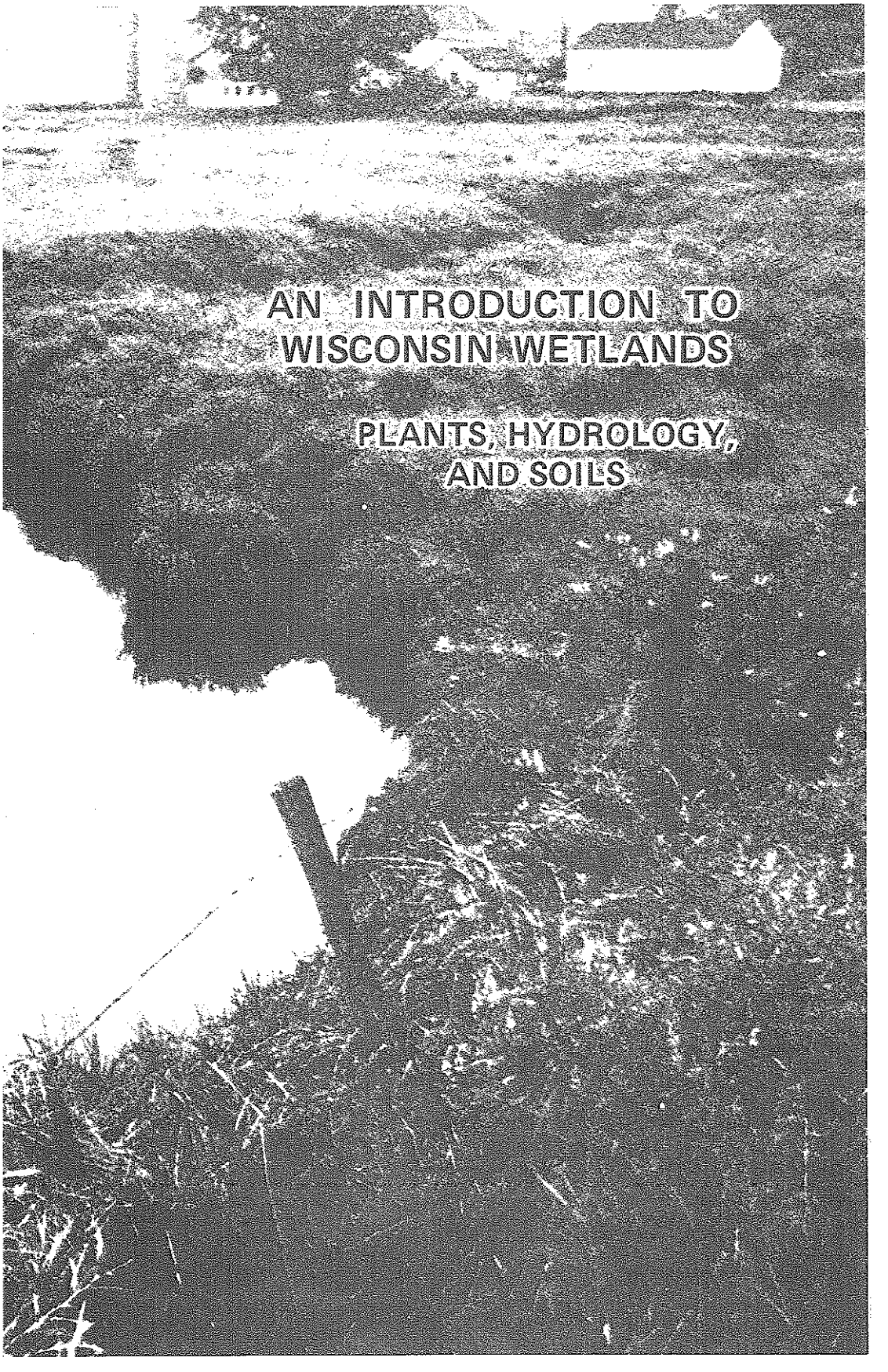

AN INTRODUCTION TO WISCONSIN WETLANDS

PLANTS, HYDROLOGY, AND SOILS

PREPARED BY
UNITED STATES DEPARTMENT OF THE INTERIOR
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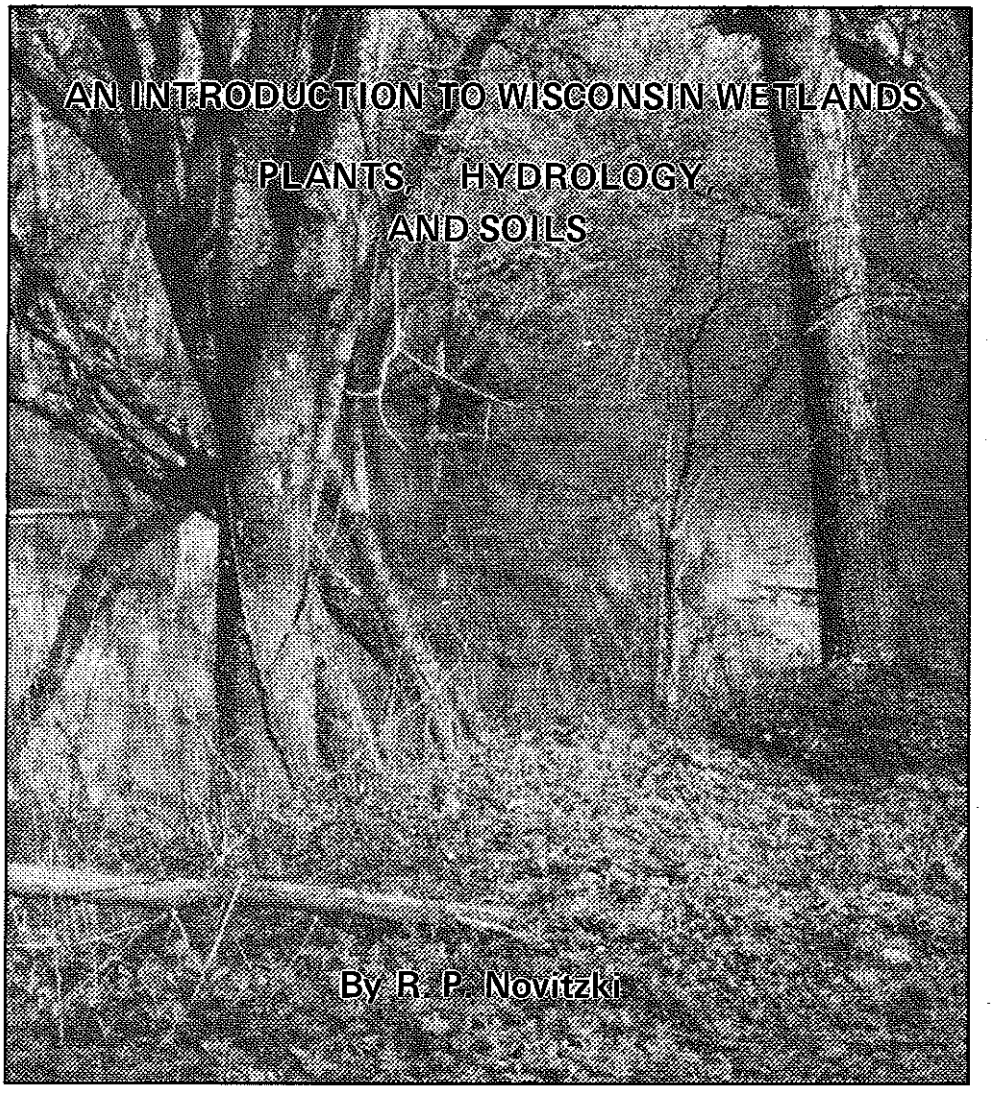

INTRODUCTION

Wetlands are an important part of Wisconsin's landscape. They occur throughout the State, but are relatively scarce in the southwest (Fig. 1). They are not well understood because only recently have they been considered important enough to be studied. This report briefly describes when a wetland is wettest, how deep the water might be, how deep the peat or muck may be, and if and when the wetland may be dry. Later reports will relate the hydrologic characteristics of wetlands to their functions so they may be properly managed as important parts of the environment.

