water tables in Hemists tend to fluctuate but are never very deep. In older systems they were called peaty muck or mucky peat. Hemic material is designated as O_e. Seven Great Groups of Hemists are recognized, based on climate, composition and evidence of illuviation: Sulfohemists (sulfuric horizon within 50 cm), Sulfihemists (sulfidic materials within 1 m), Luvihemists (illuvial horizon), Cryohemists, Borohemists, Medihemists, and Tropohemists.

Saprists consist of nearly decomposed vegetative remains in which botanical origin cannot be determined directly. Saprists are mainly dark colored (black) and have bulk densities greater than 0.2 gm/cc. Ash content is relatively high as is exchange capacity. Some Saprists exhibit good soil structure, and although not recognized in the New Taxonomy, illuvial deposits in subsoil horizons. Saprists were formerly called muck. Four Great Groups are recognized based on climate: Cryosaprists, Borosaprists, Medisaprists, and Troposaprists.

Saprists are frequently cultivated and used for vegetable crops, corn, mint, sod, and other crops. In Wisconsin they provide the basis for a considerable specialty crop.

At the Subgroup level, four modifiers are used in Wisconsin: typic (typical), Hemic (some of the fibric material is decomposed), terric (a mineral substratum at less than 50 inches), and Limnic (shallow over lake deposits).

Wisconsin also uses the Family names Euic (high pH) and dysic (very low pH). Other Family names are sandy and loamy (referring to the general texture of shallow underlying material), coprogenous (lake-laid fine organic sediments), and marly (lake sediments high in calcium carbonate).

Thus the complete classification of a deep, well decomposed, organic soil of relatively high pH in southern Wisconsin would be as follows:

After Houghton, Michigan	*Typical*	*Temperature 47° to 59°*	*Well decomposed*	*From Histosol*	*Relatively high pH*
↓	↓	↘	↓	↙	↓
Houghton	*Typic*		*Medi|sapr|ist*		*Euic*

Tests of Histic material

Rubbed fiber content and sodium pyrophosphate extract color (SPEC) are the two criteria currently used by soil scientists to classify Histosols in suborders. In the former case the rubbed sample is washed with water over a sieve while being rubbed and the resultant fiber (> 0.1 mm) measured. In the latter, the sample is soaked in a saturated solution of sodium pyrophosphate and the color, on filter paper, of the resultant solution is measured to determine the degree of decomposition.

In the event of a conflict between the two tests, solubility is generally given precedence because it is based on a more analytical test. However, in a number of samples analyzed by Reese (1977), rubbed fiber content definitely indicated that the sample was fibric, whereas the SPEC test showed that considerable amorphous organic material was present. This was probably due to illuvial deposition of mobile organic material within the fibric framework of the soil. Earlier studies by Lee and Manoch (1974) have shown strong micromorphological evidence that amorphous organic materials move downward in peat profiles, coating the peds of decomposed horizons, or the fibers of undecomposed organic matter.

In looking at the Histosols of Wisconsin, we note some differences, particularly between the Fibrists and other two classes. pH ranges from very acid in the Fibrists to near alkaline in the others; carbon and oxygen are nearly equal in Fibrists while there is more carbon than oxygen in Hemists and Saprists; the N content is low in Fibrists, consequently a high C/N ratio results as compared to the Hemists and Saprists which have a C/N ratio similar to good mineral soils used for agriculture. There is little ash in Fibrists, ordinarily ash is relatively high for the other two kinds of Histosols. The reverse is true for fiber content. The Hemists and Saprists are low while the Fibrists are high.

When we look at the morphology and the micromorphology of Histosols, we see the results of disintegration and decomposition brought about by soil animals—earthworms, mites, bacteria following aeration. Annual wetting and drying then aggregates these materials into granules, blocks, plates, or prisms. A study of the soil in University Marsh, which had been drained and used for corn for more than fifty years, showed a stage of extreme decomposition. The plow layer was granular and blocky, the subsoil was blocky and prismatic, and the material below the drain, massive in structure. This kind of soil development can only come about by artificial drainage over a substantial period of time.

Many other peatland soils are much less developed and a few consist of fibric material. However, in most peatland soils, considerable decomposition has been initiated by bacteria and fungi. These are the unseen forces whose work can best be detected by the hand rubbing test or by SPEC. Many peat deposits appear to consist of peat that is little changed, until it is rubbed and found to be essentially decomposed.

Extent and uses of Histosols

Wisconsin ranks fifth, after Alaska, Minnesota, Michigan, and Florida, in peatland acreage, having approximately 2,800,000 acres. Many uses

Amphibious Soils

By Francis D. Hole
University of Wisconsin-Madison

Nearly all of our Wisconsin soils were wild soils before 1800. Prior to that, native peoples tamed or domesticated soils only in restricted areas, most of which were on relatively high ground close to bodies of water. Today wetlands still contain an important remnant of wild soils that continue to respond to native plants and animals and to seasonal pulses of solar radiation and water, with scarcely a trace of human impact. The sense of the ages that Aldo Leopold caught from the sight and sound of large migratory birds of our wetlands is also communicated from the silent soil itself. If one stands in a cushion of sphagnum moss or a mass of sedges and discovers with the help of a steel probe that five meters of cold wet peat lie below, one is aware of being in an ancient landscape. It is hardly more ancient than adjacent uplands, but the wetland has accumulated a more impressive blanket of organic carbonaceous material to show for all its millennia.

Many wetland wild soils are amphibious. This means that they are seasonally saturated with water to the point of being flooded, after winter winds are tempered. Conservative wetland soils give up the conditions of winter long after upland soils have. The carapace of frozen muck finally softens, then comes a partial dewatering or unsaturation. Some of the soils develop shrinkage cracks by August. Long before that, scattered knee-high mounds built by colonies of ants function as rather well aerated oases in an overwatered terrain. The annual cycle of saturated-unsaturated conditions is impartial. Neither condition can be said to be more complete or mature than the other. They are as different as day and night, as summer and winter.

In its haste modern civilization has abused the wetland soils increasingly. One large peat bog was used as a practice bombing range. A drainage bog caught on fire and the soil smoldered for months, leaving craters of collapse. A road across a wetland acted as a dam. Tamarack and spruce trees died on the up-drainage side. A boat channel was sliced through a patch of orchids to permit access to a lake. A drainage ditch hastened subsidence of a 6-meter-tall, 600-meter-wide peat mound which had been fed by upwelling springs for thousands of years. A solid waste dump filled a wet kettle with cans, broken glass, and plaster.

Natural "disasters" were and are a normal part of the wetland scene. Wind-tipped trees lie jumbled at various angles. Fallen trunks are soil for seedlings of white cedar or hemlock. Raft-size pieces of bog are torn loose by storm waves and float aimlessly, trees and all, from shore to shore, ultimately to founder and contribute to the natural filling of a lake. Sphagnum moss has the capacity to spread its domain of wet blanket and drown out a patch of mesic forest. Mastodons sank into wetland soils and are well preserved still, thousands of years later. Natural leachates from uplands concentrate in low-lying wetlands, which are both libraries and dumps of natural waste.

Well-managed muck farms and cranberry bogs do claim our admiration. Truckloads of carrots, lettuce, onion, cranberries, and barrels of mint oil contribute agreeably to our dining. Sod from muck farms provides instant lawns in our cities. Although continued drainage and cultivation of a body of muck spells its ultimate disappearance by oxidation and attrition, most people take the attitude of the Dutch—whom we admire for reclaiming the North Sea—and approve of such temporary but fruitful enterprises.

The element iron is sensitive to alternating conditions of oxidation and reduction. When oxygen content of waterlogged iron compounds is thereby "reduced," the mobility of the iron increases. Upon complete reoxidation, iron compounds precipitate. Yellow brown bog iron ore, some of which is porous like crusty dark bread, has formed in the upper amphibious layer of some wetlands. Reduced iron has been moving with ground water for centuries from surrounding uplands and has precipitated on rising into aerated soil.

The amphibious soils of wetlands belong to two worlds: the world of waters and the world of land. It is a special world in its own right.■

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have been found for these soils, both in their natural state and when drained. However, because interactions with water, chemicals, and sediments are highly dependent upon the stage of peat decomposition, we cannot say a great deal about the use of an individual tract of peatland until we have characterized and classified it. In their natural state, peatlands can provide habitat for many kinds of animals and fish, they can serve as outdoor classrooms, provide open space, serve as filters between upland slopes and open water, or be used as a wildlife area. In some areas, peatlands are used to dispose of sewage effluent.

Some developed uses have included urban development, agricultural, and horticultural use, mining for peat material, and mining for energy uses.■

The Upland-Lowland Connection

By James Hall Zimmerman

Wisconsin has far fewer drainage districts than any of the five surrounding states. That we hold a significant share of all of the Midwest's wetlands and waters places on us a special onus to maintain them. It may be a shock to learn that, except in the northern forest region, almost all of our wetlands have been altered by man, often impairing their functions. As a result, protection efforts are difficult to justify, and research results are suspect.

What are the human impacts on our wetlands? Aside from outright filling and draining, the two most serious *internal* alterations are steepening the shoreline slope and constructing a "through-ditch." Steepening of the land-to-water gradient promotes chronic erosion and displaces countless species of plants and animals which depend on a stable substrate with subtle variations in depth. The through-ditch crosses an unfarmed wetland to pass floods from low upland fields, as well as muck farms, on to the nearest waterway. Between floods the wetland's water-table is unintentionally lowered, making waters too shallow or favoring peat decay and successions to upland forest or to nuisance vegetations.

The *external* alterations are equally serious, especially interference with surface and ground waters. Water levels may be intentionally altered to manage a marsh, such as for waterfowl, of course. But most water level alterations are for some *external* purpose. Muckfarming (excluding cranberry growing) tends to lower water tables generally in a region. Pumping groundwater for urban use or for crop irrigation may dry up at least the ground water-slope type of wetland. On waterways and in urban areas—the two places where wetlands have the greatest variety of uses—it is common to alter water levels to mitigate flood damage downstream and sometimes also for navigation. In most cases such manipulation damages the plant or animal life because it is arbitrary and contrary to natural input-output regimes. Water levels become too high or too low, or change too often or not often enough, or too rapidly, or too slowly, or at the wrong season. Or management policy suddenly changes, disrupting a new equilibrium being attained over several years.

By far the largest and most widespread damaging impact, however, is entirely unintentional. Unintentional because recognizing wetlands as entities has in one respect done them a disservice. The word wetlands connotes a unit or module in the landscape which is self-sufficient and can be protected by placing legal boundaries around it and replaced if destroyed by creating a similar module anywhere else. Actually, a wetland, like any water body, occupies a low spot (lowland is as good a term as wetland). Thus it is likely to receive water from a larger upland area, called the watershed. The surface watershed may be twice to thousands of times as large as the wetland; the groundwater watershed may be larger still. It follows, then, that any event that affects the watershed will influence the timing and amount of water input and the materials the water brings with it. A tree is a good model: a wetland can't exist without a healthy root system (the watershed), and its unique nature depends on what the roots bring in. This relationship can be called the upland-lowland connection. It has biological and esthetic connotations as well as physical ones.

Obviously, wetlands are especially vulnerable to leakage of pollutants applied to the uplands, such as petroleum, pesticides, and road salt. But these are probably insignificant alongside what I choose to call the "flood-mud-crud" syndrome (FMC). The cause is chronic partial or complete devegetation of the landscape, especially by plow, cow, and pavement. The result is accelerated runoff rates and volumes of stormwater and snowmelt, causing flash floods and soil erosion. A secondary result of greater runoff volumes is less storage of water in topsoil in summer and groundwater in winter. Upland plants may suffer more from drought, while wetlands and waters may receive lower and less steady amounts of cold, clean water (in those cases where groundwater discharge is one of the inputs). In the lowlands, the water received from the surface watershed arrives in erratic deluges, and the water quality declines.

Flood damage to a wetland is just as disruptive as it is to croplands and villages. Take a hypothetical basin of one acre with vertical sides, with a watershed of 100 acres. With 10 percent of the water running off, a one-inch rain produces a rise in water level of about eleven inches, but with 50 percent runoff, the rise will be fifty-one inches. Of course, the more gradual the shoreline the less the rise, hence the great protective value of many natural shore gradients of around 1 percent (a rise of one foot in 100 feet). But you can see how increasing the flood rise in a marsh by even five inches can destroy waterbird nests, drown or dislodge emergent vegetation, and enable muskrats to attack plants made accessible by deeper water, while the force of the torrents can cut deep channels through the wetland (if it has an outlet). Channelization bypasses incoming waters, causing the wetland to dry out as if ditched, while preventing the wetland from interacting with the water and executing whatever sponge and filter action it is capable of. In addition, for the wet marsh, a single summer flash flood can completely refill a basin with water even in a dry season, thus preventing the needed periodic gradual summer dry-down which recycles nutrients, renews emergent vegetation, and promotes nesting by water birds. Silt deltas are another problem, making the water too shallow to hold oxygen.

But this is not all. Today from an aircraft most of our surface waters in settled regions have only two colors: *green* and *brown.* The green ones support "blooms" of waterweeds, duckweeds, and especially nuisance algae which have displaced most plant and animal life. We call such water eutrophic (well-nourished), but a better term would be hypertrophic. The high surface productivity has far-reaching effects—sometimes toxic, sometimes competitive with other forms of life for space and minerals, and almost always highly preemptive of another essential of life—oxygen. Algae do produce oxygen in sunlight, but like all plants they consume it at night, and their abundant remains consume it even faster in decay. Their thick growth blocks light penetration that would enable submerged plants to produce oxygen in the water by day. The algae can be called the "crud" part of FMC, as these plants may form smelly, unesthetic scums or green "pea soup." The brown waters are equally damaging; eroded topsoil, and even subsoil, usually contains fine particles (the silt and clay fraction) to which additional nutrients are attached besides those washed in as soluble salts. These fine particles clog the gills of many aquatic animals, bury their eggs, and block light as well, for they may stay suspended for weeks even in calm water. In opaque (turbid) waters whether green or brown, the low oxygen levels may favor nuisance animals. Mosquitoes may fare unusually well; since they breathe at the surface, most of their enemies from fish to dragonflies die out with turbidity, and fluctuating levels trigger the hatching of mosquito eggs. The alien carp certainly prosper, since they tolerate low oxygen levels and hide in the mud they stir up from hungry herons and northern pike.

But, many people say, water always will run downhill, and soil and fertilizer, too, and all waters and wetlands are doomed to eutrophication and filling in anyway. So what is the fuss about? These same people will admit, however, that wildlife and water quality aren't what they used to be. Have we taught geologic cycles and plant succession too simplistically? If only science and technology weren't so specialized that upland and lowland people (like soil conservationists and flood control experts) could have been coordinating their work all these years! The best we can do now is to test the hypothesis that upland abuse means lowland abuse is to seek historic clues. Here are six lines of evidence suggesting that we have accelerated the geological processes to speeds thousands of times their natural rates.

1. The Missouri River would not have the reputation for being muddy if in the days of Marquette and Joliet the other tributaries to the Mississippi above it had been equally green or brown, as they all are today. The Missouri flows through desert where vegetation is insufficient to hold soil against wind and rare cloudbursts whereas the natural midwestern forest and grasslands evidently held the soil despite frequent storms.

2. Wetlands must have been continuously renewed or replaced as fast as they filled or we would not have today's rich wetland biota which arose some sixty million years ago and traces its ancestors back, as we do, to the first land life in freshwater wetlands some 300 million years ago. And the glaciers created more wetlands than they destroyed.

3. Many of our marshes and meadows show an organic soil horizon one to three feet down, marking the presettlement surface now buried in eroded topsoil and gully wash. And in about every township there is a "mud lake." Mud in the old days meant having a loose, soft (organic) bottom; these small water bodies are surrounded by fens and bogs with small watersheds and hence are often still clean today in contrast to the turbidity and *sticky* mud (mineral silt deposit) found in basins with larger watersheds with higher probability of rural or urban FMC impact.

4. The use of Dunn's Marsh in Madison to detain silt and floods to help protect the lakes provides an extreme case. Under combined rural and increasingly urban impact between 1970 and 1980, the waters turned from clear to green and brown, most of the emergent vegetation died, the diversity of invertebrate animals is now too sparse for use in teaching children, the nesting water bird species dropped from seventeen to seven, and two of the six amphibians disappeared.

5. The ocean corals offshore from each of our major river outlets are dying from siltation or from smothering by nuisance growths of algae. Since corals are extremely slow-growing, a recent sudden change in water quality is indicated. (Sewage plants, most of which as yet don't recycle all of their phosphorus and nitrogen, are part of the problem, of course.)

6. A study of stream profiles in southwest Wisconsin by James Knox of the UW-Madison geography department is most revealing. From buried stream deposits he estimated that the average surface runoff rate and volume was only about 10 percent of annual precipitation under presettlement prairie and forest cover *despite* very hilly terrain. From recent profiles the runoff was estimated to be 50 percent under careful dairy farming practice (contoured strip rotations, grassed waterways, and exclusion of tillage from steep slopes and cows from woodlots). Under current cash cropping, runoff and erosion rates are far worse than that even on the gently rolling land in Dane County; soil erosion rates, now the worst in our entire history, amount to a national scandal. It has just been noticed that our best topsoil, now half gone in 130 years of farming, isn't renewed at the rate of two tons/acre/year, but instead was the loessial one-time gift of the glaciers. If the unborn had legal standing, they would surely sue us. At least, the lowland or downstream injured party ought to be able to sue the upland or upstream abuser.

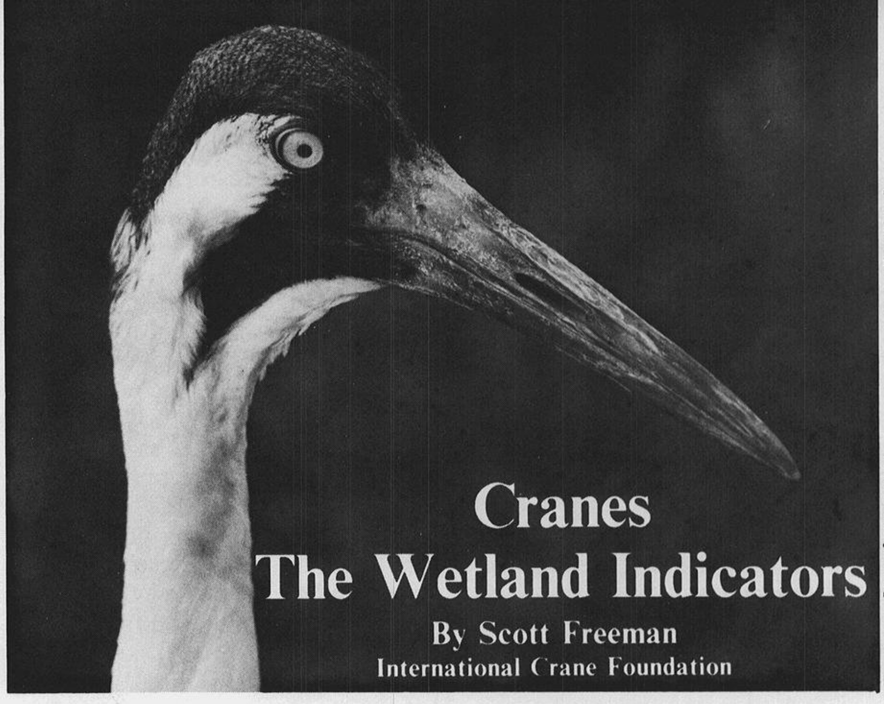
Follow-up on two case histories would confirm the extent of the upland-lowland connection whereby remedial upland management would redress the three injured parties—those downstream, the general public, and the next generation.

1. If applied to the upland, the estimated cost of the LaFarge flood control dam (dry or wet) would pay each farm family in the entire Kickapoo River watershed above LaFarge about $40,000 in cost-sharing funds—

surely enough to give a fair trial and upgrading of the promising new techniques of conservation-tillage, along with needed terracing and feedlot redesign. If the FMC syndrome were then to abate significantly, we could demonstrate that every dollar spent where the raindrop falls solves two environmental problems for the price of one. Since this work must be done to save our soil anyway, we can't lose.

2. The Madison lakes receive little sewage today but have *three* sources of FMC: urban, rural, and a special type of endangered peatland. The average annual soil loss from Lake Mendota's 150 square miles of farmed watershed is enough to fill several lanes of five-ton trucks stretching from Madison to Sauk City. The monitered rural phosphorus input is 1,000 pounds (elemental P) per year. City of Madison P input is estimated at 400 additional pounds, and dirty storm sewer waters blight the bays formerly frequented by our twenty-five beautiful kinds of migrating ducks each spring and fall. A single contractor's mistake cost the city $80,000 over a decade ago to dredge out part of a silt delta, so shore owners could again get their boats out. The Yahara Valley's large, unique fen-peatlands, fed abundantly by groundwater, are partly through-ditched intentionally at Upper Mud Lake and Cherokee and the Arboretum, and by rural storm floods at South Waubesa. Although peat is low in P, the four square miles of Cherokee fen peat contain at least one million pounds of P, by conservative estimates, hanging on a groundwater-fed slope over Lake Mendota's ten square miles like a sword of Damocles. If planned new city wells tap its aquifer, the peat will go, possibly in a spectacular fire, but certainly by the slow ditch leakage which goes on even today but has never been monitored.

This discussion had to be oversimplified in order to be brief. It seems quite possible however, that wetlands, as concentrators of and responders to what happens in their watersheds, may serve us best of all as highly sensitive early warning indicators of how well we husband our children's priceless heritage—the Earth.■



Steven Landfried

Tex, a whooping crane

Cranes
The Wetland Indicators

By Scott Freeman
International Crane Foundation

It was damp and cold, as only March in Wisconsin can be. Perfect weather for getting novices out on a field trip and excited about wetlands, I thought, as I tried to cheer people up, warm numb fingers, and defog binoculars. But we'd just gotten everyone untangled from the car caravan, buttoned up, and out of the parking lot when my coleader, a longtime wetlander with a bushy beard and bright eyes, hushed all fifty of us.

"Listen," he said, cocking his head and pointing off to the horizon. "Sandhill cranes."

We all bowed our heads, concentrating on the distant sound, until someone cried "Oh, look!"

Fifty heads turned together and stared as twelve sandhill cranes flew toward us in a V formation, not fifty feet above our heads. We could see them blink and hear their wings beat, as they called and veered slightly away from us.

No one on that field trip will ever forget that marsh, or those cranes. Wetlands and sandhill cranes will always be inseparable and significant to those fifty soggy birdwatchers. But the association of cranes with wetlands is also a key concept for conservationists all over the world.

Globally, cranes are considered one of the most useful indicator species for wetland ecosystems. Cranes are very large and demand extensive wetland territories for successful nesting. So if wetland habitats begin to deteriorate, cranes will be among the first organisms to go. And since cranes are so visible, they are likely to be the first organism we notice going. Conservationists can therefore monitor the stability of wetland ecosystems over a broad area by monitoring cranes—the indicator species.

Sandhill cranes are native to Wisconsin and have served as a particularly useful indicator species for wetlands. Sandhills are tall, lanky birds feathered in battleship gray, with a bright accent of red skin on the crown. They are the oldest extant species of bird—their fossil remains go back about seven million years. They are also one of Wisconsin's earliest migrants, appearing in the southern part of the state by early to mid-March. The migrating flocks are made up of family groups, which split off to take up residence in traditional territories by the early part of April. Crane pairs, which mate for life, then begin a period of intense activity. They drive away their chick of the previous year, call and display to defend their territory against intruding cranes, and perform their celebrated courtship dancing. But by the end of April, when the nest is built and the two eggs laid, breeding crane pairs become remarkably discrete. They do a minimum of calling and displaying to avoid attracting predators to the nest.

The reclusive part of the crane's life cycle continues when the chicks emerge after a month of incubation. The precocial young are up and out

If wetland habitats begin to deteriorate, cranes will be among the most visible organisms to go.

of the nest a day or two after hatching. They are almost impossible to observe at this time of year, as they trot beside their parents who probe and hunt for food. Tadpoles, seeds, roots, insects, and snails feed the chicks, which grow at an astounding rate. The young are constantly threatened by lack of food, predators, and disease, and usually only one of the two survives.

By the time August evenings become long and cool, the crane chicks are fully grown and ready to fly. When the youngster does indeed fledge, the family's behavior changes dramatically. The parents are no longer territorial, but lead their chick to larger marshes nearby, where other crane families begin to congregate. On these "staging areas"—eleven are scattered around the state—cranes group in numbers of up to several hundred, forming flocks which will begin migrating south, eventually to Florida, in early October.