Water is essential to a wetland. The

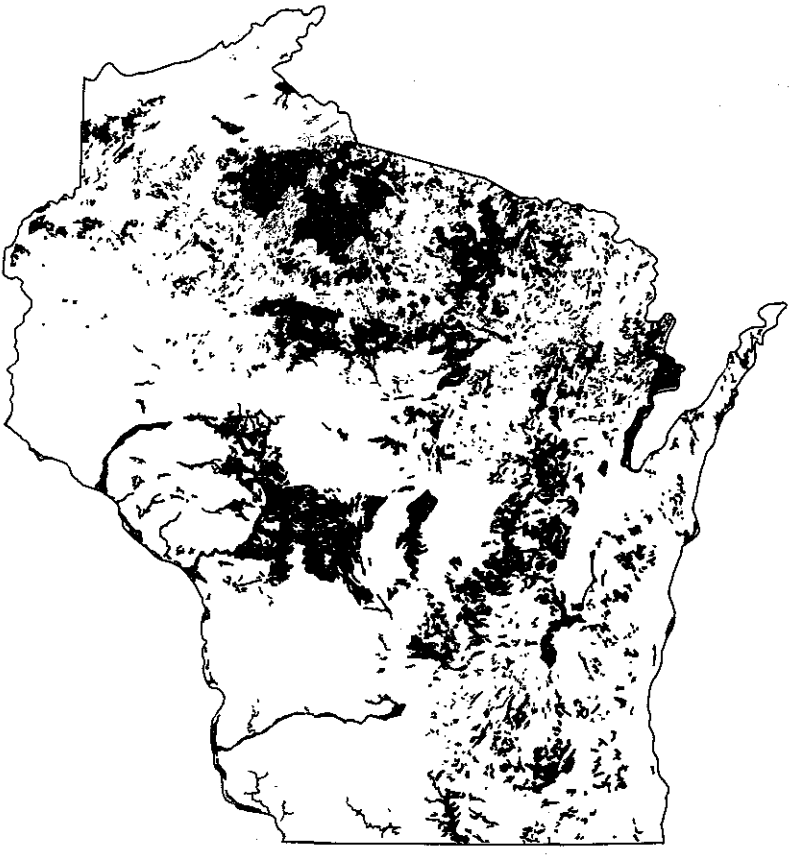

Figure 1. Distribution of wetlands in Wisconsin, based on observations of saturated soils in May, 1974.

water source and the frequency and duration of flooding are the major factors that determine the wetland type. Wetlands may receive mostly surface water (direct precipitation, overland flow, or lake or river floodwaters) or mostly ground water (precipitation that infiltrates and moves through the ground) (fig 2). Surface-water input may be of short duration, whereas ground-water

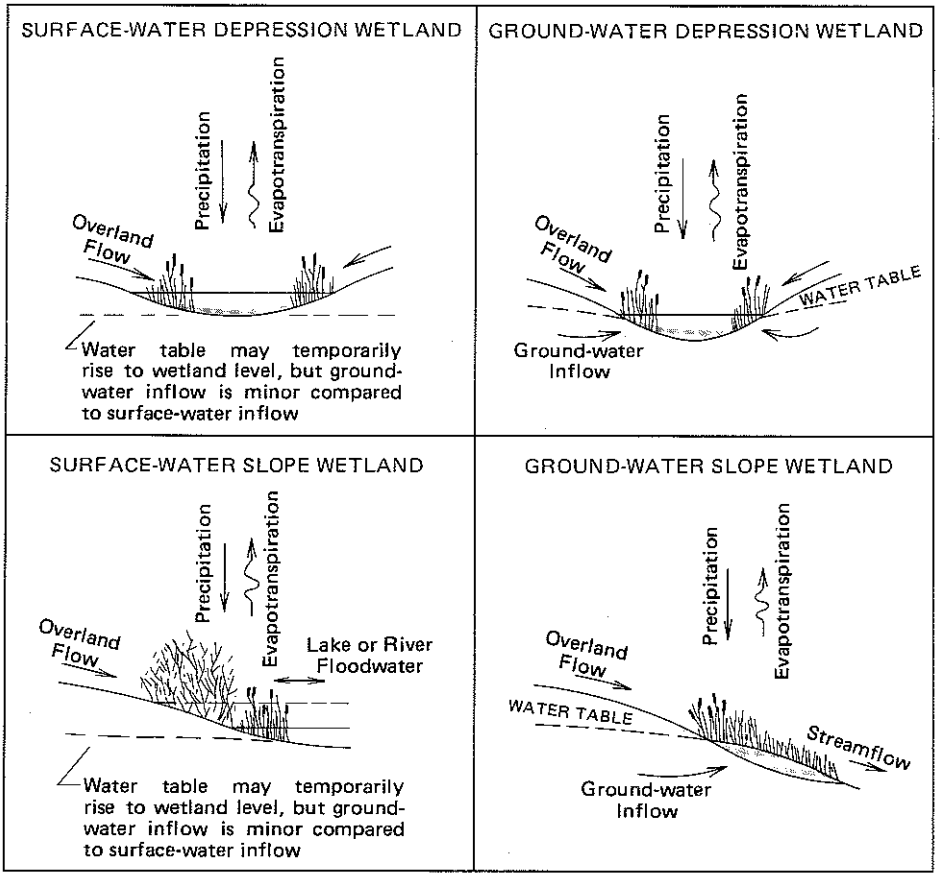

Figure 2. Basic hydrologic characteristics of wetland sites.