In Wisconsin sandhill cranes have been repeating this annual cycle since the glacier retreated. When European settlers arrived, cranes probably danced and bugled by the tens of thousands. Their wetland habitats, the soggy bottoms of glacial lakes and kettleholes, stretched out over millions of acres. But starting when the first log cabin went up in Wisconsin, the changes of 10,000 years were compressed into 100. Since settlement the crane population's fall and rise has paralleled the history of wetland use. Cranes have been reliable indicator species for more than a century.

When Europeans first began carving homesteads from the prairies and oak openings of central and south Wisconsin, cranes merely looked on. For, during the first forty or fifty years after settlement, neither settler nor crane made drastic intrusions on the other's territory. In fall or early spring crane flocks might go up into the wheat and corn stubble to feed, and in late fall teams of farmers would cut wild hay in the marshes. If damage was done to the crane population, it was done by the shotgun.

But then in the early 1900s cranes began to decline dramatically. In 1929 Aldo Leopold did a statewide survey and reported a grand total of five crane pairs breeding in the entire state. Sandhills were nearly wiped out, but the crane's fall was merely an indication of a larger problem. Leopold was one of the few who recognized both the state of indicator and the state of Wisconsin's wetlands. His essay "A Marshland Elegy" draws the connection clearly and powerfully. Cranes crashed after a boom era in diking and draining wetlands throughout the central part of the state—a boom which peaked in the 1910s.

In the depression years, however, the drainage boom ended abruptly. Many of the wetland soils were too poor to support continuous cropping, and damaging frosts came early to the low-lying marshes. Farms were foreclosed, ditches filled up, and state and federal wildlife refuges were established on the tax-delinquent former wetlands. The crane population began to recover. In fact, sandhills began what has become a steady comeback.

Between three and four thousand cranes now return to Wisconsin each spring, and their numbers and range still seem to be expanding. This comeback presents something of a paradox, because wetlands are still shrinking, perhaps quite steadily. Two questions leap to mind. Can the crane population continue to rise? Can we still use cranes as a useful indicator for the quality of wetlands in Wisconsin?

The answer to both questions is a qualified yes. The crane population is still recovering and will probably continue to rise at least for several more years. Cranes are still expanding their range, and there is some evidence that pairs have begun to use smaller or marginal quality nesting territories. At some time in the future, however, crane numbers will have to plateau. There are only so many marshes to go around, and only so many cranes can squeeze into them.

But for the next several years, sandhills probably won't be performing well as indicator species. Their numbers are going up, while wetlands are in decline. Yet cranes are still visible, still stirring, and still very useful from a conservationist's point of view. Sandhills are useful precisely because of their visibility—because they can make fifty people's hair stand on end on a cold March morning.

Wetland protection is currently the most controversial land-use question in Wisconsin, and certainly one of the most difficult. On the surface, the decline and comeback of sandhill cranes has little to do with such a complex land-use problem. But cranes do have something to contribute to the issue. For years marshes have been considered wastelands, acreages without value either to the assessor or the owner. We now know that wetlands can act as important groundwater recharge areas, pollutant filtration systems, and flood control basins, but in many minds the old prejudice still persists. I will state categorically, however, that the prejudice no longer exists in the minds of the fifty soggy birdwatchers I spoke of earlier. Cranes confer a distinction on a marsh. They are ancient, they are large, and they can raise an incredible racket. A swamp may not have obvious value, but a crane marsh is something special.

To capitalize on this theme, the International Crane Foundation and the Wisconsin Wetlands Association have sponsored a statewide Sandhill Crane survey for the last two years. In 1982 coordinators in forty-three counties recruited over 1600 volunteer participants—4-H groups, scouts, biology classes, families—to be at a marsh at dawn looking and listening for cranes. The data they return help us monitor the crane population and the quality of wetland habitats all over the state. But perhaps more important, the responses and excitement generated by the crane count indicate that cranes are doing what they do so well: inspiring respect and enthusiasm for wetlands and wildlife. If that concern can be translated into wetland protection, the cranes will have done much to save themselves.■

Creatures of the Marsh

By Ruth L. Hine
Department of Natural Resources

Frogwatching is becoming a springtime sport in Wisconsin! Actually, it's frog *listening*—for frogs and toads, like birds, utter distinctive spring breeding calls and can be identified by simply listening and sorting out the wild chorus of song.

Frogs and toads are truly creatures of the marsh. Along with salamanders they belong to the vertebrate group known as amphibians, at home both on land and in the water. They are mostly small, less than five inches long, short-bodies and tailless as adults. A few tropical species, however, get quite large, and our own bullfrog reaches eight inches in length. They are found on every continent except Antarctica.

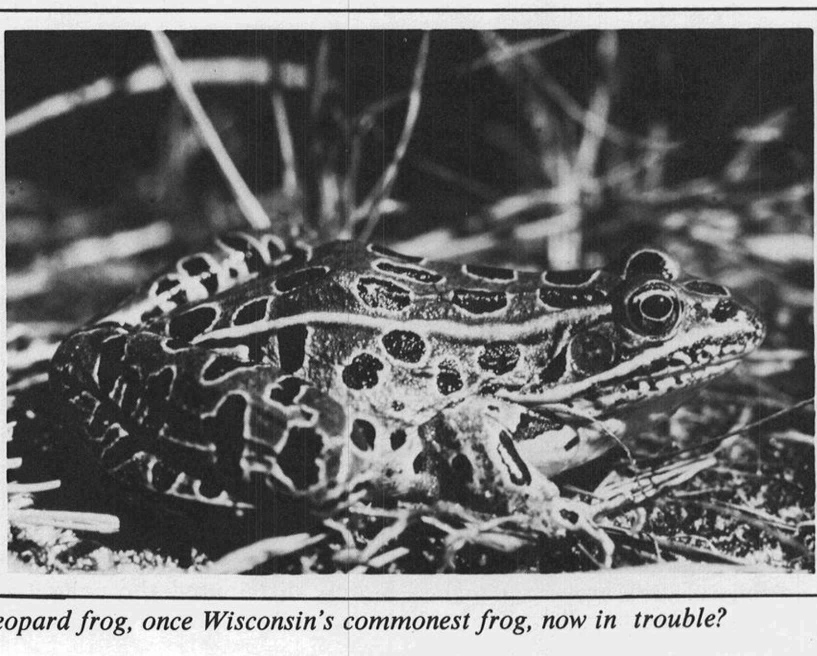
In Wisconsin there are eleven species of frogs and one toad. The pattern of their lives is quite similar. Males emerge from hibernation in spring, move to their wetland or woodland pool breeding sites, and begin to call. The females come a little later, and, often with the help of the males clasping them around the middle, lay their eggs in masses or strings or sometimes singly. Fertilization is external. After two to three weeks usually tadpoles emerge—tiny black dots with tails. In two to three months metamorphosis occurs—the amazing external and internal transformation of the gill-breathing aquatic tadpole to an air-breathing animal that can hop on land. Some frogs never leave the environs of the pond, while others venture a mile or more overland.

After a summer of feeding and growing, frogs and toads move to their hibernation spots where they remain dormant until the ice melts and the "early risers" utter their first tentative calls. Frogs and toads are a vital link in the wetland food chain. Insects are their prime diet, but they also consume a variety of other small invertebrates. One investigator found that cricket frogs filled their stomachs three times a day; this amounted to 4,800 food items eaten in a year. He then postulated that 1,000 cricket frogs in a pond would consume 4.8 million insects and other arthropods in a year! Frogs and toads, in turn, are eaten by countless animals, including fish, snakes, herons, mink, and raccoons.

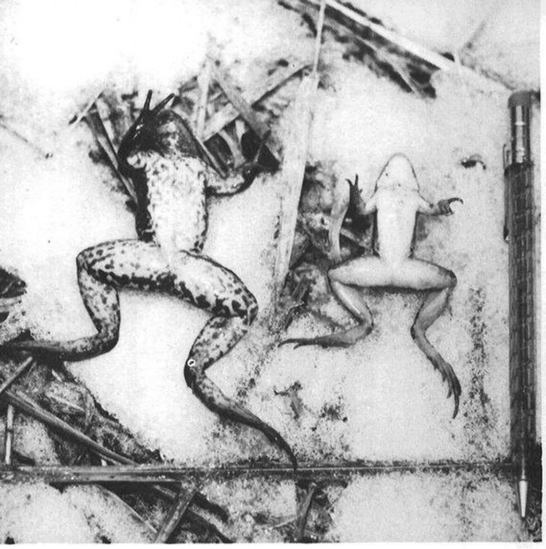
While the general behavior of frogs and toads is similar, the variety of species in Wisconsin shows a considerable range of habits and appearance. The one species of toad that occurs in our state is the American toad (Family Bufonidae). It is stout-bodied and short-limbed, with dry, warty skin (which, incidentally, does not cause warts). Toads do emit a fluid from two glands just behind the head that is irritating to the eyes and nose, but is otherwise not dangerous to humans.

Toads are common throughout the state and breed in almost any kind of water. About the time the marsh marigolds begin to bloom, the high, sustained trilling of toads may be heard, day and night. During the summer both adults and the tiny young toads are frequently seen moving with their characteristic short hops in woods, fields, gardens, and farm lands. Some years (as in summer of 1982) tiny toads occur in great densities often far from their wetland "hatcheries."

The treefrog family (Hylidae) includes five species more familiar to us by sound than by sight. These are tiny frogs with rounded sticky pads on their toes that help them cling to vegetation above the water or to climb high into shrubs and trees. The chorus frog and spring peeper become active very early in the spring, their calls filling ponds, marshes, and ditches with a medley of sound—the rising staccato notes of the chorus frog (sounding like a fingernail drawn along the teeth of a comb) mingling with high-pitched peeps of the spring peeper. The cricket frog, whose call is likened to the sound of pebbles being clicked together in your hand, begins its breeding activities a little later in the spring in much the same kinds of habitat, although it seems to prefer the marshes along rivers and river flood plains.



Leopard frog, once Wisconsin's commonest frog, now in trouble?



Frogs found dead on the bank of the Little Sugar River.

The eastern and Cope's gray treefrogs are the namesakes of this family of frogs. These two species, the largest of the treefrogs in Wisconsin, are chunky with warty backs, like mini-toads. They are the chameleons of the frog world, their color changing from green to brown to gray, depending on their background. The call is heard from mid-spring into July—a beautiful trill, repeated at short intervals. The ear must be trained to pick up the shorter, faster call of the Cope's gray treefrog.

All of the treefrogs are found generally throughout the state, except the cricket frog which is confined to the southern half.

Although the treefrogs are more commonly heard, the "true frogs" (Family Ranidae) are the ones most commonly seen—slim-waisted, long-legged, medium-size frogs that spurt out at your feet along the edges of almost any wetland.

The leopard frog, greenish brown with irregularly spaced large brown spots, is typically our mental image of a frog. It is widely distributed along lakeshores and in quiet ponds, marshes, and even upland fields during the summer. Leopard frogs start calling in early spring, sometimes while still in their winter quarters before moving up to a mile to breeding ponds. Their call is a distinctive low-pitched gutteral snore, interspersed with "chuckles." While many may be calling at once, their calls do not dominate the night music as does the chorus of spring peepers and chorus frogs.

Two rows of dark brown squarish blotches and golden yellow thighs, evident when stretched out in swimming, distinguish the pickerel frog. Also its habitat of cold spring water is more selective than that of the more ubiquitous leopard frog. The call is similar, but softer and higher.

A frog of the north country bogs is the mink frog, a medium-sized green frog with dark brown spots and wavy lines. It is never far from water, and if disturbed, will shoot off across the surface and then dive. Mink frogs begin calling in early June at night while floating on the water. The call has been likened to the clattering sound of horses' hooves on cobblestones.

The first frog to call in the spring is the wood frog—the hoarse, low-pitched "quacking" is sometimes confused with duck talk deep in the marsh. The males come to the small woodland breeding ponds as soon as the ice is out, quickly followed by the females. Mating and egg laying is done rapidly, and the whole population is out of the pond and back to the woods in ten days to two weeks.

The exception to the other "true frogs" in size and appearance is the bullfrog, a greenish to brownish frog averaging four to six inches in body length, but sometimes reaching eight inches. Bullfrogs live in the weediest areas of permanent bodies of water, staying in the water or along the banks all their lives. They are the last frogs to call and begin breeding, usually not until June. Bullfrogs develop more slowly than other Wisconsin frogs—tadpoles metamorphose in their second year, and the young bullfrogs require two to three years to mature.

The green frog is a somewhat smaller edition of the bullfrog, also living in permanent water and also breeding late. The low twang, a single note sounding like a plucked banjo string, may be heard throughout the early summer. It is probably now Wisconsin's commonest frog.

The green and leopard frogs are widely distributed throughout the state; bullfrogs and pickerel frogs appear to be more scattered, while mink and wood frogs are more northern species.

Many of Wisconsin's frog and toad populations appear to be common where they occur in the state. However, there are indications that all is not well. A startling decline has occurred in cricket frog populations. Once distributed throughout its range in southern Wisconsin and commonly heard calling in late spring, this species has decreased drastically in the last few years until now there are records of cricket frogs in only five counties, mainly in the southwestern part of the state. The cricket frog is now being placed on Wisconsin's Endangered Species List. The cause of the decline is unknown.

Another small treefrog, the spring peeper, is still common in many parts of the state, but the disappearance of this species has been recorded in some areas, notably the University Arboretum and Cherokee Marsh in Madison.

Bullfrogs have suffered from human predation, and populations are reduced in the southern part of the state. They have been collected for use as food and by biological supply houses. Pickerel frogs up until this year have been listed as a threatened species, but since an apparent low point in the mid 1970s, it has been found in an increasing number of locations statewide. This frog is sensitive to water quality changes, and although it has now been removed from the threatened list, populations will be monitored.

Frogs and toads have many threats to their survival: wetland destruction, adverse weather, disease, chemicals in the environment—and even traffic on the roads near breeding ponds. At least one community has taken action to help solve the latter problem. Traffic was closed from 8 p.m. to midnight during the mating season on one road in the German city of Muenster where thousands of toads were run over as they crossed to reach a breeding pond.

The leopard frog has received the most attention over the past decade because of its widespread decline in this country as well as in England and Europe. It was once perhaps the most abundant frog and was widely collected for use in medical laboratories and biology classrooms. Disturbances in the populations, however, were beginning to be noted even before mortalities were evident. Leopard frogs failed to behave "normally" in time-honored medical tests, and dealers in biological supply houses found that they could not keep leopard frogs for extended periods of time as they had previously.

Dead and dying frogs were reported in Wisconsin in the early 1970s. A research study was carried out from 1974 to 1978 to investigate the extent of the mortality and to obtain some baseline data on leopard frog populations. It involved a statewide survey of mortality and an intensive study of populations in the east central counties along Lake Michigan. The results of the study were alarming: low population numbers, many ponds with apparently suitable habitat devoid of any frogs, low survival of eggs and tadpoles, and widespread areas of mortality, which in some instances, was 100 percent.

Although there was evidence that ruled out disease, no cause of the abnormally high mortality could be established. Degenerative liver changes suggested that a toxic substance might be involved, and toxicity tests in the laboratory indicated that the herbicide Atrazine did cause mortality and reduced the survival and growth of leopard frog tadpoles.

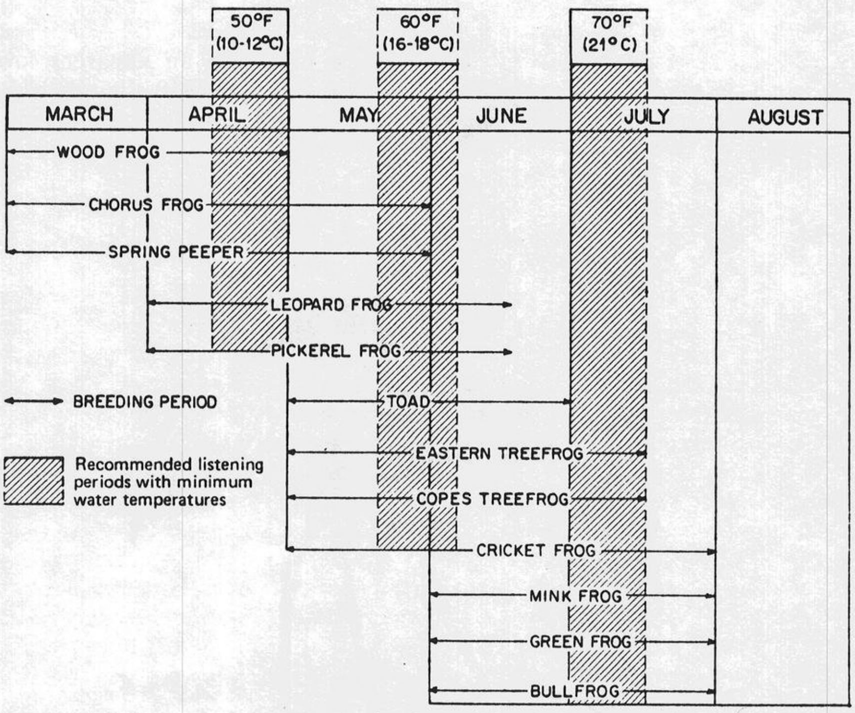
The situation at the present time is not clear. Leopard frogs are still widely distributed in Wisconsin, and in some areas in some seasons they are abundant. They are even being collected again for a biological supply house. On the other hand, in some areas where leopard frogs were formerly reported, they are not found. According to one long-time frog collector, there is no doubt that breeding habitat has disappeared due to the loss of wetlands, and breeding populations are therefore not as abundant as in former years. And surely the fall mortality, which is still reported every year, must take its toll.

The plight of the leopard frog, and the more recent crisis with the cricket frog, prompted a desire to increase our knowledge of the distribution and abundance of frogs and toads, which are especially vulnerable to human uses and misuses of the land and water. The general statewide distribution of frogs and toads has been mapped by Richard Vogt in his recent book on the amphibians and reptiles of Wisconsin. Our concern now is to obtain extensive local records of occurrence for all species over a period of time that will provide an index to current status and population trends. Frogs and toads are sensitive to changes in water quality and quantity, which in turn are influenced by adjacent land use practices. Changes in their populations, therefore, can serve as an index to environmental quality.

A technique for surveying calling frogs and toads has been developed, based on the work of Deborah Jansen and Prof. Ray Anderson of the University of Wisconsin-Stevens Point, who have been censusing the frogs and toads of Portage County for the past three years. It involves running a transect of ten wetland sites and listening to and recording all species of frogs heard during a period of at least five minutes at each site. Since the different species call at different times, from the early wood frog in mid-March to the late bullfrog in June and July, it is necessary to run the transect three times to catch the height of the calling during the three general breeding periods.

In 1981 twenty-four persons ran twenty-seven transects in twenty-two counties throughout the state. This is a much-appreciated volunteer effort by agency and university personnel and by private citizens. Many of the same transects were run and new ones started during this year's survey. As the results accumulate, a picture should emerge of the distribution and relative abundance from year to year and from one area to another.

Whether one takes part in a formalized survey or not, "frogwatching" opens up a whole new world of sound from early March to late July! And for the patient observer a close look at the bright yellow throat and breast of a male green frog, the tiny calling spring peeper with its throat inflated until it is almost as large as the frog itself, or the frenzied turmoil of toads breeding along a pond edge is a rewarding insight into the marvelous beauty and diversity of a marsh.■



Calling calendar for frogs and toads in central Wisconsin

Black-crowned night heron

Birds and Wetlands

By James B. Hale
Wisconsin Department of Natural Resources

Drawings by Dan Metz of the Minnesota DNR

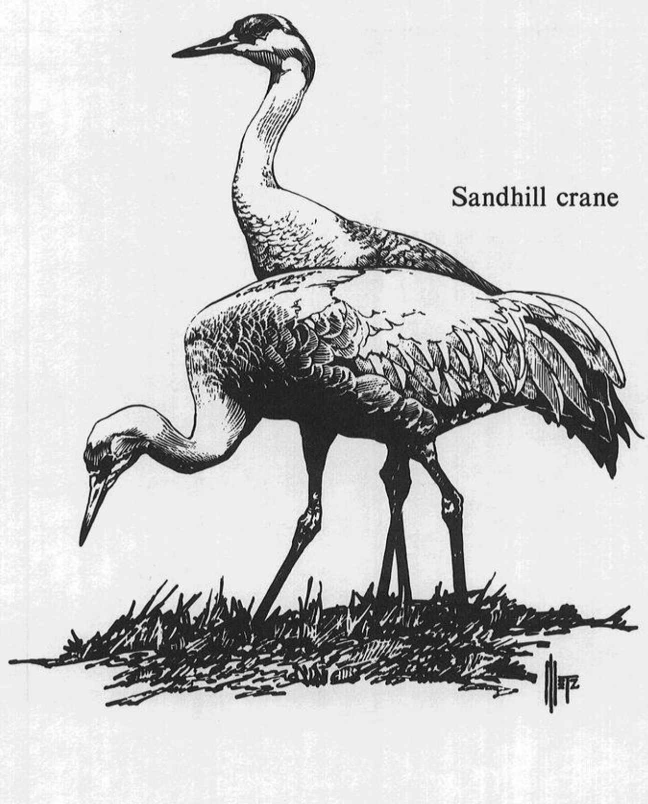
Fascination with wetland birdlife seems to be universal. Back in 1851, Thure Kumlien, one of Wisconsin's ornithological pioneers, wrote to a friend about yellow-headed blackbirds (*Xanthocephalus xanthocephalus*) at Lake Koshkonong in Jefferson County, Wisconsin, where he lived:

> The nest and eggs of the Xanthocephalus I could not find although I visited the place three different times, and I assure you I did my utmost in searching for them. The place where they breed or where I suppose they breed, because I found them there and nowhere else (in the water) among reeds so high that when I shoved my boat along I could not see over them. Then I waded in the water, which was over my knees and pushed the boat before me. So you see it was very tedious work. I saw a great many Xanthocephalus. . . .They did not seem to care a deal for my presence. Sometimes I was within ten feet of them. The note of the male is something between the note of the redwing and a young rooster, the latter part of the notes being very hoarse. It sounds as if he were endeavoring to get out something nice. The commencement goes well enough but comes very near choking him before he gets through.[1]

(Other writers have described the yellowhead's song as resembling the squeaking of a rusty hinge.)

More recently but still nearly fifty years ago, my grandmother, who taught me a great deal about birds, remarked that "It's a poor marsh without birdsong," as we stood at the edge of a Big Marsh near Stoughton watching the courting redwings and listening to the winnowing jacksnipe.

Today, elementary school children and adults alike still find wonder and enthusiasm for the wide variety of birdlife in wetlands. Ducks and bitterns in large marshes, sedge wrens



Sandhill crane

[1] Main, Angie Kumlien. 1927. Yellow-headed blackbirds at Lake Koshkonong and vicinity. Trans. Wis. Acad. Sci. Arts & Lett. 23:631-638. (Quote from pp. 631-32)

in wet meadows, woodcock in the shrubby swamps and red-shouldered hawks in timbered river bottoms are all part of the avian diversity found in wetland habitats. Even the alien ring-necked pheasant gravitates to the wetlands for much of the year.

Such unflagging enthusiasm, however, has not prevented great changes, mostly for the worse, in the quantity and quality of Wisconsin wetlands. Drainage, filling, pollution, dams, and shoreline developments have played a large part in reducing our presettlement ten million acres of wetlands to less than two and one-half million. Fortunately, the people of Wisconsin are beginning to accept wetlands as a valuable resource. Public opinion has almost come full circle. Whereas formerly the only good wetland was one that was drained or filled, wetlands today are considered biologically valuable in themselves. Degradation of wetlands has been slowed but not stopped.

Whether your interest is in cattails or canary grass, in mallards or muskrats, the biological productivity of wetlands is phenomenal. At the same time, wetlands are fragile habitats, because slight changes in water supply or water quality can drastically influence all life forms in the affected wetland. And finally, the major problem is us—the people whose lives include contacts with wetlands. People who will understand wetlands and will respect and care for them will find that birds and their habitats will respond and thrive. But people who do not, generally will be wetland destroyers.

There's little question about the importance of wetlands to Wisconsin birds. Of the state's gross area of thirty-six million acres, about 10 percent are in water and other wetlands. But of the 370 species of birds recorded in Wisconsin, 39 percent live in or use wetlands for at least part of their lives. No other habitat type comes close to these avian occupancy rates.

The National Audubon Society maintains records, the Blue List, all across the country on the status of birds as a means of identifying birds in trouble. The 1982 list has 125 species, of which 42 percent are wetland species. The Blue List has fifty-one species found in Wisconsin, of which twenty-three (45 percent) are wetland users.

The Wisconsin endangered and threatened species roster lists fourteen birds, of which nine are closely allied to wetlands. They include the double-crested cormorant, bald eagle, osprey, piping plover, Forster's tern, common tern, great egret, and red-shouldered hawk. The red-necked grebe will be added to the list shortly. The other five listed species could, by extension, be considered wetland birds because their roosting or feeding habits involve wetlands. This group includes the peregrine falcon, barn owl, prairie chicken, Cooper's hawk, and loggerhead shrike.

The affinity of birds for wetlands raises two interesting questions: Why are so many wetland birds in trouble, and how many other wetland birds may be declining that we don't know about? The status of the larger and more spectacular wetland species, such as the ducks, bald eagle, and osprey are relatively well-documented, but what about the statewide status of such shy wetland dwellers as the swamp sparrow, least bittern, or yellow rail? We don't know about these and many more species, but we should.

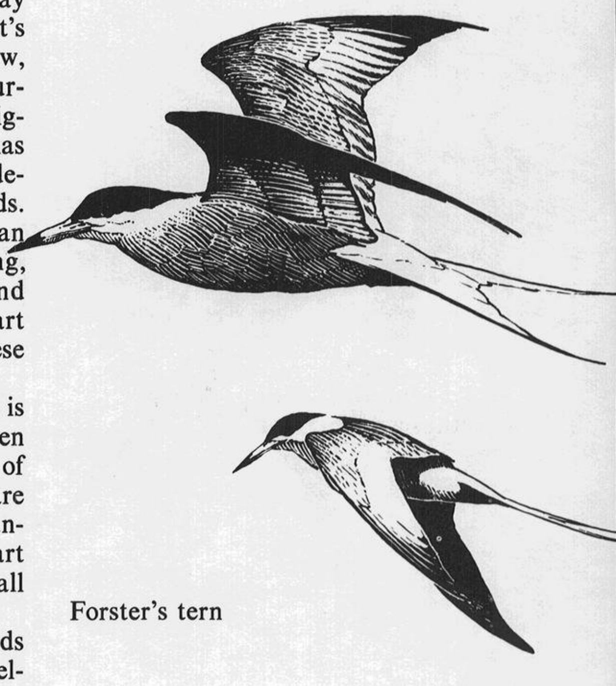
Without doubt there are many fewer wetland birds in total today than there were 150 years ago. It's not just a matter of how many now, but what are the threats to future survival? The 75 percent loss of our original wetland acreage in Wisconsin has to have been accompanied by a decline in the wetland-dependent birds. The continuing threats from human abuse—draining, filling, polluting, acid rain—are still present, and changes in bird populations are part of the early-warning system. These abuses are having adverse effects.

The bright side of the picture is that no wetland bird species has been extirpated from Wisconsin because of wetland destruction. Some species are hanging on, and others need substantial help if they are to survive as part of our native avifauna, but they're all still present.

The future of many wetland birds in Wisconsin depends on the development of management schemes for their recovery. Most such efforts are undertaken by state agencies. Information on past history of the species, evidence of a population decline, current status, identification of threats to remaining birds and their habitats, and availability of management techniques are factors determining management programs. In most cases, management means habitat improvement. Such programs in most states have been directed at the larger and more visible species. Like most wildlife management, there have been many successes and a few failures.

The four-year-old program of endangered and nongame species management in the Wisconsin Department of Natural Resources provides some examples of what can be done to help wetland birds. Here are some Wisconsin examples that typify the efforts now underway in most state resource management agencies nationwide.

Forster's terns are one of the two endangered white tern species breeding in Wisconsin, the other being the common tern. Forster's terns are one of the success stories of the DNR endangered species management program. Less than a dozen of the once-common Forster's tern nesting colonies in shallow-water marshes now



Forster's tern

remain in Wisconsin. Historically, Green Bay alone had eight colonies, while the largest one, Lake Poygan in Winnebago County, remains today. Wetland disturbance, nest disruption by people, and uncertain water levels have adversely affected populations over the years. In 1982, more than 900 young were produced in about 370 nests. This is more young than the rest of the colonies combined. The Lake Poygan project was engineered by DNR biologist Arlyn Linde. He noticed that tern nests in natural vegetation were being destroyed by wave action. Linde designed and built artificial nesting platforms of wood-framed styrofoam blocks covered with dead vegetation. In his words, "Forster's terns nested and renested in just about every platform we put out." In 1982 the National Audubon Society Chapter at Oshkosh adopted tern platform building as a group project. Their effort was of great help in the growth of the Lake Poygan tern colony. The technique can be used anywhere remnant colonies persist.

Great egret

The **bald eagle**, our national symbol, is endangered in Wisconsin. Its numbers in our state reached a low point in the 1960s, mostly as a result of contamination by chemicals in the eagles' food chain which prevented successful reproduction. Indiscriminate shooting was and is another problem. With the ban on DDT, eagles started a long, slow comeback. By 1981, 137 pairs produced 227 young, a new record high for the state. Bald eagles are wetland oriented, depending on fish as their main food, migrating along waterways, and wintering wherever there is ice-free water. The eagle's recovery has been aided by shoring up or replacing their bulky treetop nests when the nest tree is damaged by storms or old age, limiting access to nest sites by motor vehicles, and regulation of land developments and road-building near traditional nesting sites. The future of the bald eagle, while promising, is not assured. One factor which is difficult to control is the continuing residential growth around lakeshores where eagles nest and feed. Several townships in the major north-central eagle-nesting counties of Wisconsin showed in the 1980 census a ten-year growth of 10 to 20 percent in the number of permanent residents, primarily people who have built new year-round homes on lake shores. Such continuing people-pressure on nesting eagles will not encourage expansion of eagle numbers.

The **great egret**, formerly called common egret and American egret, is one of the heron family which is threatened in Wisconsin. All the heron species are susceptible to destruction of their nesting habitats, but egrets are an extreme case. By the late 1800s egrets were extirpated over much of their range by demands of the millinery industry for white egret plumes. After the Federal Migratory Bird Protection Act was passed in 1913, the egrets began to recover. They reappeared as nesters in Wisconsin about 1940. Today there are six small colonies along the Mississippi River and one larger colony at Horicon Marsh. Egrets are wading birds fond of ponds, marshes, and streams. Like the other wetland birds, habitat protection is an important management objective.

The **double-crested cormorant** is another success story. This large, dark waterbird is classed as endangered but is recovering rapidly from the low point of the 1960s. It formerly was a relatively common colonial breeder in Wisconsin. It is now reestablished at about a dozen colonies. The largest is in lower Green Bay with more than 1,000 birds. Other main colonies are on the marshes of state-owned wildlife areas at Grand River, Mead, and Fish Lake. Colonies were recently established on several of the Great Lakes islands off Door County and in the Apostle Islands. Cormorants are colonial nesters utilizing rocky shores of the Great Lakes islands and flooded dead trees on inland lakes and marshes. Such trees, however, eventually topple, leaving the cormorants homeless. Fortunately, they respond quickly and successfully to the artificial nest structures developed by Tom Meier, a DNR wildlife manager. Wooden nest platforms attached to utility poles erected as replacements to blown-down natural trees have attracted cormorants in increasing numbers. Such poles are not esthetically pleasing to some bird watchers, but the cormorants find them attractive and their once low numbers are approaching historical size. The pole nests are also sturdier than the original trees they replace. The active colonies now in Wisconsin are large enough and productive enough that the statewide population is close to the point where they can be taken from the endangered species list.

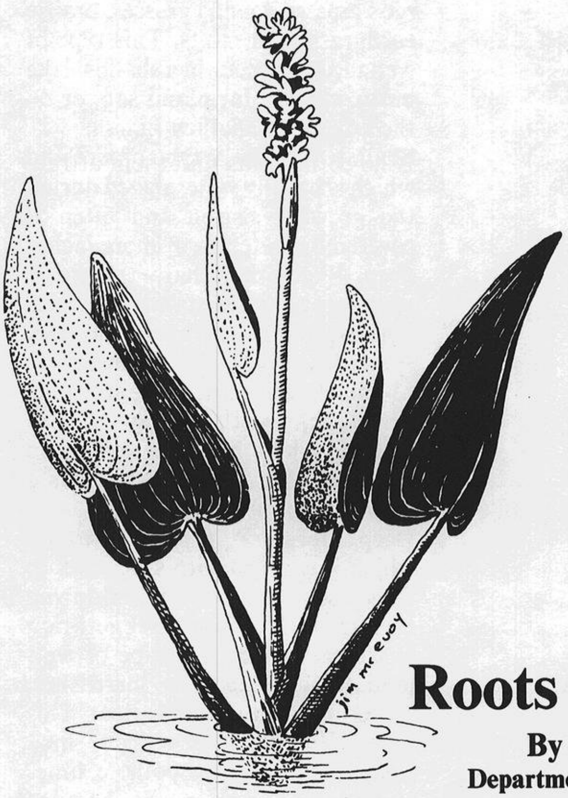
Recovery management is the key to returning all wetland birds in trouble to viable, self-sustaining populations. The goal of any endangered and threatened species program is to work itself out of business by bringing the troubled species back to the point where they may be delisted. Endangered species lists only identify problems but do nothing for survival of the beleaguered terns or eagles fighting for their future. Recovery management is essential if birds in wetlands are to prosper.■

Water was the first medium of life. Single cells floating in the sunlit veneer of the water's surface were the earliest life forms. Life, as such, was spare and vulnerable. It had not yet begun to shape and turn its earth environment, but was encased in the humblest of cellular vessels adrift in vast global waters. But if anything, life is persistent. Driven by that most primitive and powerful instinct, survival, life took on a million crude designs, variations on a theme of cell bundling and life packaging. It took a billion years or so for life to crack the chemical equation of photosynthesis, squeezing sugar from sunbeams and oxygen from water. In another two and one-half billion years, with oxygen swelling in the atmosphere, life was ready to set a primordial foot upon land.

Evolution's answer to the need for an anchor was roots, which could also double as absorbers of water and nutrients. While life had evolved from water, it had not shaken its dependence on water. A pipeline was needed to draw the water and nutrient-lode throughout land life. Water also seemed to hold the answer for the turgor needed to fight gravity's pull. The Mother of Invention gave birth to the vascular plant. The rest, so they say, is history. But at some point in the floral dominion of the planet, life (evolutionarily speaking) looked back at water and saw habitat left wanting. Spurred by the fundamental biology lesson, "life abhors a vacuum" some of these pioneering plants returned to the "old country"—water.

But life in water was different for vascular plants than it had been for their wave-tossed ancestors. While on land, life had picked up new ways and new tools, all of which had to be adapted to water life once again.

What we now see as wetland and aquatic plants is the survival of the fittest of evolution's designs for dealing with the hurdles which water presents to plants.



Roots in the Water

By Inga Brynildson
Department of Natural Resources

Wetland and aquatic plants are broadly separated into three tribes. Emergents like cattails, sedges, and grasses live with water-logged roots, often in anaerobic soil, while the top of the plant sticks out above water in aerobic conditions. Water lilies are an example of surface floaters, while other vascular plants are completely submerged.

One of the problems for wetland plants is decreased light intensity. Longer internodes and higher chlorophyll concentrations are some responses for handling this. Oxygen deficiency is solved mainly by development of a lucunar system, which equips a plant with air-space between cells or in place of disintegrated cells. Gases such as oxygen and carbon dioxide pass through the lacunae. Gas plays a secondary role when needed for buoyancy to keep the plant afloat. Some plants have spongy tissue called aerenchyma with intercellular air space to increase buoyancy.

If a response to extreme dryness is reduced leaf surfaces, such as on cacti, one would expect wetland plants all to have big, broad leaves to encourage water transpiration. But the narrow leaves of some sedges and grasses even roll at night to prevent water loss. The cumulative leaf surface in a dense wetland sedge stand may lose water by transpiration two or three times as fast as water evaporates from a bare water surface.

Carbon dioxide, a necessary ingredient for photosynthesis, may also be a limiting factor to wetland species. While this compound may be as prevalent in water as in air, the rate at which it is absorbed is ten times slower in water. To deal with this, submerged leaves on many species are much-divided or ribboned, increasing the surface area. This can boost the rate of CO_2 assimilation. Dissected leaves also cause less resistance to water currents than entire leaves. Many aquatic plants are heterophyllous, having different shaped leaves above and below water. Thin leaves are another simple adaptation to assist CO_2 absorption. Submerged or floating leaves can get away with less rigidity than terrestrial species.

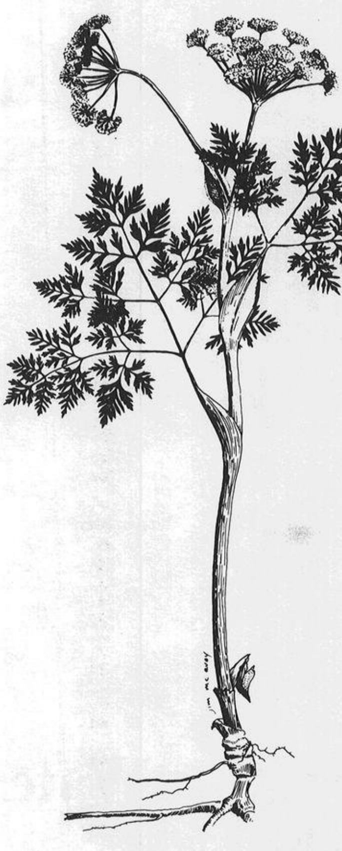
Wind can be a challenge to shallow-rooted wetland plants. The linear dominant line of sedges and grasses, no doubt, is an attempt in part to reduce wind resistance. Arrowhead or saggitate leaves are common among wetland plants. The theory goes that this triangular shape offers a plant less wind drag while boosting the solar collection surface.

Plant nutrients may be spare in acidic wetlands or bogs. This is why you'll find carnivorous plants like sundews, pitcher plants, and bladderworts in bogs. Trapping insects and other animal matter is a means to fortify the plant's nutrition. On the other hand, the cattail and sedge marsh is often a sink for nutrients and is the most productive native Wisconsin community in terms of biomass.

One benefit of life in the wetland is the role water can play in pollination and seed dispersal. While terrestrial plants largely rely on wind and animals (for example, insects) for pollination, water is a third avenue for wetland species. Many aquatic angiosperms have not relented their pretty flower heads, artifacts of terrestrial evolution. Some submerged plants even bear flowers entirely underwater, paradoxical if the primary purpose of flowers is insect attraction (unless flowers also attract underwater insects). Vegetative or asexual reproduction, however, is probably the most common mode of plant propagation in a wetland.

The spread of wetland plants also employs a number of mechanisms. The seeds of emergent plants or those with emergent flowers may be wind-tossed like those of their terrestrial kin. Water currents may also carry seeds or break plants for vegetative propagation downstream. The lax posture that causes many submerged plants to tangle about swimmers' legs or become passenger on a canoe paddle, also allows these plants to drape over the backs of diving ducks or a heron's neck to be ferried to other watersheds. This type of transport best facilitates short-distance dispersal, however, as plants may dry out. It is likely that most long-distance dispersal of aquatic plants is done in seed stage in the gut of migratory birds such as sandpipers and ducks.

In short, all that we look upon as nature's wonders are really nature's solutions to life challenges by soil, climate, and water. Just as there is no climax to the evolution of life, there is no climax to the succession of wetland plants as water grades to land. The cattail marsh is sometimes called a climax community, growing in the peaty mire of its own degeneration. But climax implies a steady-state, and nature implies dynamics. Wetlands are constantly tempered by fire, water-level changes, drought, water-exchange, sedimentation, land use, pollution, and the workings of muskrats. A beaver dam can change the whole floral character of a wetland.



Hemlock-parsley, *Conioselinum chinese* (endangered)

According to a nearly thirty-year-old scheme developed by the U.S. Fish and Wildlife Service, plants can be used to help characterize wetland types. (Adapted from U.S. Fish and Wildlife Service Circular 39, Wetlands of the United States (1956).)

Seasonally Flooded Basin or Flat. A type of wetland which is covered with water or is waterlogged during some seasons but is usually well-drained during most of the growing season. Vegetation on this type of wetland is quite variable—ranging from bottomland hardwood forests to open meadows. This type of wetland may be found in an upland depression or in an overflowed bottomland.

Fresh or Wet Meadow. A type of wetland which is not covered with standing water but is waterlogged within a few inches of the surface during most of the growing season. Characteristic vegetation on this type of wetland includes grasses, sedges, rushes, and various broad-leaved plants. Representative plants are sedges, rushes, redtop grass, reed grasses, manna grasses, prairie cordgrass, and mints. This type of wetland may occur in a shallow lake basin, slough, farmland sag, or on the edge of a shallow marsh.

Shallow Marsh. A type of wetland which is usually waterlogged during the growing season and often is covered by water six or more inches deep. Vegetation characteristic of this type of wetland includes grasses, sedges, bulrushes, burreed, spikerushes, cattails, arrowheads, pickerelweed, and smartweeds. This type of wetland may occur in a shallow lake basin or slough, on the edge of a deep marsh, or as a seep area on irrigated land.

Deep Marsh. A type of wetland which is covered with six inches to three feet or more of water during the growing season. Vegetation characteristic of this type of wetland includes cattails, bulrushes, spikerushes, and wild rice. This type of wetland may occur in a shallow lake basin, a pothole, limestone sink, slough, or on the edge of open water.

Open Water. A type of wetland which is covered with three to ten feet of water and has emergent vegetation along its edges. Vegetation characteristic of this type of wetland includes pondweeds, waterlilies, wild celery, coontail, and water milfoils. This type of wetland includes shallow ponds and reservoirs.

Shrub Swamp. A type of wetland which is usually waterlogged during the growing season and which is often covered with as much as six inches of water. Vegetation characteristic of this type of wetland may occur along a sluggish stream, on a floodplain, or on a disturbed wet meadow, or shallow marsh.

Wooded Swamp. A type of wetland which is waterlogged within a few inches of the surface during the growing season and often covered with as much as one foot of water. Trees characteristic of this type of wetland include American elm, silver maple, tamarack, white cedar, black spruce, balsam fir, red maple, and black ash.

Bog. A type of wetland on acid peat which is waterlogged. Vegetation characteristic of this type of wetland includes heath shrubs, sphagnum moss, sedges, black spruce, and tamarack. This type of wetland may occur in a lake basin, along a sluggish stream, or on a watershed divide.

Wetlands are the earth's kidneys with plants and muck soil short-stopping impurities and siltloads from entering rivers, streams, lakes, and groundwater. But the capacity of the marsh to swallow urban runoff and debris and still grow healthy plant and animal life is not unlimited. The swamp can be overburdened by sediments; the bog can be choked by chemicals. Some species are especially sensitive to impurities in their wetland medium. They are an early warning system of the fraying of the wetland web. Their roots are in the water and suck in the bad with the good.

The containers of our own human life are 70 percent water. Like wetland plants, we take in water throughout our lives. Also like wetland plants, our roots are in the water. ■

By Mark Martin and Sue Foote Martin

Picture if you can, a sixty-square-mile prairie in the early 1800s. Wildflowers bloom everywhere and sway in the wind with the towering prairie grasses until the entire area emulates some great ocean. In this vast green sea a prairie pothole resembles an island and attracts large flocks of waterfowl and shorebirds.

In the 1830s settlers from the state of New York arrived on this prairie which lies south of the village of Arlington in southern Columbia County and named the area Empire Prairie after their home state. One of those settlers, Hugh Jamieson, wrote of his experiences: "It was a tiresome journey . . . to travel over the prairie in those days. Not even a drop of water was to be found, except at a small pond, called the Goose Pond, near the center or about half the distance across."

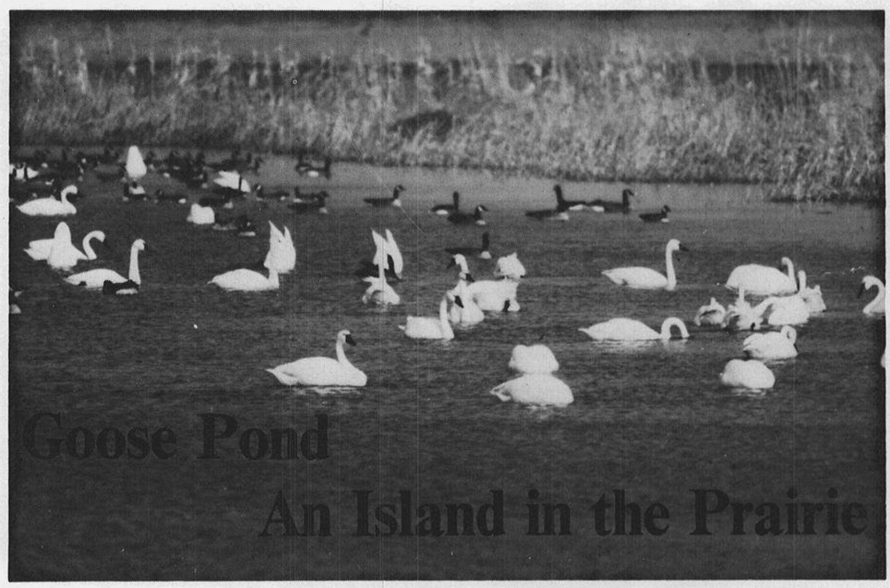
After Jamieson came other settlers who converted this prairie, which was dominated by big bluestem and Indian grass, to agricultural grasses such as oats, wheat, and corn.

Despite the changing land use Goose Pond continued to attract a wide variety of waterfowl and shorebirds. It was a popular place to go bird watching, and in 1967 the Madison Audubon Society purchased sixty acres in an effort to preserve this prairie pothole. The acquisition included part of the pond, a house, a small pine plantation, and fifteen acres of cropland. In 1977 forty additional acres were acquired.

Wildlife at the pond can be easily viewed from the road, and because of this access the number of bird watchers using the area is high. The records kept by the many visitors have made it possible to document wildlife use over a long period of time. In all 238 species of birds have been sighted on the 100 acre property. Because of its exceptional bird use Goose Pond was designated a state scientific area in 1970.

Biologists classify the pond as a Type V wetland, which is open fresh water surrounded by a ring of emergent vegetation. Arrowhead and a tall sedge-river bulrush dominate the emergent wetland vegetation, with cattail and softstem bulrush being less common. The wetland receives water only from direct precipitation and runoff. The majority of the runoff occurs in spring and after heavy thunderstorms. In 1981 a good snow accumulation and a quick thaw resulted in the pond rising two and a half feet in four days. The pond covers about sixty acres, but in years with high water an additional 100 acres of cropland can be underwater.

Spring is the best time of year to view wildlife at the pond. Twenty-



Sue Martin

Great blue heron

Yellow-headed blackbird

Lesser yellowlegs

American bittern

Stephen J. Lang photos

seven species of waterfowl have been sighted over the years, and on the average, twenty-three species visit each spring. Some bird watchers come to look for rarities such as white-fronted geese and European wigeons, while others like to see a wide variety of species or species in large numbers. It is possible to see twelve to fourteen species of waterfowl at one time during the peak of migration, and in some years hundreds of whistling swans can be found.

Goose Pond is also an excellent place to view migrating shorebirds, especially in years with very high or low water which results in exposed mud flats. Thirty-four species of shorebirds have been observed at the pond. Some of the more common species are golden and black-bellied plovers, long and short billed dowitchers and greater and lesser yellowlegs. Unusual species observed have included piping plovers, whibrels, and marbled and hudsonian godwits.

Spring is also the breeding season for frogs and toads. In April and May mating calls of spring peepers, chorus frogs, leopard frogs, and American toads can be heard. These are followed by the gray and Cope's treefrogs and green frogs. These amphibians along with tiger salamanders provide food for six species of herons, mink, and raccoons.

A wide variety of marsh birds nest around the perimeter of the pond. On the average forty pair of puddle ducks nest in the upland fields around the pond including mallards, blue and green-winged teal, shovelers, pintails, and gadwalls. Ruddy ducks are the only species of diving duck to spend the summer at the pond; they build their nests over water in arrowheads or river bulrush. Also nesting in the wetland are coots, pied-billed grebes, red-wing and yellow-headed blackbirds, and marsh wrens.

Blanding's, mud, and snapping turtles reside at the pond but are rarely seen. In August great egrets and great blue and black-crowned night herons are frequently sighted. Besides feeding on the amphibians, they also feed heavily on the fathead minnows, which are found in high numbers.