inflow is commonly continuous. The wetland may occur in a depression that retains water (fig 2). If the bottom of the depression is always above the local water table, the wetland receives only surface water. If the depression intercepts the water table, it also may receive ground-water inflow. Wetlands also occur on slopes, however, where water is not retained (fig 2). If the wetland is perched above the local water table, the chief input occurs when lake or river waters rise up the slope. Water then drains back down the slope as lake or river stages recede. If the water table intercepts the wetland, continuous ground-water inflow may exceed the short-term input from floodwaters. Ground-water-supported wetlands also occur on slopes above the reach of floodwaters, receiving ground-water inflow and allowing excess water to discharge from the wetland as streamflow. The differences in the wetland's major water source and its topographic setting account for the major differences among wetland types. Hydrologic differences are difficult to determine, however, whereas the basic differences among wetland plant communities are readily recognized.

Through the rest of this report, wetlands are classified on the basis of easily recognized characteristics of the plant community.

Wetlands can easily be separated into grassy, brushy, or forested areas. Grassy areas are so wet in spring and early summer that brush and trees cannot grow there. Brushy areas are typically drier. Forested areas may be very dry, or relatively wet. Flood-plain forests are dry most of the time. However, in forested bogs, cedar swamps, and hardwood swamps, the wetland soils (peat or muck) are wet most of the time. Despite the wet soils, these areas are forested because peat or muck accumulations are so thick that the surface may be dry enough for trees to grow.

Wetland soils (peat or muck) occur in areas wet most of the time, but not in those with flowing water or those dry for part of each year. Muck is brown or black and feels 'oozy' when wet and 'grainy' when dry. It is typically less than 3 feet thick, although in willow, alder, and hardwood swamps it may be more than 15 feet thick. Muck must be quite dry before it will support the weight of a person. Peat is green to brown, and feels 'stringy', whether wet or dry, because it is composed of preserved plant remains. It is typically more than 5 feet thick and may exceed 30 feet. Peat, whether wet or dry, will support the weight of a person except where the mat is floating free at the edge of open water.

Fire has an important role in the development and maintenance of some wetland plant communities. Light burns have little effect, but intense burns remove all vegetation and several feet of peat and cause the wetland to revert to an earlier stage of development. Multiple charcoal layers in peat deposits indicate that peat accumulation and loss by burning occur repeatedly. After burning, a wetland may be somewhat wetter until vegetation is reestablished. However, if the hydrologic characteristics of the wetland site are not changed, the framework remains for the eventual reestablishment of the same type of wetland as was destroyed by the fire.

Man also affects wetlands. Damming, draining, burning, pesticide use, timbering, pasturing, cutting hay, or even berry picking can cause changes in the wetland plant community.

The following discussion of wetland types and their characteristics applies to natural wetland sites, and may not apply to wetlands modified by man.

GRASSY WETLANDS

Grassy wetlands are dominated by grass that is rarely taller than an average person. These include seasonally flooded basins (also called meadows and ephemeral ponds), wet meadows (wet prairies and fens), marshes (sloughs), and sedge meadows (floating mats). A few grassy wetlands occur in shallow depressions wet in spring but completely dry later in the summer. In these, trees and brush are absent because the area is ponded when tree or brush seeds normally germinate. Many grassy wetlands are continuously wet, which is beneficial to the grassy plants but prevents the invasion of brush and trees except along the wetland edge and on drier areas within the wetland.

SEASONALLY FLOODED BASINS (fig. 3) usually contain one common grass, such as reed-canary grass, with only a few weeds such as smartweed, thistle, and nettles. These plants tolerate flooding as well as dry periods. Plants that tolerate wetter conditions such as sedges, cattail, and others described in the following section, occur in the lowest part of the depression. Willow, dogwood, and other brush may invade the wetland edge.

The seasonally flooded basin receives water from snowmelt and spring rains. Rain occurs sporadically through the summer, but once the wetland is dry, ponding recurs only after intense storms. Most of the water is used by the wetland plants, and the rest evaporates or seeps into the ground.

Muck is not common in the seasonal wetland because dead plant remains decompose during the seasonal dry periods. Muck may accumulate in the deep part of the basin that remains wet longer; however, in most wetlands, accumulations are no more than 3 to 5 feet thick. Overland flow may deposit sediment in the wetland.

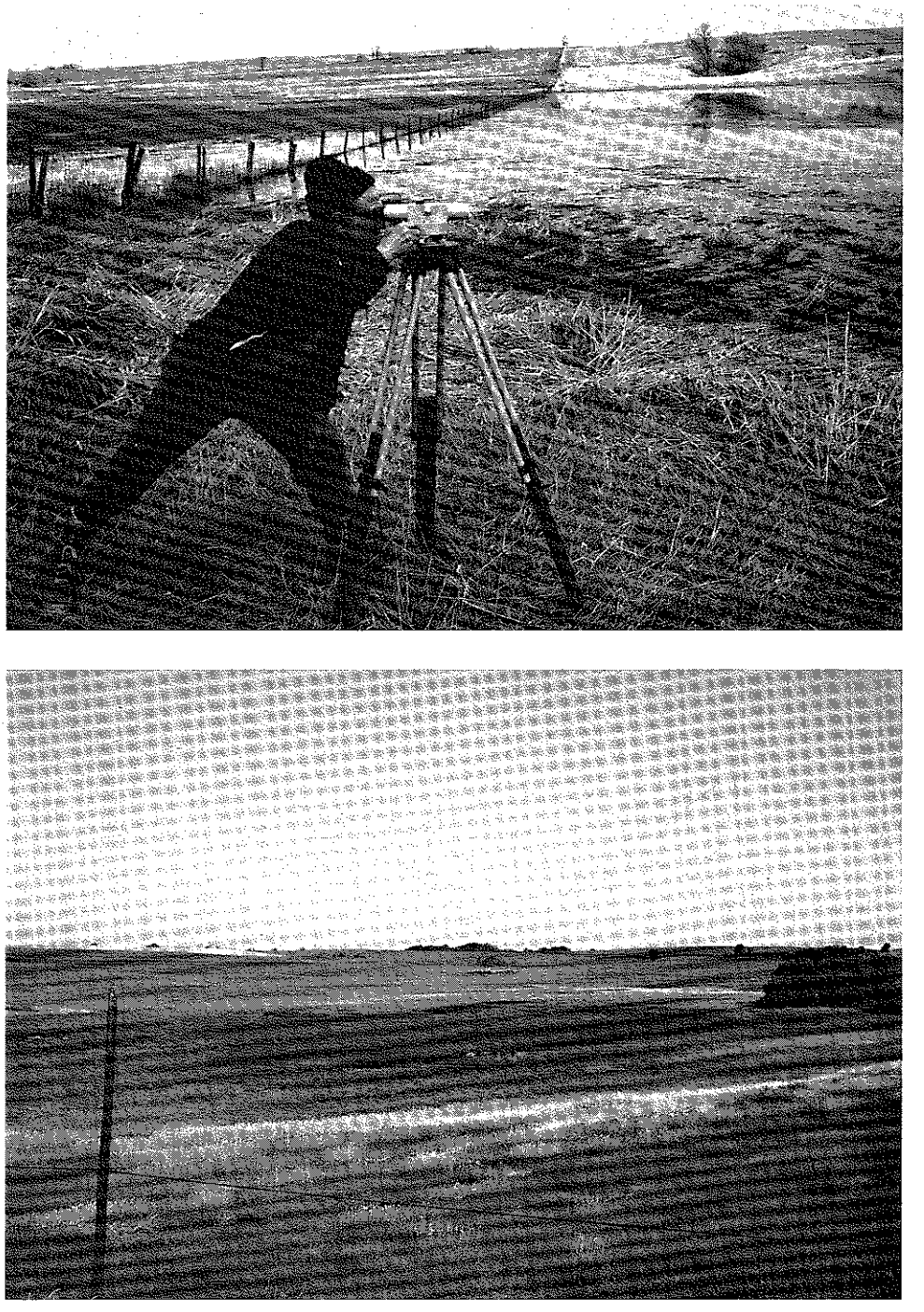

Figure 3. A seasonally flooded basin with ponded water shortly after snowmelt and nearly dry by midsummer.