The fall migration begins in August with the arrival of shorebirds. Also congregating at the pond in early fall to feed on the abundant insect life are tree, bank, and rough-winged swallows.

The waterfowl migration is spectacular in autumn. First to arrive in late August and September are blue-winged teal followed by American wigeons. The pond is divided in the center by Goose Pond road and Audubon's portion of the pond is a wildlife refuge. Waterfowl numbers increase in October with the opening of the waterfowl season and twenty species of waterfowl are usually observed in the fall with most of these being in lower numbers than in the spring—exceptions are the mallard and black duck. An estimated 9,000 mallards and 200 black ducks have been counted. They feed in the picked corn fields in the area, and with some feeding flocks numbering in the thousands, they provide an excellent viewing opportunity for bird watchers. The mallards and black ducks stay until snow covers the picked corn or until the pond freezes over; however, a large concentration of birds can keep the pond open a few days later than when it would normally freeze. Small flocks of whistling swans also stop for a few days in November before flying to their wintering grounds along the east coast.

The area attracts many raptors, and in the fall marsh hawks, red-tailed hawks, and kestrals are common migrants. In recent years, sightings of peregrine falcons, an endangered species, have increased, and what a treat it is to see a peregrine gliding over the wetland.

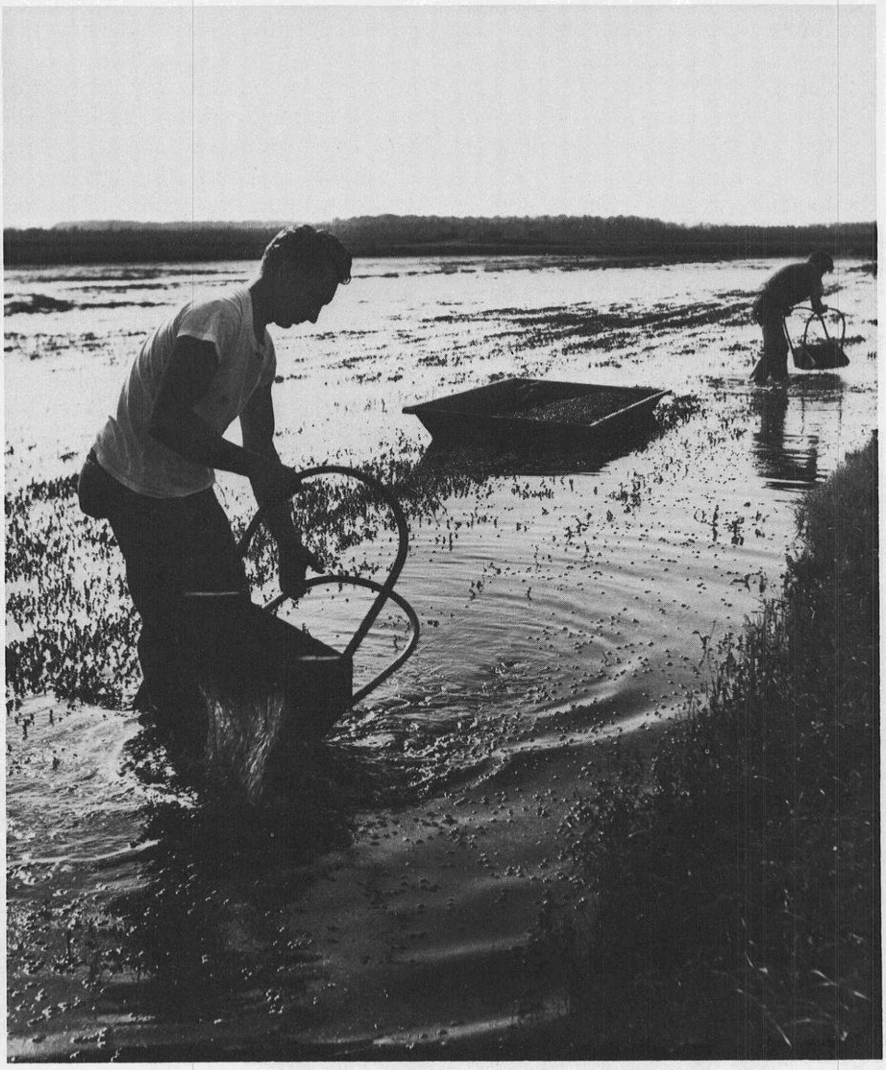
Winter brings visitors from the far north such as snow buntings, lapland longspurs, and rough-legged hawks. Snowy and short-eared owls, as well as the year-round resident, the great horned owl, hunt the wetland.

Red fox hunt the wetland nightly in search of the ring-necked pheasants which seek shelter in the dense cover provided by the river bulrush. An estimated 300–400 muskrats live in bank dens and houses and provide a prey base for their arch enemy, the mink.■

Wisconsin Cranberry Growers Responsible Stewards of Wetlands

By Byron C. Crowns
Attorney for Wisconsin Cranberry Growers Association
Wisconsin Rapids

Workers put the finishing touch on the day's harvest with hand rakes.



Across the street from the Wood County courthouse in Wisconsin Rapids, cranberries are depicted in a colorful mural which covers the side of a large building. Shown are rows of ripe red berries highlighted with an old-fashioned cranberry rake. The mural is appropriate because cranberries are Wisconsin's number one fruit crop, and Wisconsin Rapids lies near the world's most concentrated complex of cranberry marshes.

The wild cranberry, *Vaccinium macrocarpon*, is a wetland plant native to North America, found in scattered peat bogs in northeastern U.S. and southeastern Canada. As a food crop, it has been cultivated in its native range in Wisconsin, Massachusetts, and New Jersey and has been introduced into Oregon, Washington, and British Columbia. Because of exacting growing conditions these are the only areas in the world where cranberries are grown commercially. The cranberry belongs to the same plant family as the mossberry—a less-known relative with a smaller berry—and the more familiar blueberry.

The name *cranberry* was originally *craneberry*, apparently so named because the plant's tiny stem and flower bud resemble the neck, head, and beak of the sandhill crane, which nests in the same areas where the wild plant grows. Today you can still hear the resonant call of that noble bird over Wisconsin cranberry marshes.

History

Long before European settlers first came to Wisconsin, wild cranberries were gathered by prehistoric Woodland Indians. They used cranberries in their food regimen, usually dried and mixed with wild game to form pemmican, which together with wild rice and other grains was the mainstay of their winter diet.

The early French voyageurs, in their exploration of Wisconsin waterways and in their subsequent fur trade with the Indians, become acquainted with cranberries. It is said that cranberries were bartered between the voyageurs and Indians. Later, following the practice of the Indians, early European settlers harvested wild cranberries.

There is a clear-cut distinction between land uses which destroy wetlands and those which further wetlands: cranberry growing often improves natural characteristics and brings ecological benefits.

In his book, *A History of the Cranberry Industry in Wisconsin* (Harlo Press, 1970), George L. Peltier looks at the beginning of commercial cranberry growing in Wisconsin:

> About 1850, the Carey brothers fenced in an acre of wild cranberries near Berlin and, through the years, ditched and diked the area. They became so successful in their undertaking that others located wild bogs and started ditching and diking them until about 1,000 acres were under partial cultivation by 1865. With good prices for their product at the Chicago market, a boom was created and once seemingly worthless land became so valuable that it forced some of the younger men to seek other areas of less expensive (25¢ to 50¢ an acre) land. . . .By 1900, approximately 1,200 acres were under cultivation.

In Wisconsin today, there are 135-150 cranberry marshes, occupying a total of about 110,000 acres in eighteen counties. The lands owned by cranberry growers are mostly wetlands interspersed with uplands. Only about 6 percent of the total acreage is developed into beds where cranberry plants are grown and berries are harvested. The remaining 94 percent of the total acreage (not developed into beds) contains each cranberry marsh's water control system through which water is supplied to beds. The water control system includes storage and supply structures and facilities such as reservoirs, dikes, dams, ditches, canals, bulkheads, pumps, and sprinklers.

Cranberry growing requires a constant source and supply of water, which is used for (1) frost protection (usually by applying water through a low-gallonage sprinkling system); (2) harvest (by flooding beds and floating berries); (3) winter mulching (by flooding beds and keeping them covered with a blanket of ice); (4) irrigation (by sprinkling, but this use is limited because of the normally high moisture content of peat soil in beds).

Some Wisconsin cranberry marshes have been in existence for more than 100 years, and the wetlands associated with those operations are still of highest quality.

Wetlands Management

Although cranberry growing is an agricultural activity, the cultural practices followed are also a form of management of wetlands. *Wisconsin Wetlands*, a publication of the University of Wisconsin-Extension (1976), Publication G2818, comments:

> Wetlands can be managed to maintain their natural functions. In some cases, man may change wetlands to enhance their biological productivity and improve or restore their other natural functions. . . Sometimes, wetlands need additional surface water to increase habitat diversity for plants and animals. We can increase the water level by constructing shallow impoundments, using dikes or dams, excavating shallow potholes or ponds and level ditches. . . .

By coincidence the comment does a remarkable job of describing how water is used in cranberry growing. Proof of how successful growers have been over the years in managing wetlands is found in the superior quality of the wetlands making up their cranberry marshes.

Cranberry growing does not interfere with the natural functions of wetlands listed in *Wisconsin Wetlands*:

> In their natural state, wetlands can provide habitat for wildlife and fish, serve as outdoor classrooms, provide open space, reduce flood peaks and help maintain water quality.

None of these natural functions of wetlands is disrupted nor diminished in any significant way by cranberry growing.

There is a clear-cut distinction between land uses which destroy wetlands and those which further wetlands. For instance, draining or filling wetlands changes their fundamental character and converts them into areas of drier terrain, which permits land development not otherwise possible but destroys the wetlands. On the other hand, there are uses such as cranberry growing which don't change wetlands' fundamental character. They perpetuate wetlands as areas of moist terrain. Most importantly, they don't destroy wetlands; instead they often improve their natural characteristics to the benefit of all wetland species.

Cranberry growing furthers wetlands. Since the cranberry is a native wetland plant, what is good for the cranberry plant is usually good for wetlands in general. For example, the ditches, canals, and reservoirs serving a cranberry marsh hold large quantities of water, which stabilize surface water and groundwater levels in neighboring wetlands over a wide area, making all their natural functions more efficient.

Water use in cranberry growing is classified as a nonconsumptive use by both federal and state agencies. In a typical cranberry operation, water is returned to the same waterway from which diverted, with no reduction in total quantity, except for what escapes to the atmosphere through evapotranspiration, an insignificant loss because of limited use when water levels are seasonally low. As an illustration water applied to beds for frost protection is "borrowed" from its source each time needed for only a few hours, and this is the major use of water during the growing season.

Most cranberry beds are laid out in peat bogs. Peat is a soil of organic origin with special properties which make it highly efficient for retaining water and fixing and filtering impurities. Because of peat, cranberry beds (like wetlands in general) are giant sponges. Peat plays a key role in the excellent quality of water flowing off cranberry marshes.

Cranberry lands sustain wildlife

Wetlands in cranberry growing areas actually surpass wetlands in the wilderness in their ability to perform valuable services in the hydrologic system. This is apparent during a period of drought when wetlands in a purely natural state may become dry, browning off into areas of desolation and death for most wetland species. However, in cranberry growing areas during the same dry period, the landscape is marked with green; there you will find wetland species thriving in the midst of plenty—plants of all kinds, subaquatic and aquatic animals and numerous species of birds. Wetlands where cranberries are grown generally offer a more sustaining habitat for wildlife than wilderness wetlands. In Wisconsin countless birdwatchers, deer hunters, waterfowl hunters, trappers, and fishermen can verify this.

A recent survey of fauna and flora on Wisconsin cranberry marshes brings to light some interesting facts. Among unusual plants found there are wild orchids, wild iris, sundews, swamp candles, Michigan lilies, and pitcher plants. Also found is watercress, a plant said to require "pure water." Wild rice grows in large colonies on twenty-three cranberry reservoirs. Many have muskies, northern pike, walleyes, bass, or other game fish. For more than forty years one cranberry marsh has used water from a trout stream without any detrimental effect on the trout population. Some marshes are resting places for migrating swans. Nesting bald eagles are reported on eighteen cranberry marshes; nesting ospreys on five; active heron rookeries on nineteen; nesting sandhill cranes on fifty-six; and nesting Canada geese or their subspecies on seventy-three.

Growers conserve wetlands

Some environmentalists recognize the ecological benefits which cranberry growing brings to wetlands. In *Sand County Almanac* (Oxford University Press, 1949) Aldo Leopold gave credit to cranberry growers for saving the sandhill crane from extinction in Wisconsin by having brought abundant water to wetlands previously devastated by low water levels and fires. Ronald Sauey of the International Crane Foundation expressed this same view recently in testimony in an environmental case.

Cranberry growing does not have an adverse effect on water quality. Comprehensive water quality studies of cranberry operations in Wisconsin made over the years by federal and state agencies and other qualified researchers have consistently given cranberry growing a clean bill of health.

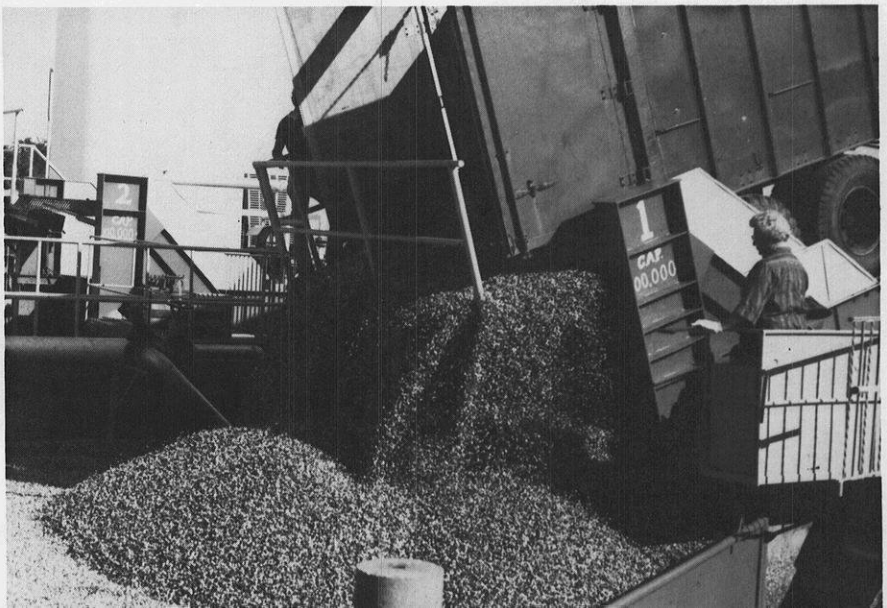
Testing, licensing, and careful application of all pesticides in cranberry growing is required under both federal and state laws. All pesticides presently used by cranberry growers are rapidly biodegradable. Studies of their use on cranberry marshes show no harmful effect on the environment and no threat to consumers.

For many years Wisconsin cranberry growers have voluntarily financed a research program to improve techniques for growing cranberries, with most of the research conducted by the UW-Madison School of Horticulture. A major objective of the program is to minimize the impact of cranberry growing on the environment. In the same spirit, cranberry growers have long practiced conservation in cooperation with the Soil Conservation Service, the Wisconsin Department of Agriculture, the Wisconsin Department of Natural Resources (DNR), and its predecessor agencies. As an example cranberry growers have reforested many acres of their uplands although the reforestation has no direct bearing on their cranberry operations. As another example before laws properly controlled pesticides, cranberry growers around the U.S. were the first agricultural group voluntarily to stop using the pesticide DDT when its harmful environmental effects first became known.

Cranberry legislation

Originally enacted as Chapter 40 of the Laws of 1867, sections 94.26 through 94.35 of the Wisconsin Statutes are commonly known as the cranberry laws. The preamble to the 1867 Act reads, *"An Act to encourage the cultivation of cranberries."* Since then the Wisconsin cranberry industry, operating under the encouragement of the cranberry laws, has gradually grown to become the state's leading fruit crop producer. Several times in recent years Wisconsin has been the number one cranberry producer in the U.S.; other times Massachusetts has enjoyed that distinction. But the prospects are good for Wisconsin to take over the lead permanently because cranberry marshes in Massachusetts are being gobbled up by urban sprawl.

For more than 100 years the Wisconsin legislature has wisely followed a policy of encouraging cranberry growing in wetlands, a policy recently upheld by the Wisconsin Supreme Court in State of Wisconsin v. William Zawistoski (1980) 95 W 2d 250, 290 NW 2d 303. In that case, the Court recognized the right of cranberry growers, under the cranberry laws, to develop and operate cranberry marshes without water permits otherwise issued by the DNR. The Court, however, did hold that, under the Common Law, cranberry growers must use water in a reasonable manner. More recently, the Environmental Protection Agency has exempted



Another load of cranberries arrives at the Ocean Spray processing plant at Babcock.

cranberry growers from permits under the Federal Clean Water Act.

Over the years the Wisconsin Cranberry Growers Association, a statewide organization of all cranberry growers, has amassed information which shows that cranberry growing produces a beneficial, not an adverse, environmental impact. This information shared with the DNR should put to rest any concerns about the effects of cranberry growing on the environment.

In February 1982 the Wisconsin Cranberry Growers Association and the DNR entered into a cooperative agreement, which provides a workable means of resolving environmental problems involving Wisconsin cranberry growers.

In a wetlands preservation program cranberry growing should be treated differently from other wetland uses because it is a unique use which improves the quality of wetlands. No other use produces a more sustaining habitat for wetland species and, at the same time, a food crop for a half-hungry world.

A meaningful wetlands preservation program in the future should encourage the expansion of cranberry growing in wetlands. The marriage between cranberry growing and wetlands which took place in Wisconsin in 1867 with the enactment of the cranberry laws has been a good marriage. The U.S. Geological Survey has recommended the expansion of the cranberry industry in Wisconsin based on a detailed study of the complex of cranberry marshes in the Cranmoor area and other wetlands in the same locality.

Cranberry economics

Cranberry growing pumps much money into Wisconsin's economy. Gross annual grower returns from the crop exceed 30 million dollars on an annual cranberry harvest of a million barrels.

Cranberries are processed into packaged fresh fruit, canned sauce, bottled juice, and frozen concentrate at processing plants in Wisconsin, which include those at Kenosha, Babcock, Eagle River, Warrens, and Cranmoor. Those facilities provide employment for many persons.

Cranberry growers in Wisconsin have a substantial investment in their operations. Their marshes are estimated to have a present market value of more than 100 million dollars. A large proportion of that investment is in the water control systems which assure a bright future for wetlands in cranberry growing areas.

Because of a market demand for more cranberries than are produced, there is a pressing economic need for expansion of the U.S. cranberry industry. In Wisconsin there will be two types of expansion: (1) To a limited extent, growers presently operating cranberry marshes will add new beds. . .depending upon the physical layout of each marsh. (2) To an even more limited extent, new marshes will be developed. This expansion will be very limited because few areas remain in Wisconsin which are suitable for development into cranberry marshes. Such areas must have level topography with adequate drainage, acid water, acid soil, an adequate source and supply of water, a source of sand (for periodically sanding beds to keep cranberry plants correctly positioned), and adequate hinterlands (for free movement of air over beds to increase pollination). In most cases, the proposed expansion of existing cranberry marshes is in keeping with long-range plans of each individual grower.

There is an urgency to the cranberry industry's expansion because growers in Canada are developing substantial acreage to produce crops in competition with those of U.S. growers. A race is on for cornering the market.

The Wisconsin cranberry industry has done an excellent job for more than 100 years of coexisting with prime wetland and waterway habitat—without growers being closely regulated by any government agency. On their own initiative Wisconsin cranberry growers have been responsible stewards of wetlands. There is no reason to suspect that the situation will change significantly in the next 100 years, even with no new regulations. But cranberry growers are concerned that, because they are relatively few in number and do not have a strong collective voice, they may be accidentally caught up in the wetlands preservation movement and end up unduly burdened with regulations. Some see it as a threat to the freedom to make decisions and to try new ideas which they need to succeed in the competitive business of growing cranberries. They see it in the long run as a matter of survival of the cranberry industry in Wisconsin.■

Women sorting cranberries to be packaged as fresh fruit at a cranberry marsh at Cranmoor.

Cranberries Make The Wetland Flower

By Malcolm N. Dana
University of Wisconsin-Madison

An adventurous tourist who strayed from the well traveled main highway passed through a wooded area and suddenly came upon a large opening in the forest. His first impression was that here was another swamp or marsh among the many he had seen in his travels through Wisconsin. But this was no ordinary marsh, for there seemed to be ditches and canals and a pond or reservoir and over across the clearing were buildings, a house and machine shed and a barnlike structure that didn't look quite right for a barn. Fitted in among the ditches and dikes were rectangular fields with a low-growing plant spread uniformly over the flat surface of the field. The tourist had come upon a cranberry marsh, carefully laid upon the wetland to take advantage of the soil and water conditions peculiar to the acid bogs of the northern two thirds of the state. Relatively few visitors to our state and surprisingly few natives in our state have been so fortunate as to discover and recognize these units of a thriving agricultural industry tucked away in remote areas of Wisconsin's northwoods.

The Wisconsin cranberry industry has 140 producing marshes located in eighteen counties. A triangle drawn with Wisconsin Rapids, Tomah, and Black River Falls as its corners and including parts of Wood, Jackson, Juneau, and Monroe counties would include 70 percent of the acreage. Marshes outside the triangle but within the four counties or within Clark, Eau Claire, and Portage counties adds an additional 5 percent of the acres. Several properties near Three Lakes, Oneida County, and Manitowish, Vilas County, total 11 percent of the acreage. Scattered developments in Burnett, Douglas, Lincoln, Polk, Price, Rusk, Sawyer, and Washburn counties have 14 percent of the acreage. Only one marsh is visible from the Interstate Highway system (Warrens Interchange, Monroe County) and that only if you look eastward quickly. State Trunk Highway 54 west of Wisconsin Rapids provides the most accessible view of marshes in operation.

Cranberries harvested from unimproved marshes entered into commerce as early as 1829 when Daniel Whitney sold berries in Galena, Illinois. The first attempts to improve the marshes for cranberry culture occurred about 1850, when entrepreneurs in the Berlin area constructed ditches and dikes around reasonably uniformly level areas in order to control water levels, i.e., to flood or drain areas by proper management of flood gates and dams. The early harvesters had quickly learned that the frequent spring and summer frosts and the cold, drying conditions of snowless winters controlled the quantity of cranberry production on the wild vines. History does not record who was the first person to observe that cranberry plants could withstand submergence in water for months at freezing temperatures and for hours at late spring and early summer temperatures. That observation and its adoption as a standard practice provided the basis upon which the extensive and sophisticated industry found today has developed. Water is used to modify the micro-environment for protection of the cranberry plant against the stresses of high and low temperatures, desiccation from wind and low relative humidity and soil drought, and to assist in the harvest and handling of fruit.

To be eligible for development as a cranberry marsh, a wetland must have available an adequate supply of fresh water at all seasons and in even the driest years. It must provide either a peat or sand soil with a reaction below pH 5.5 and preferably at pH 4.5. There must be a supply of coarse rock-free sand convenient for movement onto the prepared marsh before planting and for triennial surface applications to the established marsh. An area for development must be large enough to provide acreage to generate crop volume of a magnitude to cover expenses and the very high cost of capital investment. Certain wetlands in the state provided all these requirements in addition to being located such that gravity would move the large volumes of water onto the prepared fields and the high water table would hold the water in place for extended periods to gain the climate modification needed. In turn the water was drained away by gravity to return to the stream course or a neighboring stream at a lower elevation than the developed marsh. Several marshes developed in the mid twentieth century pump water from natural lakes and then drain the water back to its source after use ready for reuse at the next cold period.

From the humble beginnings in the latter half of the nineteenth century the industry has grown to encompass approximately 8000 acres of planted vines. These planted vines are of selections from the wild and a small acreage from selections made fifty years ago from controlled hybridization of cultivars. Selections were made on the basis of berry size, productivity, fruit color, and storage quality. Once chosen and named, the selection becomes a cultivar which is increased in volume by asexual propagation (cuttings) until many acres in Wisconsin are planted to 'Searles,' 'McFarlin,' 'Ben Leer,' and 'Stevens' and lesser areas to 'Crowley,' 'Howes,' 'Bergman,' and 'Pilgrim.' A new promising cultivar is slow to assume an important place in the industry, for replacement of plantings is a costly proposition that is not much favored by growers.