WET MEADOWS (fig. 4) usually contain a diverse plant community of common grasses, sedges, aster, goldenrod, milkweed, ragweed, thistles, and Joe-pye weed. Willow, dogwood, and other brush may occur along the wetland edge and in drier areas within the wetland.

The meadow usually receives continuous ground-water inflow, occasionally observed as springs along the edge or within the wetland. Ground water not used by the plants or evaporated discharges from the wetland as streamflow. The meadow may occur next to a stream or lake and receive overflow during high lake or stream stages. Meadows seldom occur in small closed basins because ponding lasts too long, and the meadow plants cannot tolerate prolonged flooding. Ground-water inflow to the meadow is several times greater than precipitation on the wetland.

Muck accumulates in the meadow, but rarely more than 3 to 5 feet thick on the average. It may be more than 10 feet thick in small areas within the wetland. The muck is wet most of the time, but water rarely stands at the surface. Because air is in contact with the muck surface much of the time, decomposition occurs and limits accumulation. Overland flow and floodwaters may deposit sediment that is added to the muck accumulation.

Figure 4. A wet meadow showing a diverse plant community in late summer.

Figure 5. A marsh during low water in late summer.

MARSHES (fig. 5) contain cattails, rushes, and reeds in the shallower areas and pond weeds and lily pads in the deeper areas. These marsh plants are usually rooted in mineral soil. Muck may accumulate in the deep-water areas of the marsh, or where water is stagnant. If the muck becomes so thick that the plant roots don't reach mineral soil, a sedge meadow plant community may replace the marsh plants, unless inflow water continues to provide nutrients to the marsh plants. The edge of the wetland shifts as water levels change, and smartweed, thistle, and willow that invade the wetland edge during dry periods are flooded out during wet periods.

Marshes normally have water a few inches to several feet deep, but may fluctuate several feet from wet to dry periods. They occur in depressions and in shallow areas of lakes or shallow reaches of streams where water movement is slow. Those associated with lakes or rivers receive water from the lake or river. Marshes may receive either surface water or ground water, but they seem to occur only where water can flow readily through the wetland.

Muck accumulates in areas of stagnant, or very slowly moving, water. In areas where water moves freely and along the wetland edge that is occasionally dry, decomposition is more complete and muck accumulation is restricted. Marshes in depressions where water levels are very stable may have thicker muck accumulations.

Figure 6. A sedge meadow along a sluggish stream with little seasonal water-level fluctuation.

SEDGE MEADOWS (fig. 6) contain mostly sedges; short, grasslike plants triangular in section (rather than round as are grasses). The sedge is suited to growing on soft muck and is tolerant of flooding. If the muck becomes dry the sedges will die, and grasses, smartweed, thistle, and willow may invade.

The sedge meadow is very wet, for although standing water may be only a few inches deep, the saturated muck may be several feet deep. Water levels may fluctuate only a few inches from early spring to fall. The sedge meadows can occur wherever marshes occur: in shallow areas of lakes or sluggish streams and in depressions. In some places they may succeed a marsh that has filled with muck. Like marshes, the sedge meadows may receive either ground water or surface water, but they seem to occur in areas where waterflow through them is sluggish, enhancing conditions for muck accumulation.

Muck accumulates in stable sedge meadows, but peat accumulates in sedge meadows becoming more like bogs. As the sedge community becomes denser and muck becomes thicker, water movement slows. Stagnant conditions and constant wetness inhibit decomposition and accelerate the accumulation of muck. When decomposition is sufficiently slowed, the sedge plants are preserved as peat, rather than muck. The mat of peat may 'float' upon the underlying wet muck. The mat will support a person, although during high water one can fall through where the mat is thin. If the accumulation of peat becomes thick enough, a brushy bog may replace the sedge meadow.

BRUSHY WETLANDS

Brushy wetlands are dominated by woody plants, generally with multiple stalks and less than 20 feet tall. These include willow swamps, alder swamps, and brushy bogs. The willow swamps usually occupy sites somewhat drier than the wet meadows and marshes. These areas are dry occasionally, allowing the brush seed to germinate and survive. The alder swamps seem to tolerate longer periods of continuous wetness. Brushy bogs may be wet continuously.