A marsh selected for development is surveyed to determine the detailed topography of the site as a basis for establishing the optimum water control system. Drainage ditches or main drainage canals are established so that excess surface water can be removed to provide better conditions for machinery operation in land preparation. The area is laid out with rectangular sections that may be 150 to 300 feet wide and 500 to 1000 feet long. These

The cranberry industry is an important and growing segment of Wisconsin's agricultural economy, by far the most important fruit crop.

sections are normally placed on the land in a regular pattern to provide for convenience of management. From each section the surface vegetation is removed along with the top three to ten inches of soil. This material is pushed to the edge of the section and becomes the base of the dike surrounding the section. Later, sand will be hauled in for the top of this dike to form a useable roadway and stabilize the diverse base material. Each section is leveled such that an applied flood will be at equal depths on all areas of the section. In the early years of industry development growers planted cuttings directly in the leveled peat surface but commonly, in recent years, a layer of three to four inches of sand is applied over the peat surface before planting. This sand layer assures a firm surface for machinery operation and provides good surface soil drainage for optimum rooting of the cranberry plants. Cuttings taken from established plants are spread over the prepared surface in the spring or early summer and are pushed into the "soil" by tractor mounted discs or the cleats on a crawler tractor. Roots of cuttings and new shoot growth appear two to three weeks after planting. Three or four years later the planting will produce a harvestable crop of fruit.

The cranberry industry in Wisconsin is an important and growing segment of the agricultural economy. State production reached over 1,000,000 barrels (100 lbs. per barrel) in 1976 and 1980 and promises to go over 1,100,000 barrels in 1982. With a return of approximately $35.00 per barrel in 1981 the on-farm income reached nearly $35,000,000 and will surely go higher in future years. As an income producer cranberries are by far the most important fruit crop in Wisconsin (apples, $7-$10,000,000; strawberries, $4-$5,000,000; cherries, $1-$5,000,000) and rank high among all horticultural crops including sweet corn, peas, and potatoes. The recruitment of seasonal labor, the purchase of supplies and equipment, and the payment of local taxes by cranberry growers contribute substantially to the economic activity in communities such as Tomah, Wisconsin Rapids, Black River Falls, Hayward, Manitowish Waters, and Three Lakes. The handling, storage, processing, and marketing of the crop are important to Babcock, Eagle River, and Kenosha where receiving and processing facilities are located.

To generate the on-farm income, growers own over 100,000 acres of Wisconsin land. There are about 8,000 acres actually planted to cranberry vines—land maintained in permanent cover without soil disturbance after the initial preparation for planting and thus without erosion hazard or depletion of water resources. Many sections—over 400 acres—have been in continuous production for over fifty years and a few acres for over 100 years. About one half the acreage has been established in the last thirty years, which means that 4,000 acres have been in production for over thirty years. Ditches, dikes, canals, and roadways to service the fields occupy another 3,500 acres. Shallow water reservoirs constructed by growers for water storage total 23,000 acres. The undeveloped wetlands associated with cranberry properties and under grower ownership total 56,000 acres—32,000 acres with grass and sedge cover and 24,000 acres with the main vegetative cover made up of woody species. There are 19,000 acres of wooded upland contained within cranberry properties. Unfortunately, there has been no accurate inventory of feet or miles of shoreline created by the reservoirs nor the extent of wetland ditches that serve as prime habitat for numerous plant, mammal, bird, and reptile species. If the 23,000 acres of reservoir were distributed in fifty perfectly round reservoirs of 460 acres each it would total up to 150 miles of shoreline. The irregular shoreline of the typical flowage or reservoir would generate a much greater shoreline than the minimum calculated here. To manage this water with intake and drainage ditches requires many miles of waterway for wildlife habitat. The cranberry grower preserves the wetland condition for maintenance of an adequate supply of water—the very life blood of crop growth and protection.

The cranberry industry increased rather steadily from 1,200 acres in 1900 to 7,000 acres in 1970. In 1968 the growers in the United States voted for a Federal Marketing Agreement and Order which eventually established a marketing quota for each property in the U.S. The quota was determined by a formula based upon production from acres planted prior to August 15, 1968. Because berries produced in excess of the quota were presumed to be above expected consumption, the effect of the order was to restrict further planting of cranberries. Thus, from 1968 to 1978 there was no expansion of acreage although the harvested acreage continued to increase until 1974 when all acres planted before 1969 became producing acres. Because of improvements in production methodology the number of barrels harvested on the 7,000 acres increased by about 30 percent or nearly 200,000 barrels annually. In 1978 market consumption caught up with production levels, and the marketing quotas were adjusted upward which permitted some growers to make additional plantings with an expectation of a reasonable market for the production. Thus, there have been several hundred new acres planted in Wisconsin since 1979. This planting has been expansion of existing properties rather than development of new marshes, in fact, some of the planting has been on non-marsh, sand areas adjacent to the natural marsh but accessible to the water supply. Water for flooding is pumped up to the fields for harvesting, winter flood, and frost protection and drains back to the source after use. The development of uplands was pioneered in Oregon and has only recently started in Wisconsin.

Cranberry growing has provided a valuable supplement to the agricultural income of Wisconsin for well over 100 years. The industry continues to expand in acreage, yield per acre, and economic benefit to the state and its people. The conservation of the water supply and stabilization of the wetland conditions maintain the bases for an indefinite continuation of this romantic and economically sound industry.■

Wetland Regulation
The Muck Farmers' Perspective

By Michael R. Vaughan
Counsel
Wisconsin Muck Farmers Association

As counsel for the Wisconsin Muck Farmers Association since 1974, I have been involved in the battles, skirmishes, and infrequent truces that have characterized the political end of the debate over wetland regulation in the last decade. In that debate the Association has sought to make these recurring points: the political debate is premature; the proponents of legislation have not sustained the burden of laying facts before the public which demonstrate that their proposed "solutions" deal with factually identified "problems"; and the establishment of a factual base is a necessary concomitant (if we believe that our legislative process is a rational, intellectual process) to the development and enactment of a legislative solution.

All this may be getting ahead of the game, however. The reader may still be puzzling over the questions of what are muck farmers and what do they have to do with wetlands? To begin at the beginning, a muck farmer farms muck. (Sounds good so far!) Muck is organic soil, the residue of what was a swamp bed a million or so years ago. Organic soil, therefore, is chemically different from the dirt in our back yards (and the dirt on most farms, for that matter) which is mineral soil.

Muck farming is a unique kind of farming with unique problems (a need to guard against soil compaction, a need to prevent oxidization of the soil) and with high crop specialization. An inordinately high percentage of the state's onions, celery, lettuce, carrots, and mint, and a substantial percentage of the entire U.S. production of those crops, is grown on the small number of acres of Wisconsin muck land, which are concentrated almost exclusively in the southeastern quarter of the state. A route from Madison to Waukesha on I-94 with forays south into western Racine County and north through Beaver Dam into Green Lake and Marquette counties would pass through almost all the muck farming areas in the state.

Not all wetlands are agriculturally suitable muck lands (muck to a depth of at least three feet); in fact, not many are. However, many proposed definitions of wetlands in the regulatory proposals over the last decade would have encompassed the muck land that muck farmers are cultivating, and *all* definitions would regulate any undeveloped muck land which a farmer may have owned for years but not yet cultivated. Thus, muck farmers have more than a passing interest in the legislative proposals for statewide wetland regulation.

Muck farmers contend that the facts have not been demonstrated to warrant enactment of proposals adding new regulatory controls over ownership interests in wetlands. In 1977 muck farmers and other agricultural interests spearheaded enactment of the first Wisconsin law dealing with wetlands. That law (Section 23.32, Wis. Stats., created by Chapter 374, Laws of 1977) directed the Department of Natural Resources "for the purpose of advancing the conservation of wetland resources [to] prepare or cause to be prepared maps that, at a minimum, identify as accurately as practicable the individual wetlands in the state which have an area of five acres or more."

The DNR is still laboring to complete that work. It would appear to this observer that such a mapping project would be a necessary first step toward obtaining the information from which to determine whether, to what extent, and in what areas wetland regulation may be deemed to be needed. I must ruefully note, however, that proponents of regulation—who were not the initiators of the mapping directive in the first place—were not deterred by the existence of the project and have relentlessly pushed forward in their efforts to enact regulatory legislation. In fact, the DNR itself commenced the next round of regulatory bill-drafting well before it commenced the mapping work.

What does all this mean? It means we still don't know a great deal about a subject which has fostered strong emotions and hard legislative battles. **For example, how many acres of wetlands are left in the state?** Many answers are suggested to that question in public debates on this subject, and the greater the answerer's degree of intensity as a proponent, the lower his or her estimate is likely to be. Nonetheless, there appears to a consensus that approximately two and one-half million acres of wetlands remain. **What is the current loss rate?** Estimates vary here, but public testimony over the decade seems to indicate that proponents believe approximately 40–50,000 acres of wetlands are drained, filled in, or otherwise lost as wetlands (by their definition) each year. Interestingly enough, the estimate of two and one-half million total acres has remained constant over the decade to the same degree as the estimate of a 40–50,000 acre annual decrease in wetlands. This seeming contradiction suggests the original point: we need to establish a solid data base before concluding that we have arrived at Armageddon.

The degree of public ownership of existing wetlands would also seem to be a significant statistic. There appears to be general agreement that roughly one million acres of wetlands are already under public control through either ownership or control at the federal, state, and local levels. If this and other estimates are correct (and I hasten to add that this number is no less anecdotal than any of the others used in this debate), it would indicate that 40 percent of existing wetlands are already in public control.

This leads to the next question. **What and where are the "critical" wetlands?** If the reader believes that all wetlands are critical and must be retained as undeveloped wetlands, we may part company here. If the reader believes that there are differences in the societal values of wetlands as wetlands, we may share the view that completion of the mapping process is a necessary step in order to determine the extent to which those wetlands deemed to be critical wetlands remain outside the scope of present governmental control. And in determining government control, presumably we will assess not only public ownership and public control through strategic purchases of outlet sources, but also control through the authority exercised under existing state and federal statutes and regulations. As the product of this review, we all will be able to form an opinion about the degree to which critical wetlands in private ownership necessitate further governmental regulation—something which no one really knows today.

One other fact on which we have a pretty good handle today is that there are 35–40,000 acres of muck land in specialty crops and another 35–40,000 acres of muck land in general agricultural use. We in the Association have estimated, based both on empirical data and on advice from specialists in UW-Extension, that no more than an additional 20,000 acres of undeveloped muck land have potential for agricultural use. The grand total of 100,000 acres equals something less than three/tenths of one percent of Wisconsin's 54,464 square miles. The more useful measurement of the 20,000 suitable acres of undeveloped muck land against two and one-half million acres of undeveloped wetlands indicates that the former comprises eight/tenths of one percent of the latter.

But enough of statistics, whether real, invented, or estimated. Where does the Wisconsin Muck Farmers Association stand on issues of environmental protection? Doesn't its refusal to agree to a wetland regulation bill, even one endorsed by the State Board of Agriculture, Trade, and Consumer Protection, really mean that the Association is irrevocably in opposition to any regulatory proposal?

Every member of society today must be concerned about environmental protection in all its forms. Muck farmers are no exception. They do care about protecting the environment and about preserving the land, developed or undeveloped, with which they must live in concert. One hopes, however, that concern for the environment does not require a lockstep uniformity in reacting to various legislative proposals. There seems to be a dangerous tendency to believe that if a proposal is offered in the name of environmental protection, its soundness may not be questioned. One might hope that muck farmers and others may disagree with the direction of approaches taken to date and call for the development of data to support solutions proposed for not fully identified problems. One might even go so far as to suggest that this is precisely the kind of inquiry which the members of a nineteenth century Board of Regents had in mind when they resolved to "encourage that continual and fearless sifting and winnowing through which alone the truth can be found."

Evidence of muck farmer willingness to compromise on environmental issues is no further distant than the past legislative session. The Association strongly supported a bill to reinstate farmers' rights to clean out artificial ditches without DNR involvement, but was sympathetic to expressed concerns about adverse impacts on trout streams, and willingly accepted an amendment allowing DNR review over farm ditch maintenance where such an impact might be present. (See Chapter 330, Laws of 1981.)

The Association did oppose last session's wetland regulation bill which had been jointly endorsed by the Natural Resources Board and the Board of Agriculture, Trade, and Consumer Protection. The Association was joined in opposing the bill by several environmental, governmental, and rural groups, each of which decided that the proposal developed by the two state agencies was fatally deficient from its perspective. Whether the proponents or opponents were right, it would appear from the wide-ranging nature of the opposition that no single opponent should be convicted of terminal intransigence for failure to embrace the agencies' bill. In fact, muck farmer concern about the bill boiled down to essentially one element: a refusal to consider giving the same kind of special treatment to *previously owned* (the limitation is highly significant) undeveloped land held by a farmer, as the special treatment provided in the bill for mining activities, for highway, railroad and utility construction, for parks, and for a host of other activities. Put most simply, the Association was surprised to learn that agricultural use of a wetland was deemed a less appropriate use than, say, snowmobiling—one of the other specially treated activities.

All of this is history, and we need to look to the future and to further public dialogue on all aspects of environmental protection. We in the Association look forward to participating in public discussions and debate on the subject of wetlands and in what legislation may be appropriate to that subject. We hope that other participants in those discussions will share our view that there is a difference between an agricultural "using" of land and an urbanizing "using up" of land, but that is a matter for consideration in other forums.[1] We also hope that those other participants will agree that the societal benefit of agricultural use of wetlands will receive consideration, both in debate and in any legislative proposals, and will be weighed alongside the societal benefits of other uses of wetlands or of retention in their natural state.

Several months ago I noticed a bit of doggerel in a newsletter of the Wisconsin Wetlands Association (Volume V, No. 1, January 1982). Entitled "Economy," it read,

[1] We all know that much of the Horicon Marsh was farmed decades ago. Whether it is a "lesser" marsh today because of that experience is less certain.

Mucklands, a unique soil resource for agriculture in Wisconsin, will continue to be necessary for supplying important food crops for the future.

When the wetlands shrank to but a few—
A road was built from which to view—
The will of nature in succession.
The farmer grinned, eyeing the procession,
"I never cared for this stinkin' mess, but—
A buck a car—who'd of guessed?"

The polarization and hostility felt by the author cry out, as does the low-road appeal to the reader's emotion. I hope that most participants in the wetlands debate ascribe more good faith to those with differing views than this unpleasant little poem suggests, but it's not clear that such tolerance does exist.[2]

Farmers are acutely aware that the problems and needs of those who grow the food are little heeded in times of plenty. Burgeoning crop surpluses and the growth of the weight reduction industry tell us how abundant these times are. As civilization continues to ravage productive cropland, however, we may come to view farming in a different light once again and may need to assign a higher societal value to crop production. In "Tommy," Rudyard Kipling[3] (if I may offer a bit of verse in rebuttal to the lines quoted above) described this aspect of human nature best:

For it's Tommy this, an' Tommy that,
an' "Tommy wait outside";
But it's "Special train for Atkins,"
when the trooper's on the tide. . .

[2] See also William Tucker's *Progress and Privilege: America in the Age of Environmentalism* (New York: Anchor Press/Doubleday, 1982).

[3] Kipling also offered in "The Land" a more accurate view of those who live on the land than is suggested in the quoted verse from "Our Wetlands."■

Growing Specialty Crops on Wetland Soils

By John A. Schoenemann
University of Wisconsin-Madison

Drained marshland soils have been used for the production of special crops in Wisconsin for many years. Some of these crops are ideally suited for production on these soils and, in some cases, cannot be grown satisfactorily on other types of soils. In Ireland, Holland, Germany, and in other parts of northern Europe these drained marshlands have been utilized for crops for many centuries.

The term muck farming has been used to describe this type of agricultural production, particularly in the United States. Actually, most muck farms are located on peat-type soils (histosols), which consist largely of plant or vegetable material in various stages of decomposition. This kind of agricultural activity might be more accurately called organic soil farming.

When first developed or cultivated, drained marshland soils are usually low in phosphorus and potassium—two nutrients necessary for good crop growth and production. Nitrogen, while usually abundant in organic materials, may also be largely unavailable for satisfactory plant growth. After the soil has been cultivated intensively for several years, the decomposition rate increases and an abundant supply of nitrogen can be released. Micro-nutrients such as copper, zinc, and manganese are also usually low in newly developed peat soils. These elements along with larger amounts of phosphorus and potassium must be added to provide proper nutrient levels and satisfactory soil fertility for good crop production.

Not all marshlands are suitable for crop production. Of the several million acres of organic soils in Wisconsin only about 2 percent or about 50,000 acres are used for the cultivation of specialty crops—those produced by muck farmers. These crops are potatoes, cranberries, mint for oil, lawn sod, carrots, lettuce, celery, onions, cabbage, sweet corn, and red beets. In addition to these crops some marshlands in Wisconsin are drained for use as hay or pasture and sometimes relatively small areas are used in combination with upland soils for field crops such as corn or soybeans. These latter uses are not considered to be muck farming.

The basic requirements for successful use of a marshland to produce specialty crops are (1) adequate area size, (2) satisfactory soil pH, (3) sufficient depth, (4) a suitable drainage outlet, (5) suitability for a practical water level control system, (6) reasonable clearing and development costs, and (7) low frost hazard.

To justify the heavy financial investments for machinery and facilities to meet modern production and marketing needs, a farming unit of sufficient size is required. Therefore, modern muckland farms require a land area of at least several hundred acres; some muckland farms in Wisconsin are over 1,000 acres. Size requirements vary with crop or crops to be grown. When specializing in a particular crop, lettuce for example, the farm must produce a large and constant supply over several months to satisfy market requirements. Farm size must therefore be large enough to meet this kind of marketing demand and to justify the large financial investment in special cooling and shipping facilities.

Some muckland crops demand special equipment which dictates scale of operation. For production of mint oil, for example, a costly distillation facility is needed. The economic investment requires a minimum mint acreage to utilize fully this equipment. Therefore mint-growing farms are characteristically at least several hundred acres in size.

The production of any of the common muckland crops also necessitates large scale of operation to utilize fully the management skills of the producer and to return an adequate income base for the operator. These factors dictate the minimum size of acreage per farming unit.

Most of the specialty crops grown on mucklands must have a soil pH level of between 5.5 and 6.0. (An exception to this is the cranberry, which thrives at more acid pH levels of 4.0 to 5.0. Cranberry production is located in central or northern Wisconsin marshes which have a lower native pH level than those of southern Wisconsin.) If the undeveloped muckland is highly acidic, liming material must be added to raise the pH to a desired point. Peat soils need larger amounts of lime per acre to increase pH than most upland soils. Abnormally low pH level can materially affect development costs.

Consideration must be given to depth of marshland when selecting a location for crop production. Shallow marshes with a few feet of depth of organic material may have short production lives, especially when the marsh is located over a sandy subsoil. When the organic material is oxidized through tillage and cultivation, shallow marshes have but a limited productive life. If the subsoil is a silt or clay, a reasonably productive soil remains after the organic material is utilized. For best muck farming productivity marshes of considerable depth are sought.

Marshes are wetlands because of their low elevation in relation to surrounding land. In order to crop them, excess water must be removed and a satisfactory water table level maintained while the crops are being grown. Failure to plan adequately for this can result in heavy economic losses, especially in a high rainfall season. Without an effective natural drainage outlet for the marsh successful production of most crops is usually not feasible.

Another basic consideration when selecting a marshland for crops is cost of the initial clearing and development, which includes the cost estimate for a satisfactory water level control system. These costs must be added to the initial land purchase and must be financed before cropping can begin. If these costs are abnormally high, it may not be economically feasible to consider development. Usually grass and sedge-covered marshes offer the best value because development costs are lower than tree and brush-covered marshes.

Many northern Wisconsin marshes are not considered suitable for cropping because of high frost risk during the growing season. Since marshlands in Wisconsin hold greater frost risk than surrounding uplands, crops which are less frost-sensitive must be grown there. Cranberries can be grown in northern marshes since frost protection methods are an integral part of growing this crop.

If properly selected, developed, and managed, organic soils can be highly productive and ideally suited for a variety of crops. Some crops suited to muckland production are not well adapted to other types of soils in Wisconsin. Therefore, mucklands are a unique soil resource for agriculture in Wisconsin. Organic soils have some special advantages for crop production: (1) they are deep, loose, friable—thus easily worked and prepared for planting; (2) they have a high water and nutrient-holding capacity; (3) these soils have a large potential reserve of nitrogen fertility due to their high organic content; (4) the nitrogen reserve becomes available at a reasonable rate each season once the soil has been cultivated for a few seasons.

Because of the nitrogen fertility crops such as cabbage, spinach, celery, lettuce, and lawn sod are especially suited to muck soil production. Other crops such as carrots and potatoes do well because of the deep, loose, and friable soils, which allow for the development of long, straight carrot roots and uninhibited tuber growth of potatoes.

Both spearmint and peppermint are grown in Wisconsin due to another unique feature of organic soils. The perennial nature of the mint plant is favored by the insulating value of these deep, loose, fluffy textured soils. The mint plants are plowed under in the fall to provide a thick layer of organic soil during the winter months, where they are protected against freezing. In the spring they are plowed back up to the surface to resume growth for another season.

Organic soils do have some inherent disadvantages for crop production, but many can be minimized by proper development and careful management. Disadvantages include possible flooding where exceptionally heavy rains occur in a short time, possible wind erosion particularly in the spring after planting but before crops are well established, and greater risk of killing frosts during the normal growing season. Some crops are definitely not suited to marshland production in Wisconsin and other northern states, for example tomatoes, due to excess available nitrogen, and vine crops such as cucumbers, due to frost sensitivity.

Florida, California, Minnesota, Wisconsin, Michigan, Ohio, New York, Indiana, and Louisiana are the leading states in use of organic soils for crop production. Marquette, Columbia, Jefferson, Walworth, Dodge, Fond du Lac, Racine, Dane, Portage, Waukesha, Waushara, Green Lake, and Oconto are important counties in Wisconsin in production of specialty crops on organic soils. Cranberry production is important in Wood, Monroe, Washburn, and Vilas counties.

The development of virgin organic soils for specialty crop production in Wisconsin has diminished in recent years. Future development is also likely to be limited because of market potential for some of these crops, high development costs, and pressures for conservation of wetlands. It is, therefore, important to farm and manage our existing developed organic soils in a manner that will conserve their unusual and unique value for specialized crops. These soils will continue to be necessary for supplying important food crops for the future.■

Wetlands Protection in Wisconsin

By Susan H. Bergan and Karen S. Voss
Wetlands Task Force

Wetlands in Wisconsin were once considered wastelands, of use and value only if drained and filled. It is estimated that only one fourth of the state's original wetlands still remain. Attitudes towards wetlands began to change in the 1930s, when their importance as wildlife habitat was recognized. They are now valued also for flood control, water quality, as enclaves for endangered species, for education, recreation, and open space. In order to preserve them almost one million acres have been brought into public ownership. Regulation has generally been considered the best way to protect the rest. At present, a confusing patchwork of regulations exists at federal, state, and local levels. Which regulation, if any, affects a given wetland depends on several factors: its proximity to a navigable waterway, whether it is within city or village limits, and sometimes by how big it is.

The Army Corps of Engineers regulates all the navigable waters—streams big enough to float sawlogs—of the United States. The definition of "navigable waters" has been interpreted to include wetlands contiguous to these waterways.

The state is also interested in our navigable waters and extends its jurisdiction to the smallest trickle, if it is capable of floating a canoe at some time during the year. Any wetland that lies below the "ordinary high-water mark" of a navigable water is subject to restrictions on physical alterations which might impair the natural functions of the wetland.

In addition the Department of Natural Resources (DNR) has a shoreland zoning rule, NR 115, to extend protection to rural wetlands in defined shoreland areas—generally within 300 feet of a navigable river or stream and 1000 feet of a lake, pond, or flowage. This rule was promulgated in 1980 and was sustained despite public opposition because the rule-making process does not require action by the full legislature. Since NR 115 depends on not-yet-completed DNR maps of the state's wetlands, no wetlands have been regulated under this rule.

Since 1971 the state legislators have attempted in each session to pass a bill to protect Wisconsin's remaining wetlands. These bills were usually "comprehensive," offering protection to all of the state's wetlands. In the eleven years of effort no such all-encompassing bill has passed. Two wetland protection bills were introduced in the legislature this session. A comprehensive attempt, the Ag-DNR bill, commanded much attention but ultimately failed to pass. Although a bill mandating the DNR to map the state's wetlands was passed in 1978, it provided no protection. A modest bill did pass the legislature in April of 1982, pertaining to wetlands falling in defined areas along urban lakes and streams. This bill was the complement of the DNR rural shoreland zoning rule and was designed to fill the loophole between urban and rural wetland regulation. It was introduced in the legislature in early 1981, but was dealt a severe setback when it failed to pass the Assembly and was sent to languish in the Local Affairs Committee.

Urban wetland bill passed

Soon after, a different and much more comprehensive bill emerged, following months of negotiation between the boards of the DNR and the Department of Agriculture, Trade, and Consumer Protection (DATCP). It attempted to draw together the loose ends of existing regulations, defining a single Wisconsin wetland protection policy. The compromise nature of this Ag-DNR bill drew fire from many sectors, including farmers, some environmental groups, and municipal officials. The attempts to recall Senator Tom Harnisch, sparked by his stand on wetland protection and soil conservation issues, contributed to the bill's failure to gain the support of the legislature. However it wasn't until the Ag-DNR bill was finally tabled in January 1982 that the urban wetland zoning bill could again be considered.

The original urban zoning bill never emerged from the Local Affairs Committee, but it served as a model for AB 839, the bill released in February by the Assembly Environmental Resources Committee. This bill charted a difficult but ultimately successful course through the legislature.

Although narrow in scope the new law will provide significant protection to some previously unprotected wetlands. It will require that shoreland wetlands of five acres or larger in incorporated areas be zoned. Uses would generally be restricted to those that do not adversely affect the natural functions of the wetland. The new law grandfathers in existing buildings and permits their upkeep and expansion—an important aspect of the bill in the viewpoint of industries already located on or near wetlands.

The passage of AB 839 was hailed as a step toward better wetland protection, but it is one of the few bright spots in a long history of failed legislative attempts. A look at the complex issues and chief factors involved in wetlands legislation will provide some insight into this discouraging legislative record.

Constitutional issue

The constitutional issue has often been at the center of the controversy surrounding wetlands legislation. Does the government have the authority to restrict a citizen's use of his property, thereby lowering its value? If the property's value is reduced beyond a certain point, a "taking" of private property for public use may occur, which violates both the United States Constitution and the Wisconsin Constitution. Where the land value is significantly reduced, compensation must be made or the law is invalid. At the many public hearings on wetlands bills and wetlands rules over the past decade, farmers and other landowners have protested over and over that the government has no right to tell them what they may or may not do with their wetlands.

The "taking" issue was dealt with in the landmark case of *Just* v. *Marinette County* (1972) in which the court upheld a county ordinance which required a permit before filling a wetland adjacent to a navigable waterway. The court ruled that a taking had not occurred because the loss of value claimed was based not on the land in its natural state, but on what it might be worth if developed. The *Just* decision was hailed as an important precedent, but since the wetland in question was adjacent to a navigable waterway, it does not resolve the issue of protecting wetlands beyond the shoreland zone. Currently wetlands are not considered part of the "waters of the state" which Wisconsin is pledged to protect. However, the constitutional issue is not the stumbling block it was once. With the passage of time and the continuing regulatory efforts to protect not only wetlands but our air, water, and soil, the government's inevitable role in preserving such resources seems to be gaining rueful acceptance.

Other issues, any of which can trip up the progress of a bill, must be dealt with in putting together a piece of wetlands legislation. The term "wetland" must be defined for the purposes of regulation. The variable nature of many wetlands—those marshes, swamps, sedge meadows, bogs, floodplain forests, wet meadows—makes crafting a definition agreeable to biologists, bureaucrats, farmers, and zoning officials a formidable task.

Wetland bill parameters

In the 1981–82 session the Ag-DNR wetlands committee, made up of members of both agriculture and natural resource boards, spent many hours haggling over three words in the definition of a wetland. They finally agreed on the following modification of the definition used by the DNR wetlands mapping program: "an area where water is at, near, or above the land surface long enough to support aquatic or hydrophytic vegetation, and which has soils indicative of wet conditions." Another parameter to be determined is whether the bill will cover all wetlands in the state of a certain size or only a portion of them. A bill might regulate only shoreland wetlands or non-shoreland wetlands, or might cover unincorporated or incorporated wetlands. Another approach might be to regulate only specific, high-priority areas. A number of formulas are possible.

A wetlands bill normally indicates which activities will be permitted and which prohibited in a protected area. In recent bills this issue has been reduced to whether or not agricultural use—the chief source of wetland loss—should be exempt from regulation. Early bills regulated agriculture, later bills usually exempted it, although the 1981–82 Ag-DNR comprehensive bill provided a carefully worked-out partial exemption. Obviously, the more activities permitted, the weaker the bill.

An element critical to any wetlands protection scheme is the choice of regulatory method. The permit approach, rezonings, and restrictive orders have been considered in various bills. The regulatory method creates an administrative process. A wetlands law could be administered by the state, by the local government, or by the local unit of government with state oversight. The urban wetlands bill recently passed uses the third method. The DNR promulgates minimum standards, after which the local unit of government adopts a complying ordinance and enforces the law. The standards provide a guide for the decision-making agency in granting or denying permit or rezoning applications. If the standards are very strict, fewer permits will be granted than if they are very weak. The regulatory method, administrative level, and standards are central to the final character of a wetlands bill and require careful negotiation among those of differing views.

The use of tax abatements to compensate regulated landowners has been a volatile aspect of wetlands policy. Farmers consistently demand tax breaks for their zoned wetlands, and environmentalists do not oppose such an approach. Yet, curiously enough, the Ag-DNR compromise bill, drafted under the leadership of farmers on the agriculture board, did not include a tax abatement for affected wetland owners. Current reality is that, despite the symbolic importance of a tax break to many farmers, the differential between the proposed tax change and what a farmer might earn from draining and farming a wetland is enormous. The Ag-DNR wetlands committee felt that a tax break would have little real effect on whether or not a farmer preserved a wetland.

Overview of past wetlands bills

Reviewing the many wetlands bills which the Wisconsin legislature has considered, we see that the same difficult, interrelated policy issues persist. These issues have been reshaped and recombined into various formulas in the effort to put together a bill which will survive intact the many hoops and hurdles of the legislative process. An overview of those earlier bills reveals a progression from stronger to weaker measures and from state to local administration. With the exception of last spring's small bill, they are similar in their defeat.

Consistent too are the proponents and opponents of wetlands protection. Opposition to wetlands preservation has been led by the Wisconsin Muckfarmers Association and the lobbyist they employ in Madison. Because muckfarmers grow crops such as lettuce, cabbage, carrots, and mint in drained wetlands and periodically need new wetland acreage to drain and cultivate, they see any prohibition on drainage as a threat to their livelihood. Although the muckfarmers are only one of the interest groups which oppose wetlands legislation, they are better organized and more outspoken than most. At a wetland hearing they turn out in force, packing the hearing room to testify in opposition, along with representatives of such groups as the paper companies, drainage boards, the League of Wisconsin Municipalities, representatives of farm groups, and individual farmers and landowners speaking for themselves. Opposition to a bill may shift depending on the makeup of the legislation. Since many of the bills have sought to regulate only unincorporated wetlands, rural landowners see themselves as victims of an effort to protect a so-called public resource at their expense.

Promotion of wetlands protection comes from a melange of committed individuals and conservation, environmental, hunting, fishing, and trapping groups. These groups have traditionally been no match for their opponents, primarily because although they may feel strongly about preserving wetlands, their concern pales beside the outraged commitment of a muckfarmer who feels his livelihood threatened.

Environmentalists *have* made significant strides in organizing themselves for the legislative scramble in the last few years. The Madison Audubon Society employs a half-time executive secretary who closely follows legislative developments as part of her job. The Environmental Decade, also based in Madison, keeps its expanding membership abreast of legislative matters with a monthly "issue" mailing. The Decade also employs two full-time lobbyists, and has, with other groups, founded the Environmental Political Action Committee. Adding to the environmental presence in Madison was the wetlands resource person hired by the Wetlands Task Force for the 1981–82 session, who kept the entire environmental community posted on the wetlands issue. A professional lobbyist hired by a concerned conservationist to help pass AB 839 was instrumental in that bill's success. The improved organization and sophistication of Wisconsin environmentalists have increased their effectiveness in dealing with the legislature on issues such as wetlands.

The persistence of wetlands advocates in pushing for legislation was partly responsible for the involvement of agricultural leadership in drafting the 1981–82 comprehensive bill. The agricultural community was for the most part consistently obstructionist through the years of wetlands protection efforts. The endurance of the issue, along with the promulgation of NR 115 despite agriculture's protests, and the prodding of more progressive members of the agriculture board resulted in the board's taking the initiative on the issue in the 1982–82 session. The bill, drafted by a joint Ag-DNR committee, never reached the floor of the legislature. Although it was endorsed by leaders of the major farm organizations and some environmentalists, it was opposed by the usual parties, as well as some environmentalists, and would have met certain defeat. Despite the failure of the bill, the precedent of agricultural involvement was most significant.

Future legislation

A new session of the legislature will convene in January of 1983. Will the legislators be forced to deal once again with a wetlands bill? Some environmentalists are talking of drafting a bill to protect nonshoreland wetlands, which make up as much as 50 percent of the resource. Although the need to take action seems compelling, other factors may make this a questionable idea. The county wetlands maps, upon which NR 115, the shoreland zone rule, is based, are not projected to be completed until July of 1984. Public hearings on the preliminary maps must be held in each county as they are issued. After the DNR finishes those maps, maps to implement AB 829, the wetland zoning law for cities and villages, must be prepared. These maps must also go to public hearings. Meanwhile, the DNR is also drafting rules to implement AB 839. Those preliminary rules must go to public hearings around the state, as will the final version. Inevitably public agitation on the wetlands issue will again be stirred up. If one adds to the scenario a new bill, with its attendant publicity and hearings, confusion about wetlands protection will be greater than ever. Such a situation makes the possibility of smooth adoption and enforcement of the rule, NR 115, and the new law, AB 839, much more difficult.

Some environmentalists feel that, if there is to be a new bill, it should be more specific than those of the past and feature different approaches from those which have failed earlier. All close to the issue agree that, regardless of what happens in the next session, citizen involvement in the mapping review process, in the rolemaking process, and in the administration of the laws once they are in place is critical. The belief that a comprehensive bill can solve all our wetlands' preservation problems is no longer credible. Those who care about saving Wisconsin's wetlands can do no better than to become involved in their local government and make the laws now going into effect work as well as possible.■

DNR Wetland Regulations

By Kristin Visser
Department of Natural Resources

When settlers came to Wisconsin, they found about ten million acres of wetlands within the thirty-six million acres of the new state. They considered them wastelands, an impediment to progress, to be drained, filled, or dredged for farms and settlements. Milwaukee, Green Bay, Portage, Prairie du Chien, and Superior are cities built partly on wetlands.

Farmers drained large tracts for crops and pastures. Wetlands disappeared under the lakes created by damming the Rock, Wisconsin, and other rivers for flood control and navigation.

With wetlands the "public good" was anything that made them "useful." The importance of untouched wetlands for protection of water quality, natural flood control, wildlife habitat, and fish spawning areas wasn't understood or considered. There were endless acres of wetlands, and the new state needed dry land to grow.

In the 1920s and '30s, attitudes began to change. Biologists, conservationists, and engineers now understood the natural uses of wetlands. Wildlife managers found that wetlands provided vital habitat for all types of game. Engineers and soil scientists knew that wetlands are natural sponges, soaking up and slowly releasing floodwaters and runoff, absorbing nutrients and pollutants before they enter lakes and streams. Perhaps the public had an interest in leaving wetlands alone. Development might not always be the best use.

And wetlands were rapidly disappearing. Millions of acres had been drained, flooded, or filled. There was no longer an embarrassment of riches. Beginning in the 1930s, there were calls for limiting the destruction of wetlands, primarily to protect wildlife habitat.

The state, as the legal owner and protector of the state's wildlife, clearly had an interest in protecting wetlands. A landowner, faced with the loss of potential profits from development of a wetland, is not always in the best position to be caretaker of the public's interest in wildlife and water. Local governments, looking for development to increase the property tax base, and with no strong local push for wetlands protection, have never been aggressive about protecting wetlands in their natural state. The federal government, concerned only with the effects of commercial navigation on wetlands, and with buying land for wildlife refuges and hunting areas, does not require state or local wetlands protection.

In the 1930s, the state's role consisted of buying wildlife habitat, fish spawning grounds, and public hunting areas. It wasn't until 1966 that s. 144.025, Wis. Stats., mandating the DNR to protect the waters of the state, including wetlands, became law. Section 59.971, Wis. Stats., part of the same 1966 legislation, required counties to adopt shoreland zoning ordinances for unincorporated areas to protect the land adjacent to lakes and navigable streams. Shorelands were defined as the land within 1000 feet of a lake or flowage and within 300 feet of a stream or to the edge of the floodplain, whichever is greater.

As instructed in s. 59.971, DNR established minimum standards for county shoreland zoning ordinances for unincorporated areas, creating a new administrative rule, NR (for Natural Resources) 115. That rule did not require specific wetland protections within shoreland areas. A few counties had shoreland zoning ordinances or some other zoning ordinance specifically addressing wetlands protection. Most did not.

In 1979 a coalition of environmental groups petitioned DNR to adopt rules protecting all wetlands, arguing that the general authority provided under s. 144.025 was adequate for the department to act. DNR legal staff rejected this argument, pointing out that while the department was the agency designated to protect wetlands in the legislative policy statement, the legislature had provided no specific authority or wetlands protection program. In other cases, such as actions affecting navigable waters, the legislature had enumerated specific protections, specific programs, and in some cases specific standards.

The 1979 petition did result in several DNR actions aimed at protecting wetlands using the authority clearly provided by the legislature. For example, DNR administers a number of laws the application of which can have serious effects on wetlands. A permit under Chapter 30 of the statutes for dredging, filling, or altering navigable waters can easily cause water level changes in an adjoining wetland. Permitting a new dam under Chapter 31 of the statutes can destroy wetlands.

So while there is no specific mention in either Chapter 30 or 31 of wetland protection, issuing a permit can have a serious effect on a wetland. The laws require projects to meet specific standards, and they must not harm the public interest. Recognizing this, in 1980 the Natural Resources Board adopted a policy, NR 1.95, that defines the public interest to include wetlands protection. It requires DNR personnel to consider the effect on wetlands when granting permits and states that minimizing wetlands damage is a goal of the permitting process.

The department also revised NR 115 to require that county shoreland zoning ordinances contain specific protections for wetlands in those areas covered by the shoreland zoning ordinance. A large percentage, perhaps 50 percent, of the state's remaining wetlands are wholly or partly in shoreland areas.

Adoption of an administrative rule is a six-step process, which takes from a few months to a few years. After a rule is proposed, it is approved for a public hearing by the Natural Resources Board. Depending on the complexity and controversy surrounding a rule, there may be no hearings or as many as six. After the hearings, DNR staff make changes necessary to accommodate concerns expressed at the hearings. The Natural Resources Board then approves the rule, sometimes with additional changes. The final step is review of the rule by standing committees of each house of the legislature. The legislature can veto all or part of a rule before it takes effect. All rules, no matter how minor, undergo legislative review. In addition, once a rule is in effect, the legislature can repeal it by passage of a bill specifically repealing the rule. The legislature neither vetoed the NR 115 amendments nor attempted to suspend them.

In the case of the NR 115 wetlands amendments, there were four public hearings conducted by DNR around the state in July 1979; public comment sessions before the Natural Resources Board; a public hearing before two legislative committees in May 1980; and a meeting in June 1980 with Governor Dreyfus. There were several redrafts of the proposal to take into account the comments received at public hearings from local officials and from legislators.

The amended NR 115 requires each county to protect wetlands, or those portions of wetlands, within the area defined as shoreland (1000 feet from a lake, 300 feet from a stream or to the edge of the floodplain, whichever is greater). The maps produced by DNR under the wetlands mapping program are used as the basis for identifying wetlands that must be protected.

NR 115 prohibits draining, dredging, filling, or flooding a wetland without first obtaining rezoning approval from the county. Rezoning can be granted if the proposed project will not cause significant adverse environmental impact. (This does not mean you can't touch any wetlands, since destruction of some wetlands would have no adverse impact.) Should the county grant a rezoning, DNR can veto it if the county failed to consider significant environmental factors in granting the rezoning. In addition, some activities such as forestry, hunting and fishing, harvesting marsh hay and other wild crops, pasturing livestock, and farming are allowed as long as the wetland is not filled, drained, dredged, or flooded. In other words, if water levels drop during a dry year, a farmer may grow crops on the area or pasture livestock on it, as long as it occurs during a wetland's natural wet-dry cycle.

All seventy-two counties are required to adopt the provisions of NR 115. If they refuse to do so, DNR can adopt the ordinance for them and require the county to enforce it. If the county does not adequately enforce an ordinance, DNR can take over enforcement until the county demonstrates its ability to enforce the ordinance.

Wetlands ordinances under NR 115 must be adopted within six months after receiving a final wetlands map from the department. Brown County will have the first ordinance, in effect early in 1983. By the end of 1983, about thirty counties will have new wetlands ordinances in place. Almost four years will pass from the time DNR was petitioned to adopt the wetlands rules, in 1979, until 1983 when the first ordinance under NR 115 becomes effective. It will be 1985 before all seventy-two counties have wetlands ordinances in place.

Since shoreland zoning only covers unincorporated areas, and only land within 1000 feet of a lake and 300 feet of a stream (or the edge of the floodplain, whichever is greater), many wetlands would still be unprotected by zoning. The legislature, unable to agree on a comprehensive wetlands protection law, passed a law (Chapter 330, laws of 1981) extending the shoreland wetland protections to incorporated areas. The new law specifically limits annexing wetlands protected by a county shoreland zoning ordinance and then allowing them to be developed. Though still incomplete protection, the anti-annexation provision alone will protect many wetlands in the populous southeastern part of the state.

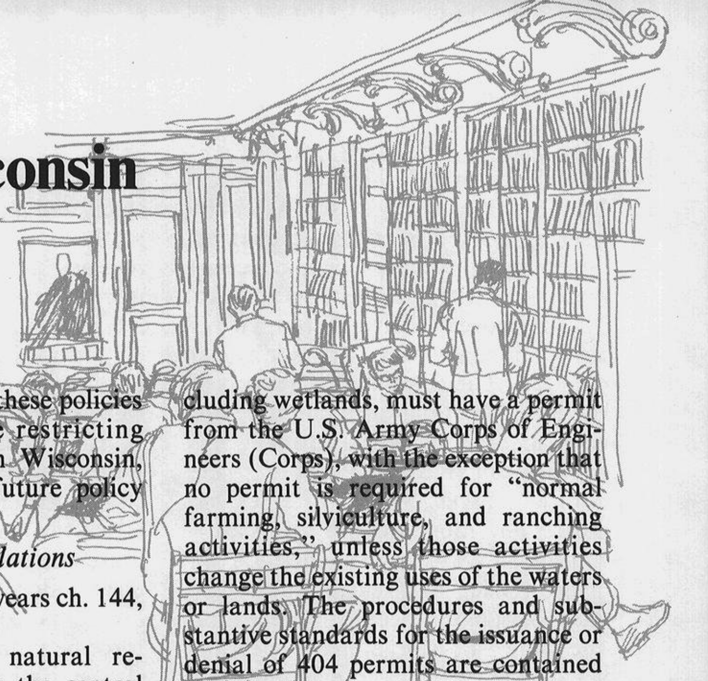
The new wetlands law will take effect the same way as wetlands ordinances under NR 115. DNR will provide maps of the city or village, and local officials will be required within six months to adopt a shoreland wetlands protection ordinance based on the map.

Currently, DNR staff are working on regulations under the new law. The current draft requires protections similar to NR 115. If the Natural Resources Board agrees, NR 117, the proposed rules, will be taken to public hearings in the spring of 1983. Final rules will be approved by the Natural Resources Board and will go the legislature for review in the fall of 1983, and if approved will be in effect in late 1983. That means the first ordinances adopted under the incorporated areas law will be in effect in the spring of 1984.

Because there are approximately 500 communities that must adopt a new wetlands ordinance, and because DNR has limited staff to supervise the adoption process, meet with local officials, and explain the wetlands maps, it will take about four years to get all the incorporated areas with wetlands in their boundaries to adopt ordinances. So from the passage of the law to adoption of the first ordinance will be more than two years. From passage of the law to adoption of all required ordinances will be perhaps six years.

Will the new rules really protect wetlands? In the long run, yes, if ordinances are properly enforced. In the short run, no. It's a long time between adopting the rule and getting local ordinances in place. In many counties, farmers and developers are draining or filling wetlands now, before the wetland protection ordinances are in effect. The new rules may actually speed up wetlands destruction in some counties.

Finally, wetlands will only be protected if local officials administer the regulations properly and don't let wetlands be developed by simply ignoring the requirements of the regulations. It's important for local politicians to know that they have constituents who care enough about protecting wetlands to come to hearings and to complain about inadequate enforcement if it occurs. Without that kind of continuing citizen involvement, DNR and local officials will not get the support they need to require tough enforcement.■



Plugging The Leaks In Wisconsin Wetlands Protection Law

By Thomas J. Dawson
Wisconsin Public Intervenor

By now anyone who has studied the environmental issue of wetlands losses in Wisconsin is familiar with these oft-cited facts: Presettlement Wisconsin is estimated to have had ten million acres of wetlands. Two and one-half million acres remain. Of these, 1.6 million acres are held in private ownership. Losses continue at an estimated rate of 1 percent to 2 percent per year. (Wisconsin Department of Natural Resources (WDNR), *Wetlands Use In Wisconsin: Present Policies And Regulations*, 1976.)

Since the early to mid 1970s, the issue of wetlands in Wisconsin, their continuing disappearance, and what to do about it, has been the subject of numerous legislative bills. (Wisconsin Legislative Council staff report, "Protection of Wetlands," *Informational Bulletin* 74-4, July 22, 1974.)

Despite these facts, the Wisconsin legislature has consistently failed to adopt a comprehensive regulatory permit program needed to stem the tide of wetlands losses in Wisconsin. In the next session of the Wisconsin legislature we can again expect legislative proposals to be introduced for added protection of wetlands.

While I believe that Wisconsin's wetlands will not be afforded the protection the Wisconsin public deserves until a wetlands permit program is adopted by the legislature, we should not mistakenly assume that public policy for the protection and wise use of Wisconsin's wetlands has been or will be solely dependent upon the adoption of long overdue legislation.

Existing statutory framework for wetlands protection

Modest, although significant, gains have been made in wetlands protection policies providing at least the proverbial fingers in the leaky dike, which would otherwise burst and cause more drastic wetlands losses. The resulting mosaic of these policies and regulations, while restricting wetlands' destruction in Wisconsin, provides direction for future policy development.

State statutes and regulations

For more than fifteen years ch. 144, Stats., has directed:

> The department of natural resources shall serve as the central unit of state government to protect, maintain and improve the quality and management of the waters of the state. The purpose of this section is to grant necessary powers and to organize a comprehensive program under a single state agency for the enhancement of the quality management and protection of all waters of the state, ground and surface, public and private. . . .

The following definition of "waters of the state" in sec. 144.01(19), Stats., makes clear that wetlands are included within the DNR "waters of the state" definition:

> Waters of the state includes . . . all lakes, bays, rivers, streams, springs, ponds, wells, impounding reservoirs, *marshes*, water courses, drainage systems and *other surface or ground water*, natural or artificial, public or private, within the state or its jurisdiction.

Under ch. 144, Stats., DNR has adopted a general wetlands protection policy (Wis. Adm. Code section NR 1.95). DNR has also adopted regulations that include wetlands protection provisions, such as those in shoreland, mining, and sanitary landfill codes.

Federal statutes and regulation

Of the dozens of federal laws that have impact on our nation's wetlands, perhaps the most important one now being administered in Wisconsin is the Clean Water Act (CWA).

Under CWA Section 404, persons wishing to dredge or place fill in "waters of the United States," including wetlands, must have a permit from the U.S. Army Corps of Engineers (Corps), with the exception that no permit is required for "normal farming, silviculture, and ranching activities," unless those activities change the existing uses of the waters or lands. The procedures and substantive standards for the issuance or denial of 404 permits are contained in the federal code of regulations. Under them, a presumption exists that valuable wetlands may not be destroyed unless the public interest benefits of a project outweigh the detriments to public interests in preserving them.