WILLOW SWAMPS (fig. 7) may contain nearly all willow or they may include red ossier dogwood, alder, and other brush as well as the willow. Although brush dominates, grasses, wildflowers, and weeds may be present. The plant community tolerates occasional flooding and thrives on moist soil but requires some dry periods each year. It seems to require a large nutrient supply, and usually grows on mineral soil. (Willow may occur within sedge meadows or bogs where recent burning or drying has released nutrients.)

The willow swamp may have water from a few inches to a foot or more deep in spring. This ponded water drains quickly, but the soil may remain wet for days or weeks, and the water table may be near the surface throughout the year. Willow swamps occur along lakes or rivers,, where they receive floodwaters as well as direct precipitation. They also occur in depressions, where they receive precipitation and runoff from the surrounding upland. They may be in contact with the ground-water system, but ground-water levels must be below the wetland part of the year.

Muck accumulates 1 to 3 feet thick in willow swamps that are wet for most of the year, but not in those that are dry for long periods. Willow swamps in depressions with clay or silt bottoms have little flow through them, are wet longer, and are more apt to accumulate muck than those on sandy, well-drained soils next to lakes or rivers. If muck becomes more than about 3 feet thick, an alder or bog community may replace the willow and brush community.

Figure 7. A uniform willow swamp on well-drained sandy soil.

Figure 8. A uniform alder swamp along a sluggish stream with little seasonal water-level fluctuation. The alder swamp is bordered by conifers and hardwoods on the upland.

ALDER SWAMPS (fig. 8) may contain largely alder, or include willow and other brush, sedges, marsh marigolds, skunk cabbage, and ferns. The alder community can occur on mineral soil, or on muck, but the stands comprised largely of alder usually occur on muck more than 5 feet thick. Those separated from mineral soil by thick muck require nutrient import from periodic flooding or from ground-water inflow. Water movement in alder swamps is usually slow, favoring muck accumulation.

Alder swamps may be wet and dry seasonally (those sites with little muck accumulation) or they may be continuously wet. Alder swamps occur along slow, sluggish streams, particularly in the northern part of the State and along the shores of lakes, at the fringe of grassy wetlands and bogs, or in depressions. Alder also occur within sedge meadows and bogs where overland flow, floodwaters, or ground-water seepage provide a source of nutrients, or in areas where recent burning or drying has released nutrients.

Muck may be more than 10 feet thick in the wetter alder swamps that receive slow ground-water inflow. However, muck accumulation may be minimal in wetlands that have good water movement through them and those with seasonal dry periods.

BRUSHY BOGS (fig. 9) contain chiefly leatherleaf, sphagnum moss, cottongrass, and sedges. They occur on peat thick enough to separate them from mineral soil and from the input of nutrients from overland flow or ground-water inflow. They occur within a narrow range of conditions between those that favor the sedge meadow and those that allow a forested bog to develop.

Figure 9. A brushy bog during the spring high-water period. Open water occurs in the central pond and in cracks that resulted during a drought several years earlier.

Brushy bogs are wet except during extreme drought. They occur in depressions or next to streams or lakes, often succeeding marshes or sedge meadows. In spring, water stands less than 1 foot deep between the hummocks of moss and leatherleaf. Standing water is gone by late summer or fall, but the moss remains wet enough that water can be squeezed out of it. The peat absorbs and stores water, but does not readily release it. Although the wetland may receive ground-water inflow, the peat is thick enough so that the wetland surface, except the edges, is well above ground-water levels and receives mostly direct precipitation and occasional overland flow. Open ponds occasionally found in the center of the bogs contain rainwater stored within the confines of the surrounding mass of peat.

Peat accumulates in the brushy bogs, mainly because the acids associated with bog plants and the continuous wetness inhibit decomposition. Peat accumulates when the bog is kept wet, but as precipitation varies from year to year, the bog may be dry enough to allow decomposition. In the absence of fire, peat accumulates until the accumulation during wet periods equals the decomposition during dry periods.

The thick, spongy peat mat appears to 'float' during high water, but it actually overlies many feet of saturated peat and muck. The mat actually floats only where free exchange of water with an open-water area has allowed erosion or decomposition of the muck beneath it. The mat may have openings or trenches over springs and where increased decomposition and erosion occur.