Under CWA Section 401 no Corps 404 permit is valid unless the applicant obtains from the state a "water quality certification" for the project. This gives the states a virtual veto power over Corps' issuance of the 404 permits. Although no federal regulations establish criteria for the issuance of 401 certifications, Wisconsin has adopted some criteria. And even with these rules, the Wisconsin DNR waives water quality certification on many 404 wetlands fill permits for the lack of standards in the rules directly related to wetlands water quality values.[1]

Federal and Wisconsin state regulations governing the issuance of 404 dredge and fill permits, although far from perfect, are helping to slow the otherwise rapid depletion of our remaining wetlands resources. The Corps of Engineers' St. Paul District is sensitive to the concerns of the Wisconsin public and their state agencies, which increasingly demand wetlands protection. This is largely due to the coordinated efforts in Wisconsin of the U.S. Fish and Wildlife Service-Green Bay Field Office, the Wisconsin Public Intervenor's Office, U.S.E.P.A., the Wisconsin DNR, regional planning commissions, and

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[1] *See* fn. 4, below.

conservation and environmental groups.

Legislative gains on wetlands protection

While the Wisconsin legislature has not adopted a comprehensive wetlands permit program, it has shown a modestly positive track record.

By adopting ch. 374, Laws of 1977, the legislature required the mapping of all Wisconsin's wetlands of five or more acres. Although this legislation is not regulatory in nature, the maps will be useful in developing future wetlands policy.

The 1979 and 1981 legislature failed to adopt a comprehensive wetlands bill, but did enact a significant measure to improve protection of *shoreland* wetlands. Under 1981 Assembly Bill 839, shoreland wetlands in municipalities (villages and cities) are protected under the same regulations (Wis. Adm. Code NR 115) that previously applied only to shoreland wetlands in unincorporated areas (town and counties).

Even these modest improvements in existing laws mean little without agency regulations and administration to carry them out. Many wetlands regulations and policies were initiated by a vigilant citizenry that remains ever concerned about this invaluable resource.

Citizen initiated wetlands' rules

In the summer of 1976 the Citizen Advisory Committee to the Wisconsin Public Intervenor established as the two top program priorities, wetlands protection and environmental protection from metallic mining.[2] The committee also reaffirmed a continuing necessity for public participation in agency environmental decisionmaking. In June 1978 the Wisconsin DNR saw the first of what would be many citizen public policy initiatives on wetlands protection.

At that time, the Public Intervenor submitted, on behalf of fifty-nine associations and groups representing thousands of individual citizens, a petition to the Natural Resources Board (NRB) to adopt administrative rules for the preservation, restoration, and management of Wisconsin's wetlands resources. The petition requested DNR to establish a comprehensive wetlands permit program and to adopt standards and procedures for the protection of wetlands under the state's shoreland zoning law.

Although in June 1978 the NRB tabled the petition, in July the Board authorized two courses of action. First, the NRB requested that the attorney general give a formal opinion "on whether the Department of Natural Resources may adopt a wetlands protection program under its current legislative authority." Second, the Board directed that a special committee be established to draft wetlands protection legislation to be introduced in the 1979 legislative session.[3]

Later, although refusing to adopt a *permit program* for the protection of wetlands, DNR did adopt, in April 1980, revisions of Wis. Adm. Code chapter NR 115 to protect wetlands in *shoreland zones.* Those revisions established the requirement that "shorelands-wetlands zoning districts" be established in shorelands and that specific activities, such as filling, draining, dredging, ditching, and excavating in those districts be prohibited. After stormy legislative review hearings on the rules, they were adopted.

April of 1979 saw two more citizen-initiated petitions sent to DNR. The first petition pointed out that applicants for wetlands fill permits were successfully offering to trade their development rights in certain wetlands for permits to fill other wetlands. The net result of this "mitigation" or "trade-offs" policy was the overall loss of wetlands resources. The citizens requested the DNR Board to prohibit this form of "selling permits." The Board did, by amending Wis. Adm. Code section NR 1.95.

The second petition requested that the DNR adopt administrative rules to guide its decisions on whether to grant, deny, or waive "water quality certification" of U.S. Army Corps of Engineers' permits to dredge and fill wetlands under CWA Section 404. In December 1980, the DNR Board adopted Wis. Adm. Code chapter 299 which established standards for water quality certification decisionmaking on CWA 404 permits.[4]

In May 1979 the Public Intervenor submitted to the WDNR still another citizen petition which requested the adoption of administrative rules to implement the legislatively mandated permit procedure under ch. 88 of Wisconsin's drainage district laws. The petition requested 1) a policy statement requiring DNR staff to enforce the law; 2) DNR to develop rules requiring drainage districts to obtain permits as required by the statute; 3) the establishment of standards for the grant or denial of ch.

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[2] For a discussion of Public Intervenor involvement in Wisconsin mining issues, *see* Peter Peshek, "New Metal Mining In Wisconsin: A Classic Environmental, Economic, and Political Dilemma," *Wisconsin Academy Review*, December, 1981, p. 27.

[3] That legislation, 1979 Assembly Bill 515, providing wetlands protection through specific "special orders," failed.

The Attorney General Opinion, 68 Op. Att'y Gen. 264 (September 17, 1979), concluded that although DNR did not have the authority to adopt a permit program for the protection of wetlands (in part, because of its failure to implement the existing authorizing legislation of 1965), DNR does have authority to adopt other administrative regulatory programs to protect wetlands.

[4] Although Wis. Adm. Code chapter NR 299 establishes procedures and "standards" for the waiver, grant, or denial of water quality certifications for Army Corps 404 permits, those criteria are incorporated by reference from Wis. Adm. Code chapters NR 102 and 104. Those chapters contain established water quality standards and effluent limits for pollutants in waters of the state. However, those chapters are deficient of standards relating to the physical, chemical, and biological values of wetlands that serve to enhance water quality. Therefore, chapters NR 102 and 104 still require necessary amendments to realize their potential for protecting wetlands in Wisconsin.

88 permits for the protection of public rights and interests in waters of the state, including scenic beauty, environmental quality, wetlands preservation; and 4) the development of standards for establishing the minimum level at which waters, including wetlands, must be maintained by drainage boards. This petition was denied by the Natural Resources Board. Other parts of the Wisconsin Administrative Code have been refined in recent years to protect wetlands. The Wisconsin Administrative Code rules governing navigable waters permits and landfill approvals also have been amended to take wetlands values into account and to avoid their destruction.

Currently unresolved wetlands issues

On the state front

The most important unresolved wetlands issue in the state is the need to legislate a comprehensive wetlands permit program. The debate whether DNR has authority to adopt a wetlands permit program can only be resolved, short of litigation, by legislative action. Therefore, the first task is the formulation of a consensus wetlands bill.[5]

The second task is for DNR to develop and adopt water quality standards for incorporation into Wis. Adm. Code chapter NR 299, governing water quality certifications of Corps of Engineers' 404 permits.

Third, DNR should designate priority wetlands areas for protection under its CWA Section 208 area-wide plans. Because most state and federal permits for activities in wetlands must be in conformance with area-wide plans, the designations could protect valuable wetlands.

Fourth, there has been talk in recent years of using wetlands as receivers of secondarily treated wastewater from municipal and industrial sewage treatment plants. While it has been generally known that wetlands serve water filtration and nutrient absorption functions, serious questions remain regarding the capacity of wetlands to "treat" municipal and industrial wastewaters adequately. We should not be quick to consider using our wetlands routinely as filters for the advanced treatment of waste effluents.

Fifth, the recently adopted state wetlands statutes and regulations must be vigorously administered and enforced. No laws are self-executing. Wetlands mapping must continue apace. County and municipal shoreland zoning ordinance amendments to incorporate the new "wetlands zoning districts" regulations remain to be finished. Local governments wishing to comply with these new rules must be assisted by DNR, while those delaying or obstructing the process must be dealt with firmly and fairly. DNR's wetlands policy contained in Wis. Adm. Code section NR 1.95 must continue to be integrated into every planning and regulatory process of that agency.

Sixth, DNR must clarify its position regarding wetlands which lie behind municipally established bulkhead lines, which serve as the boundaries for shoreline development. The public is confused about the status of such wetlands, wondering if DNR has "written off" wetlands behind bulkhead lines. If the clarified position by DNR of these wetlands' status is not protective enough, wetlands protection advocates must be prepared to obtain necessary administrative or judicial declarations regarding the limits of bulkhead line authorizations with respect to wetlands.

Last, DNR must be flexible enough to allow its wetlands regulations to evolve with the continuing flow of information that is being prompted by policy initiatives. For example, continuing studies and policy development in solid waste, mining, and groundwater will bring forth facts and considerations previously unincorporated into present wetlands-related regulations.

On the federal front

The Clean Water Act of 1977 is up for reenactment by the Congress. The "404 dredge and fill program" has been targeted for emasculation by development and agricultural interests. One proposed revision of Section 404 would totally eliminate existing protection of wetlands by limiting Section 404's coverage to traditionally "navigable" waters. This revision would burst the leaky dike of wetlands protection in Wisconsin.

Meanwhile, under the guise of "regulatory reform," the U.S. Army Corps of Engineers has recently revised its regulations governing the issuance of 404 permits.[6] Preexisting opportunities for public participation in the decisionmaking process have been significantly curtailed, while the Corps has written off some of the nation's most precious wetlands resources through the issuance of general "nationwide permits." Fortunately, Wisconsin is one of a growing number of states which have denied water quality certifications for many nationwide permits, or have "conditionally certified" other nationwide permits to protect their most valuable wetlands resources.

These developments make evident what needs to be done. First, the congress needs to hear continually from DNR and the public about the need for enhancing, as well as maintaining, wetlands protection laws.

[5] Although the DATCP/DNR version of 1981 Assembly Bill 839 (LRB-4210/2) did not get out of the Assembly Committee on Environmental Resources, its provisions contained a breakthrough on the question of an acceptable "agricultural exemption," which traditionally has been the downfall of wetlands bills. Unfortunately, the bill would have had the effect of: 1) superseding the newly adopted revisions to the shoreland zoning wetlands rules in Wis. Adm. Code chapter NR 115; 2) rendering impotent the operation of the Clean Water Act Section 404 "dredge and fill" program in Wisconsin; and 3) excluding the public from their rightful opportunity to participate and influence local wetlands decisions. A renewed effort to develop a wetlands bill, built around the acceptable agricultural exemption, should be made with the cooperation of the agricultural, environmental, and business communities along with interested state agencies and the public.

[6] *See* 33 C.F.R. Parts 320-30 (1982), 47 Fed. Reg. 31794 (July 22, 1982).

Second, the Wisconsin DNR must remain firm with the U.S. Army Corps of Engineers regarding the status of nationwide permits for wetlands destruction activities where water quality certifications have been denied or conditionally granted.

Third, the DNR, EPA, U.S. Fish and Wildlife Service, and the Wisconsin Public Intervenor are currently working with the St. Paul District Army Corps of Engineers to develop an acceptable general "regional permit" for authorization of certain activities which fall under the concurrent jurisdiction of the Corps and WDNR. At the time of this writing, the St. Paul District has been responsive enough that no wetlands have been "written off" by the proposed regional permits. Issues surrounding public participation and procedures for taking specific activities out of general permit categories on a case-by-case basis remain. The Corps of Engineers' St. Paul District Office must continue to be responsive to Wisconsin's interests in protecting its remaining wetlands resources.

Fourth, the U.S. Army Corps of Engineers' policy of "dual adjacency" must be abolished. Under this policy, a wetland that is adjacent to both a nonnavigable stream of less than five cubic feet per second (cfs) of water flow (generally permitted under the Corps' regulations), and equally adjacent to a navigable stream of more than five cfs (requiring a permit), is considered by the Corps to come under the general permit.

Conclusion

The fragile net of federal and state laws currently in operation in Wisconsin are working together to hold back increasing pressures to fill, drain, and otherwise destroy the remainder of our dwindling wetlands resource. But as we see, those protections are tenuous and incomplete. Wetlands continue to be unnecessarily lost due to gaps in the law, attacks on existing laws and regulations, and deficiencies in their administration and enforcement. Whether Wisconsin's precious wetlands resource survives the present and future onslaught is dependent on how well we are able to preserve and build upon the existing laws for protecting them.

As it was when the Wisconsin Public Intervenor wrote to the Natural Resources Board on June 16, 1978, with reference to its wetlands policy, **"It is now time to carry to fruition the promise inherent in the Board's policy declaration of a wetland resource that is the public's right to enjoy forever."■**

Wisconsin Wetlands Inventory

By Steve Fix, Marge Wetzel, and Dan Homblette
Department of Natural Resources

In 1977 the state legislature passed a law, Chapter 374, Laws of 1977, requiring the Wisconsin Department of Natural Resources (DNR) to map "as accurately as is practicable the individual wetlands in the state."

The law defining wetlands instructs the DNR to map individual wetlands down to at least five acres utilizing the best methods practicable with a completion date for the mapping project set at July 1, 1983. The statutory definition of wetlands is:

> 'wetland' means an area where water is at, near, or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation and which has soils indicative of wet conditions. (Section 23.32. (1),Wis.Stats.)

This definition is compatible with the U. S. Fish and Wildlife Service definition found in *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al., 1979) in that it emphasizes vegetation, hydrology, and soils.

All information on the DNR wetlands maps was collected from black-and-white infrared aerial photographs taken during the summers of 1978-80.

Classification system

The wetlands classification system designed to correspond with this definition evolved from a year-long study of past inventories and classification systems used throughout the country. Very few exclusively freshwater wetland inventories had been conducted on a statewide level, with most wetland mapping occurring in the coastal regions or as research projects concerned with individual wetlands.

The classification system that was decided upon for use by the DNR Wisconsin Wetlands Inventory is based on the U. S. Fish and Wildlife Service (Cowardin et al.) system, but with a few simplifications to make it more pertinent to Wisconsin conditions. Wetland areas delineated on the aerial photographs are classified using a code that describes covertype and hydrologic characteristics with "human influence" or special wetland type modifiers added where appropriate. The classification code is usually comprised of three or four letters and digits. For example, in E2Kg, E indicates covertype class, 2 vegetation subclass, K hydrologic modifier, and g special type modifier.

Each wetland mapping unit is classified into at least one of seven covertype classes. The covertype classes are denoted by capital letters: "A"-aquatics, "E"-emergent, "S"-shrubs, "T"-trees, "W"-open water six feet deep or less, "F"-unvegetated wet areas, and "M"-moss. These classes, except for moss, are then broken down into subclasses denoted by numbers. For example, an E2 class and subclass designates an area of narrow-leaved persistent emergent vegetation such as cattails or sedges; a T3 indicates an area of broad-leaved deciduous trees. The third component of a single wetlands classification is the hydrologic modifier, represented by a capital letter. There are four hydrologic modifiers used: "L"-standing water greater than twenty acres, and/or greater than six feet deep, "R"-flowing water of a stream or river, "H"-standing water present, and "K"-wet poorly drained or very poorly drained soils. Therefore, an E2K wetland classification indicates an area of narrow-leaved persistent emergent vegetation growing on wet poorly drained or very poorly drained soils.

Often, special or unique conditions which can be seen on the air photos are indicated by adding a special type modifier, denoted by a lower case letter, to the wetlands classification. For example, if we can tell from the photos that an E2K area is grazed, we will then add a lower case "g" to the classification: E2Kg. There are two general categories of special modifiers: human influence and wetland complexes. Human influence modifiers are used to show things such as grazing (g), wetlands farmed only in dry years or areas of marsh hay (f), man-made cranberry bogs (c), abandoned farmland reverting to wetland vegetation (a), areas where vegetation has been removed (v), and shallow excavated ponds (x). Some examples of more commonly used wetlands complex modifiers are floodplain complex (w), which includes some small upland areas too small to delineate, floating bog mats (m), and the ridge and swale wetland complexes (s) found along Lake Michigan.

Wetlands classification codes can be mixed if two vegetative life forms make up at least 30 percent each of the wetlands mapping unit. For example, if an E2Kg area has broad-leaved deciduous shrubs mixed in such that the shrubs constitute 30-40 percent of the ground cover, we indicate this condition by combining covertype classes. The E2Kg is then classified as S3/E2Kg to indicate the mix of shrubs and emergent vegetation. The accompanying table shows some examples of Wisconsin Wetlands Inventory classification and their equivalent classification to either John Curtis's *Vegetation of Wisconsin* or the U. S. Fish and Wildlife Service's Circular 39.

Photo interpretation

The wetlands are interpreted using an aerial photograph stereo pair: two consecutive photos, exposed so there is at least a 50 percent ground coverage overlap from one photo to the other. When the two are viewed simultaneously through a stereoscope, a three-dimensional image of the earth's terrain is seen. This allows the viewer a better perspective of the topography, vegetation, and other features of the landscape. Additional sources of information such as USGS topographic maps and USDA Soils Conservation Service soils maps are used by the interpreters to define better boundaries and vegetation conditions within the wetlands. The mapping of wetlands is conducted on a county-by-county basis, with three to four counties being interpreted at any one time.

Sample Classification of Representative Wisconsin Wetland Types

Code	Examples	Curtis Equivalent	Circular 39 Equivalent
A3L	Water lilies in a lake	—	Type 4
E2K	Sedge meadow	Southern sedge meadow Northern sedge meadow	Type 2
E1Kf	Wetland cultivated during dry years only	—	Type 1
E2H	Cattail stand	Emergent aquatic community	Type 3, 4
S3K	Red osier dogwood and willow shrubs	Shrub carr	Type 6
T5K	Black spruce swamp	Wet northern forest	Type 7

Base maps

Upon completion of the field checking of a township the wetland information interpreted on the aerial photographs is transferred to a reproducible mylar photo base map.

Wetland boundaries and classifications are drafted in ink on an aerial photo base map. Photo bases from two sources are used for the wetlands maps: one type is United States Geological Survey orthophotoquads; the other type is surveyed township-centered photo bases produced by the Wisconsin Department of Transportation. Final map scale of 1:24,000 (one inch represents about 2,000 feet) was decided to be the optimum scale for most potential uses of the maps.

The drafting conventions used in the production of base maps generally include specifications for the labeling of types of wetland, political and cultural features, wetland classification codes, cultural names, and interpretation data, all of which are included on the base map. The classification system and drafting conventions are described in the booklet "Users Guide to the Wisconsin Wetlands Inventory" sold by the Wisconsin Geological and Natural History Survey, 1815 University Avenue, Madison, Wisconsin 53706.

Digitization

A primary goal of the wetlands inventory is to generate wetland acreage totals for the state. To do this manually would be a monumental task, so it was decided to utilize the computer technique of digitizing.

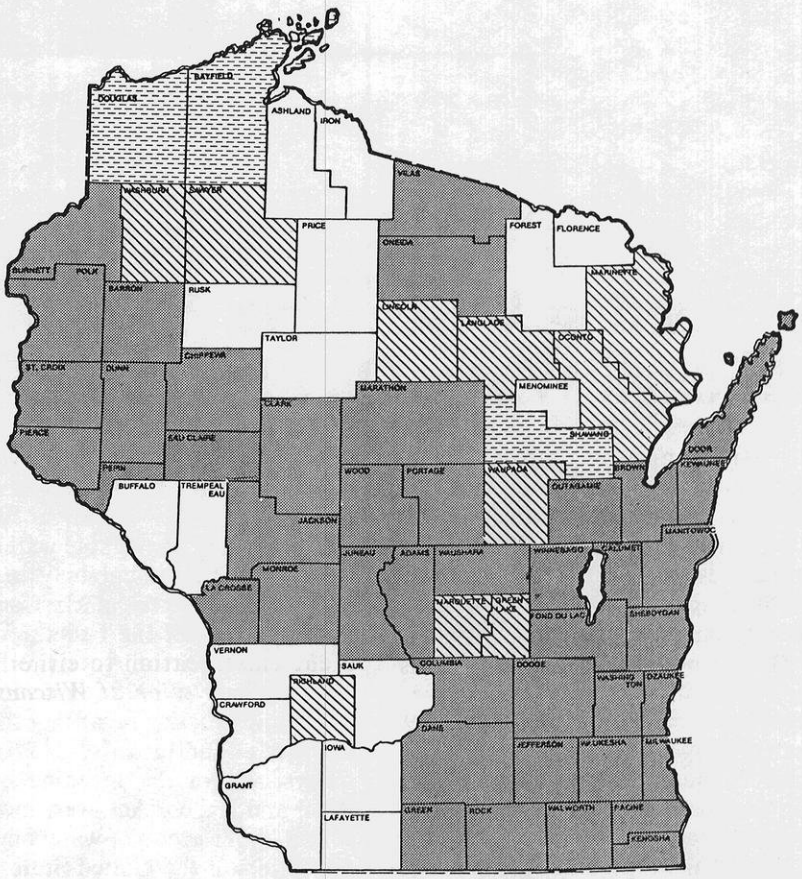
The wetland boundaries are digitized or traced and the lines are recorded in digitally on magnetic tape for computer processing. The resulting product is a computer-based file of lines which define polygons for each wetlands map. These polygons correspond to each wetland unit on the original map. An individual working on a computer graphics terminal can then label each of the polygons with its correct wetland classification. The data can then be processed by the computer which can printout each polygon on the digitized map, its wetland classification, and the size in acres of this particular wetland unit. This data can also be aggregated to get wetland acreage totals for each wetland type such as T2K (tamarack swamp) on each map. County and state wetland acreage totals will also be made available.

Uses of wetlands maps

The major use of the wetlands maps at present is for regulatory purposes under Wisconsin Administrative Code NR 115. Under NR 115 each county has up to six months to review and submit comments on the accuracy of the preliminary wetlands maps. The comments are reviewed and changes to the maps are made where needed. After the county receives final wetlands maps, they have six months to adopt an ordinance protecting the wetlands in the shoreland zone of unincorporated areas. The recently passed Chapter 330, Laws of 1981, will extend similar procedure and requirements into incorporated areas.

Other uses for the wetlands maps include solid and hazardous waste disposal site planning, prime agricultural land preservation planning, identifying potentially good wildlife habitat for protection or acquisition, and other natural resources research projects.

The Wisconsin Wetlands Inventory mapping project intends to provide the people of Wisconsin with fundamental information about the number and nature of wetlands in the state. The materials, techniques, and products of the project represent the best that can be done given the time, budget, and bureaucratic constraints we operate under. We believe the maps and generated data will be extensively used by local, state, and federal agencies and that the maps and data will continuously be maintained and updated to provide the most up-to-date data possible.



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Curtis, John T., 1959. The Vegetation of Wisconsin. University of Wisconsin Press, Madison, Wisconsin.

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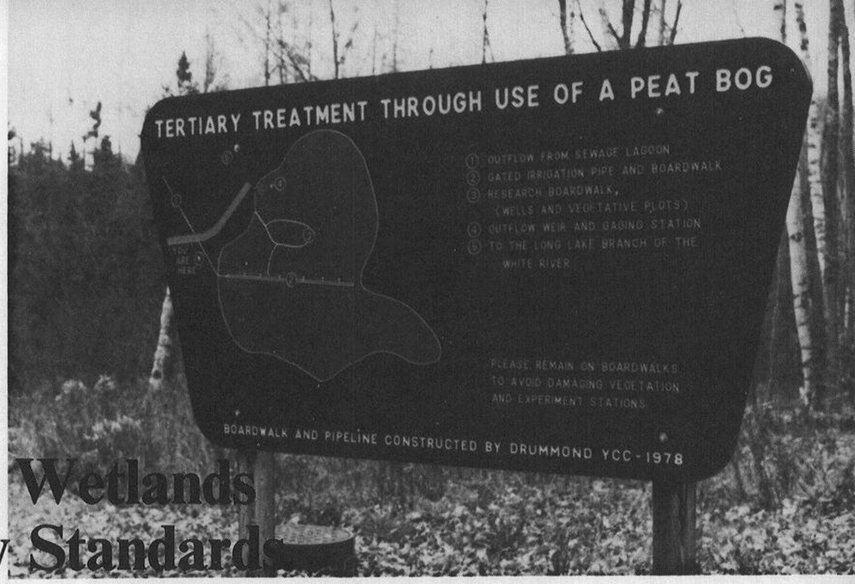
When Winter Came

All the midwest winter long,
As icicles formed the windows
    Into jaws
    To gulp in cold,
We crouched inside
Over the fires
Of flower catalogues.
    As January wind
    Pounded
The temperature down
And the house's visage
Grew long in the tooth
    We fanned
    The blooms
    To flaming masses:
Daffodil bonfires,
Infernos of windflower
    Burning up
    The heartwood of spring
    For wintry survival.

R. S. Chapman



Protecting Wisconsin's Wetlands Through Water Quality Standards

To many Wisconsin citizens, the U.S. Fish and Wildlife Service is primarily identified as the federal agency responsible for the National Wildlife Refuge System, National Fish Hatcheries, Endangered Species, Law Enforcement, and Research. However, my division, Ecological Services, is responsible for reviewing many proposed federally related projects, programs, permits, grants, and licenses in order to determine their impact on fish and wildlife resources. This responsibility originated in the Federal Fish and Wildlife Coordination Act which requires federal agencies to give fish and wildlife values equal consideration with other project purposes. The coordination act operates in a complementary manner with other statutes such as the National Environmental Policy Act, the Endangered Species Act, the Coastal Zone Management Act, the Clean Water Act, and the River and Harbor Act of 1899. These statutes, and others that implement our overall mission "to provide the federal leadership to conserve, protect, and enhance fish and wildlife for the continuing benefit of people," give the service, particularly the Division of Ecological Services, a basis for addressing wetland issues. I will discuss the existing pollution control program as it relates to Wisconsin wetlands and offer some observations on opportunities that are available to strengthen it.

Federal Design

The federal role relative to permit requirements affecting wetlands has a long-standing justification in the commerce clause of the Constitution of the United States. Section 10 of the River and Harbor Act of 1899 mandated review of all activities which affected "navigable waters" of the United States but only to their ordinary high water mark. Congressional passage of the Federal Water Pollution Control Act (FWPCA) Amendments of 1972, expanded the federal jurisdiction regarding the discharge of pollutants. Navigable waters, within the meaning of the River and Harbor Act, were included with a larger group of waters defined as "waters of the United States" under the FWPCA. The legislative history explains that "...the term navigable waters be given the broadest constitutional interpretation unencumbered by agency determinations which have been made or may be made for administrative purposes." When the commerce clause is considered in the intended broad sense, it is difficult to find surface waters, including wetlands, which do not factor into interstate commerce. Administratively, this congressional intent was not implemented immediately. The Environmental Protection Agency took a very broad view of discharges from point sources under Section 402 of the act. However, it was not until 1975, following a successful lawsuit by the Natural Resources Defense Council, that the Corps of Engineers expanded coverage of the Section 404 program to require permits for the discharge of dredged or fill material to be consistent with the congressional intent to regulate all waters of the United States, including wetlands, for which there was federal interest under the commerce clause.

In December 1977, congress amended the FWPCA, now known as the Clean Water Act. Congressional policy was clarified in the 1977 amendments in Section 101(b) to give the states more direct management in Clean Water Act programs. Specifically, the declaration stated: "It is the policy of Congress that the States manage the construction grant program under this Act and implement the permit programs under sections 402 and 404 of this Act." Additionally, the congress amended Section 401 to include state water quality standards, developed pursuant to Section 303, as an additional criteria for granting or denying of state water quality certification. This certification is required of "Any applicant for a Federal license or permit to conduct any activity including, but not limited to, the construction or operation of facilities, which may result in any discharge into navigable waters..." Section 404 was also amended to allow for states to assume the 404 permit function, in lieu of the Corps of Engineers, for waters which, from a federal standpoint, were considered nonnavigable in fact (i.e. not Section 10 waters). Most importantly, congress sustained continuing federal interest in "waters of the United States." Congress did exempt certain activities or projects with conditions and allowed the issuance of general permits for specific activities. It is readily apparent that the original 1972 legislation, as amended by the 1977 Clean Water Act, showed congressional concern over the discharge of pollutants because states, at least originally, were not capable of providing the necessary controls to prevent continued environmental degradation. However, it is equally apparent that a long-term partnership between the federal and state governments is mandated, with the states being active, not silent, partners. State policy and prerogatives are important in leading the water quality protection and restoration effort.

State Implementation

Passage of the FWPCA Amendments of 1972 placed certain requirements on the states. Section 303 of the act requires states to develop water quality standards for "waters of the state." These standards also are required under Wisconsin law by Section 144.025(2)(b) Stats. The Wisconsin Department of Natural Resources (DNR) is designated "...as the central unit of state government to protect, maintain and improve the quality and management of the waters of the state, ground and surface, public and private." The state of Wisconsin, in Section 144.01(19) Stats. has a broad definition of "waters of the state." Indeed, wetlands or at least water within them, fall within the definition including "...marshes, watercourses, drainage systems, and other surface or ground water, natural or artificial, public or private, within the state or its jurisdiction." The DNR has adopted water quality standards in the Wisconsin Administrative Code for wetlands. However, the language of the standards appears suitable only as guidance for DNR decisions regarding wastewater discharges regulated under Section 402 of the Clean Water Act and Chapter 147 Stats. This is important, however, because of wastewater discharges into the state's wetlands. Although, this sort of wetland disturbance is not well understood, especially the long-term resource implications, it is not widely practiced. **In 1981 there were 568 Wisconsin municipalities discharging wastewater to surface or ground waters. Approximately 5 percent of these discharged to wetlands.** Almost all of these wetland discharges are fairly old. The city of Brillion's discharge is probably the oldest, beginning in 1923. No new discharges have been approved by the DNR in recent years, although some have been continued as a result of decisions made in the facility planning process. Other discharges, like those at Arcadia and Florence, have been approved for changes. Arcadia will cease using wetlands adjacent to the Trempealeau River and discharge to the river itself. Florence will switch from a wetland discharge to groundwater using seepage cells.

The concept of using wetlands as receiving waters is one that should be approached cautiously. **Present discharges do not impact significantly on the quality of wetland values on a statewide basis, but there is reason to be concerned with continued use of the concept.** Wetlands have been publicized as having water purification as one of their valuable functions to society. However, they can be "overused" as can lakes and streams, with adverse ecological effects. Additionally, wetlands differ functionally depending on a variety of influences including the surrounding landscape. This response to the particular mix of local influences causes wetland functions and values to be individually unique. The uniqueness of individual wetlands is amply demonstrated by comparing values and functions of a designated state scientific area with other areas such as Horicon Marsh; an acid bog; a sedge meadow next to a trout stream; or a wetland severely degraded from its natural state by human activities such as encroachment fills, ditching and nonpoint pollution. This means that wetland values and functions need to be identified on a case-by-case basis and protected accordingly.

Wisconsin's existing water quality standards lump all wetlands of the state into a "marginal surface water" category, mostly for hydrological classification purposes. The numerical and narrative criteria which comprise the standards, also are generalized to include all wetlands. However, these criteria do not adequately reflect individual wetland functions or values. Due to natural variations, some wetlands have higher and/or lower quality than these standards. This is not a capricious attempt by DNR to allow wetland degradation by wastewater discharges. On the contrary, DNR acknowledged that wetlands are important by specifically recognizing them in the standards at a time when most pollution control and standards development were targeted at stream discharges because of historic practice, technical understanding, and the sheer magnitude of the problem. Likewise, no guidance was available on appropriate criteria for wetland related standards. Therefore, the criteria were based on the best professional judgement available. In late 1980 the DNR recognized the inherent complexities of the wetland/wastewater issue when it commented on EPA's proposed generic environmental impact statement for wetland discharge usage. Specifically, the department stated in part that it "...strongly recommends avoidance of wetland areas and concurs with their use or alteration only when necessary to minimize overall environmental impacts of a proposal."

Approving wetland discharges, based upon existing standards, is a perplexing problem. The existing standards do not provide sufficient detail to determine whether an existing discharge should be allowed or should be removed from a wetland. For instance, the village of Paddock Lake in Kenosha County discharges to an intermittent tributary approximately 1,000 feet upstream of a wetland adjacent to Brighton Creek. This wetland is known as the Harris Tract Marsh and is designated by the Scientific Areas Preservation Council as a Natural Area (NA1) because of its ecological values of statewide or greater significance. Past facility planning did not resolve the question of whether the discharge should continue in this highly valuable wetland of southeastern Wisconsin.

When consideration is given to the possible future requirement to remove phosphorus, ammonia, or other pollutants from sewage to protect certain streams, it can be seen that wetland discharge will be looked at with greater interest. Many smaller communities, faced with tertiary treatment requirements, may be ill-prepared fiscally and technically to deal with stream discharge requirements and so can be expected to investigate the wetland discharge option. Without detailed guidance and direction on protection requirements, the state's wetlands could be subjected to ecologically harmful stresses.

Studies, such as the experimental sewage discharge to an acid bog at Drummond, Wisconsin, will provide additional data that can be used to formulate appropriate criteria for wetland protection. The Fish and Wildlife Service has funded part of the Drummond research and is now funding a study to put all related research into a comprehensive review of what has transpired there since introduction of the discharge in 1979. Additionally, the service and EPA cosponsored a workshop on wastewater discharges to wetlands at the University of Massachusetts this past June. Results of these efforts and related nationwide studies could be assembled to help revise water quality standards to conform with our understanding of wetlands and their wastewater discharge protection requirements.

The Department of Natural Resources also has one of the finest water regulatory programs in the nation to protect wetlands from activities other than wastewater discharges. However, only approximately 30 percent of the state's wetlands are within the direct permit authority of the DNR under Chapters 30 and 31 Stats. This does not mean that the state of Wisconsin does not hold all wetlands within its public trust responsibilities. Chapter 144 recognizes wetlands as "waters of the state." Also, all nonexempt dredged and fill material discharges under Section 404 must be permitted by the Corps of Engineers, and the DNR can issue, waive, or deny Section 401 water quality certification for all federal permits resulting in such a discharge. Without state Section 401 certification, the federal regulatory agency cannot issue a permit for the project in question.

Wisconsin has effectively asserted its own prerogatives on the 404 permit program through the 401 certification process. DNR denied certification this past summer for Corps of Engineers proposed nationwide permits for certain "waters of the states" within its legal jurisdiction and conditionally approved certain nationwide permits for specific activities. What is evident from this action is that the DNR recognized the legitimate use of 401 certification to protect both the national and state interest in the state's water resources including wetlands. The congressional design of the Clean Water Act placed at the doorstep of the state an active and substantive role in federal permit decisions. Section 401 certification is the vehicle by which states can make their water quality related objectives substantive requirements on federal permit decisions, absent direct permit authority by the state. Wisconsin has not assumed the 404 permit program, therefore, its 401 certification is operative for 404 permits issued by the Corps of Engineers. DNR does not issue 401 certification for Section 402 permits since it has an EPA approved program under Chapter 147 Stats.

DNR's outright denial of certification for the Corps of Engineers "categories of waters" nationwide permit was based on violation of the Wisconsin Administrative Code's NR299 criteria. These criteria encompass more than just water quality standards. However, the DNR's existing water quality standards are not sufficiently detailed to provide the necessary protection of individual wetlands potentially affected by federal permit issuance. As with wastewater discharges, additional detail is necessary in the standards to provide sound criteria for 401 certification decisions and at the same time for reasonable and flexible consideration of the varying functions and values of an individual wetland as well as the varying degrees of fill impacts to be incurred.

Concluding Observations

The Clean Water Act and Chapter 144 Stats. provide the necessary institutional framework for protecting Wisconsin wetlands from the discharge of pollutants. This framework does not deal comprehensively with wetlands management and protection since it speaks exclusively to pollutant discharge. However, in the absence of the passage of state comprehensive wetland legislation, improvements in wetland protection can be made by more thoroughly utilizing existing federal and state statutes.

The concept of utilizing water quality standards as the driving force in pollution abatement has been successful and accepted in Wisconsin. Wetland standards are also an accepted part of this pollution abatement strategy. As part of Wisconsin's continuing planning process, water quality standards are periodically reviewed and revised. The DNR is currently looking at a long-term strategy for overall water quality management planning. Comprehensive water quality standards for the discharge of pollutants into wetlands is an alternative approach to be considered seriously in any long-term management strategy.■

The Role

By Thomas J. Murn
Wisconsin Wetlands Association

Once wetlands were so plentiful in Wisconsin that major destruction of this resource went unopposed and even approved. But wetlands have always had friends—remember Francis Marion, the Swamp Fox of the Revolutionary War? Wetlands have gained advocates as they have dwindled over the years. Today in Wisconsin when wetlands are threatened by drainage or filling, people from many walks of life are ready to resist.

The Audubon Society was founded when a group of women banded together to protest the slaughter of egrets for feathers to adorn hats. They succeeded not only in saving the egrets, but in launching a powerful force to preserve natural habitats throughout the country.

When the Remington Arms Com-

# of Private Organizations in Wetland Advocacy

pany sponsored Aldo Leopold's wildlife habitat research, they were continuing a tradition of the sports hunter's close association with wetlands protection. Hunting, fishing, and trapping licenses and fees have paid for the acquisition and maintenance of many Wisconsin wetlands over the years. Conservation groups such as Trout Unlimited and the National Wildlife Federation take the case for wetlands to their membership and to the public.

As wetlands dwindled, the growing environmental movement brought more friends to the swamps and marshes. The various environmental organizations in Wisconsin take an active role in wetlands preservation. Some groups concentrate on being watchdogs of local wetlands. They work with state and local government in demonstrating the values of wetlands and in demonstrating the strength of the preservationist constituency. Wisconsin's Environmental Decade acts for wetlands by using legal initiatives and bureaucratic savvy. Local chapters of the Sierra Club and the Audubon Society inform their members of developments in wetlands protection and call upon them to write letters and appear at public hearings when valuable wetlands are threatened with destruction.

A valuable function of the environmental groups has been to get people's feet wet with field trips and wetlands study sessions. A growing number of environmental education centers such as Wehr Nature Center at Whitnall Park in Milwaukee help to demonstrate the beauty and diversity of wetland ecosystems. Boardwalks and guide booklets allow anyone to watch wetland flora and fauna through the seasons and to gain respect for the complex and fragile system of organisms.

Wetlands are unique ecosystems, and in Wisconsin numerous northern bogs and southern fens and marshes contain threatened or endangered species. One private organization, the Nature Conservancy, has worked since the 1940s to preserve examples of valuable natural ecosystems, including wetlands. The Nature Conservancy is a low-profile but vital operation, raising funds from corporate as well as private sources. The Nature Conservancy's stated and only purpose is to work to save rare wild land when public agencies are unable or unwilling to act quickly. In Wisconsin the Nature Conservancy has purchased or maintained easements to several unique wetland areas, including Summerton Bog in Marquette County, dedicated as a National Natural Landmark because of its populations of rare orchids. The Nature Conservancy also owns wetlands from low prairie swales in Kenosha County to virgin spruce lowland forest in the northland.

Wisconsin wetlands play such an important role in the water-dependent quality of our life that it is perhaps not unusual that a separate private organization exists devoted specifically to Wisconsin wetlands.

The Wisconsin Wetlands Association started in the early 1970s as the Southern Wisconsin Wetlands Association. A group of concerned citizens wanted SWWA to serve as an educational group and rallying point to stop proposed wetlands destruction along a route being considered for relocation of Madison's South Beltline Highway.

WWA dropped the 'Southern' as it began the task of advocating wetlands protection statewide. Though wetlands have many important practical values, they are still not well understood by the general public. Providing information to those who want to learn more is a purpose of WWA. Through a monthly newsletter, *Our Wetlands*, WWA members follow local initiatives and state and federal developments. WWA sponsors monthly public meetings on interesting topics involving wetlands and sponsors field trips. WWA also holds Wetlands Week activities in spring, with special speakers, displays at libraries, and a photography contest. WWA is a cosponsor, along with the International Crane Foundation, of a yearly crane count. Trained observers are sent out to watch a springtime sunrise and listen and watch for the movements of sandhill cranes. The resultant data show how well the large and impressive birds are surviving, even as many thousands of acres of wetlands are lost each year in Wisconsin.

WWA maintains a dialogue with other public and private groups in Wisconsin who work for wetlands preservation. A coalition group of environmental concerns called the Environmental Agenda has made wetlands preservation a priority, and WWA has worked with EA's Wetlands Task Force to inform members on the status of various wetland protection bills which come to the Wisconsin legislature.

Perhaps the most important job which WWA performs is to provide logistical support to local groups who believe in wetlands protection. Without local grass-roots support, wetlands can more easily be destroyed. Local people can make the biggest difference in preservation of local wetlands. At Green Bay's Tank Farm Marsh, at Swan Lake in Columbia County, at Silver Lake south of Milwaukee, local people have taken the time to defend successfully local wetlands against unreasonable threats. Until society at large is ready to protect its wetland resources, informal local conservation and environmental groups must be the standard-bearers in the struggle. With assistance from groups working on the state and national level, the tasks of education, information, and preservation will bear success.■

Authors and Artists

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John A. Schoenemann is professor of horticulture and agricultural economics at UW-Madison and extension specialist in vegetable crops, UW-Extension. He grew up on a commercial greenhouse vegetable and market gardening farm near Milwaukee. Professor Schoenemann earned B.S., M.S., and Ph.D. from UW-Madison. In the department of horticulture he is responsible for education to commercial producers of potatoes and other vegetable crops in the state. Professor Schoenemann has also been engaged in such research as potato variety evaluation. He is the author of publications on potato and vegetable production and marketing. For many years he has served as a special liaison representative to the Wisconsin Muck Farmers Association, providing educational and technical assistance to this special agricultural group.

James B. Hale was born and raised in Stoughton. He earned a degree in botany (1945) and M.S. in wildlife management (1947) from UW-Madison. For thirty-five years he has worked as a wildlife biologist and administrator in Wisconsin DNR. He is presently director of the Bureau of Endangered Resources. Other interests include music, outdoor photography, biking, hiking, bird and flower watching, grouse hunting, trout fishing, and miscellaneous collecting. A Wisconsin Academy member since 1957, Jim Hale is married and lives in Madison.

Scott Freeman is a biologist turned educator-naturalist. From Carleton College in Northfield, Minnesota, he received a B.A. in plant sciences and ecology. He came to the International Crane Foundation (ICF) as a volunteer in January of 1980, helping to plan the development of their new site and restore the native vegetation. While volunteering at ICF, he organized seminars on land-use at the nearby Aldo Leopold Memorial Reserve. He became ICF's education coordinator in October of 1980.

Francis Hole received training in earth sciences and ecology, with emphasis on soil science, at Earlham College (Indiana) and at UW-Madison. Since 1946 he has worked with the Geological and Natural History Survey in the cooperative soil survey program in the state and has studied soils in wetlands. Professor Hole has been a Wisconsin Academy member since 1952.

Ruth L. Hine came to Wisconsin for graduate work at UW-Madison from Connecticut. She received a Ph.D. in zoology with work in wildlife management and botany. Since 1949 Ruth has worked for the DNR and its predecessor, Wisconsin Conservation Department. In the seventies Ruth was closely associated with the endangered species program and directed studies of leopard frogs. Involved with environmental education and the development of a land ethic, Ruth loves the outdoors—from camping to gardening. An Academy member since 1956, Ruth worked with the *Review* as editor and reporter in the sixties and early seventies.

Ursula Petersen has worked as naturalist on Washington Island for the past twelve seasons. Her particular interest is in Great Lakes education. She is currently working at DNR in the wetlands mapping project.

Byron C. Crowns is a native Wisconsinite, a *cum laude* graduate of St. Norbert College and graduate of the UW-Madison Law School with a Juris Doctor degree. In addition to a life-long interest in geology, he has done freelance writing, including *Wisconsin Through 5 Billion Years of Change* published in 1976 by the Wisconsin Earth Science Center. He has represented the Wisconsin Cranberry Growers Association since the environmental movement first gained momentum.

Tom Murn is board member of WWA and newsletter editor of "Our Wetlands." A freelance writer, he lives in Belleville.

Thomas J. Dawson was born in Pennsylvania and received a B.A. in political science from Rutgers University. He was graduated first in his class from the Howard University School of Law in Washington, D.C. with a *magna cum laude* Juris Doctor degree. Since 1976 Tom has been Assistant Attorney General and Public Intervenor of Wisconsin. Married, he lives in Madison.

James H. Zimmerman received B.A., M.A., and Ph.D. from UW-Madison in botany with a specialization in plant taxonomy. He has applied his broad interests in field biology and student training serving as a naturalist; writing a biology text, a field guide to wild plants, and numerous articles on nature; planning restoration of biotic communities; and founding organizations in applied field sciences. In 1977 Jim joined the UW-Madison Department of Landscape Architecture to train people in environmental awareness. Sharing a keen interest in the outdoors with his wife Libby, a wildlife artist, Jim spends as much time as possible in canoeing, gardening, traveling, and in environmental action.

Malcolm N. Dana received his B.S. degree in agriculture from the University of Vermont in 1948 and completed the doctorate in horticulture-plant physiology from Iowa State College in 1952. He came to the University of Wisconsin in 1952 to teach courses in fruit production, general horticulture, and later in plant propagation. He has been supportive of UW-Extension's eminently successful educational program for cranberry growers. He has written several technical papers as well as numerous popular articles.

Jim McEvoy, a graphic artist for the Wisconsin DNR, was a biologist/naturalist for many years before becoming an artist. Jim's pen-and-ink drawings of some of Wisconsin's endangered flora will be on exhibit at the Steenbock Center in January.

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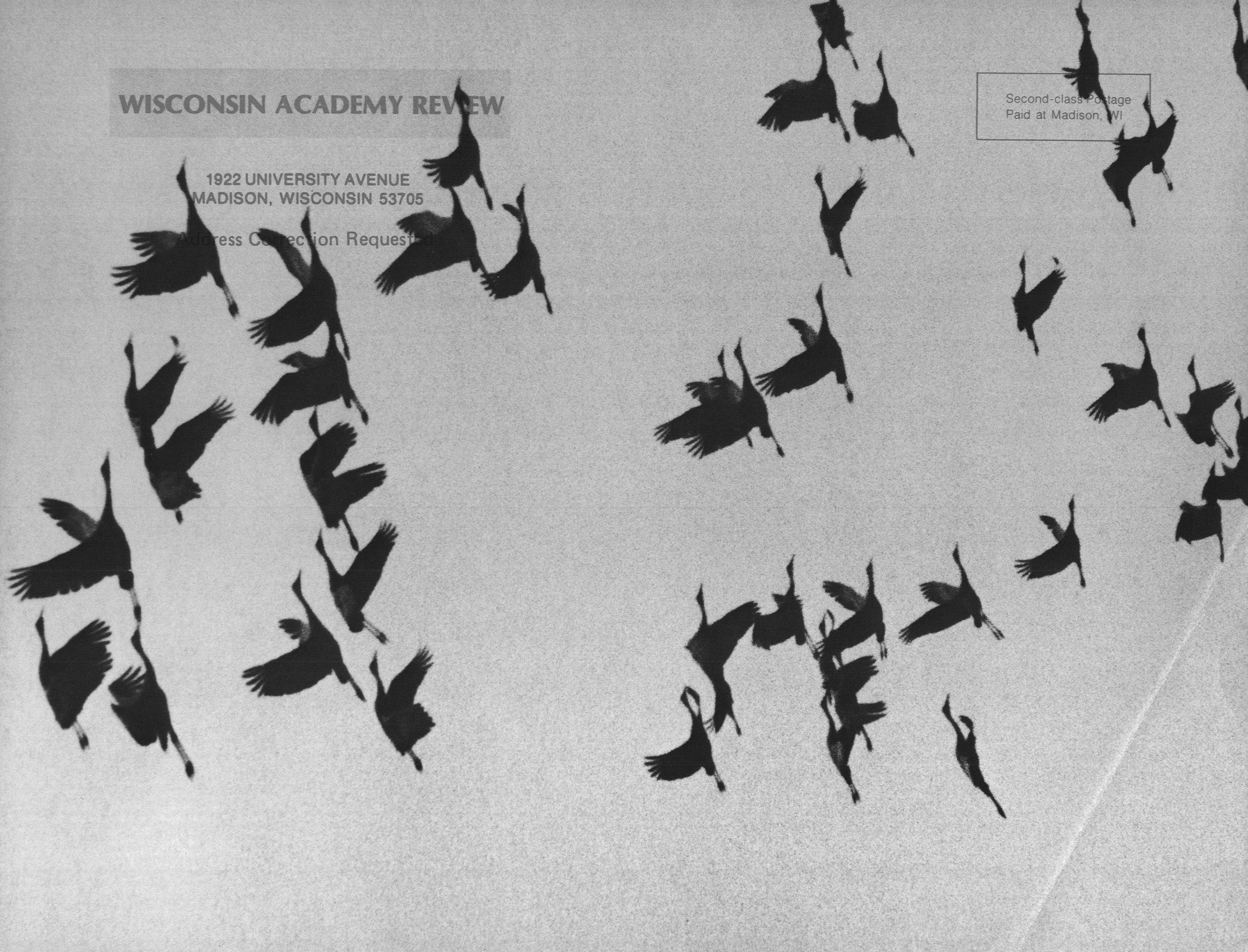
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