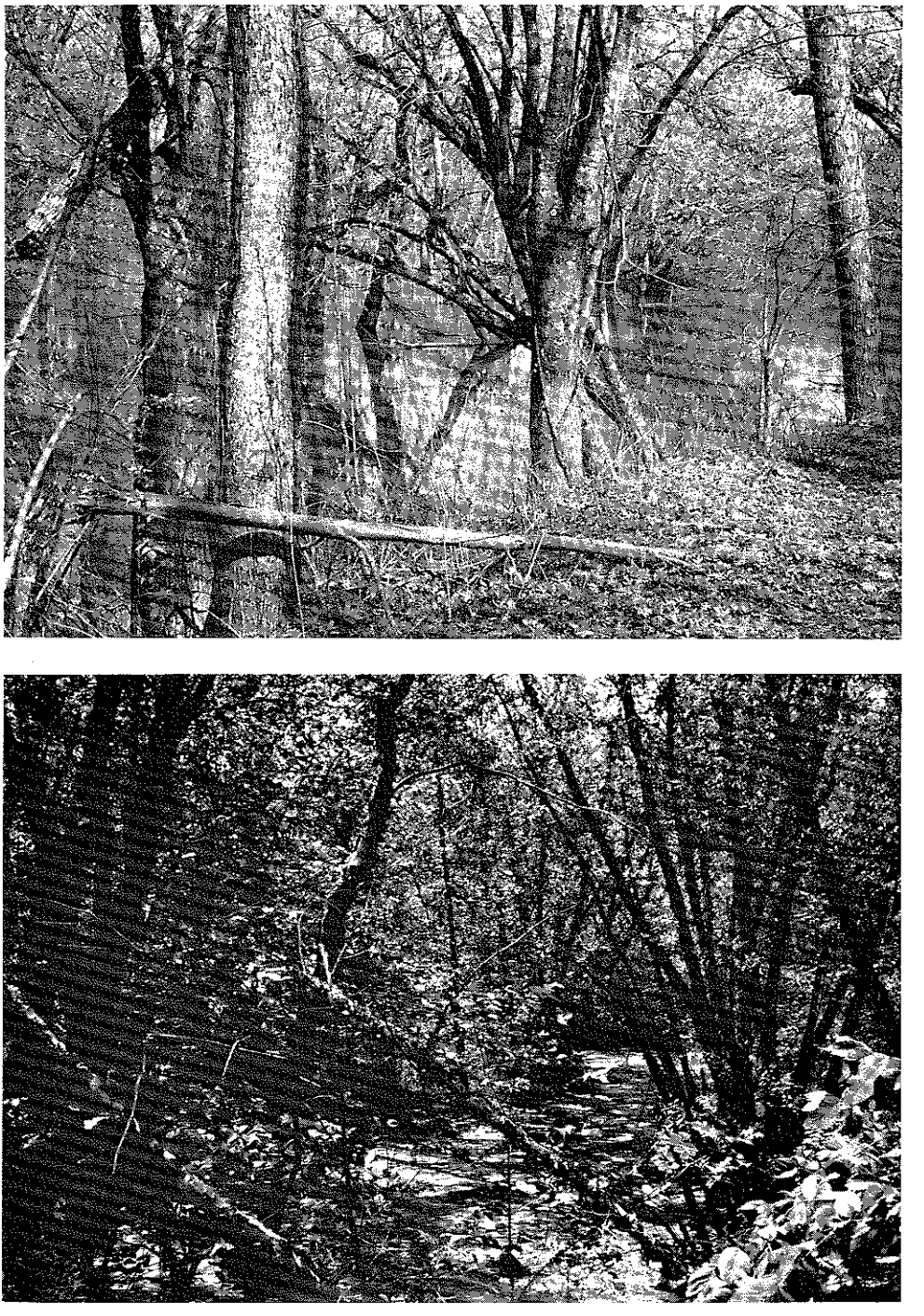

Figure 10. A flood-plain forest during spring high water and later in summer.

FORESTED WETLANDS

Forested wetlands contain mostly trees: woody plants generally having a single trunk and capable of growing more than 20 ft tall. These include flood-plain forests, hardwood swamps, cedar swamps, and forested bogs. The flood-plain forests are found only on the flood plain of rivers, whereas the hardwood swamps, cedar swamps, and forested bogs occur along lakes, rivers, or in depressions.

Trees in wetlands typically have shallow roots. Bogs, cedar swamps, and hardwood swamps generally have water readily available at or near the soil surface throughout the growing season, so tree roots need not be deep. Flood-plain forests are dry most of the time, but ground-water levels may be near the surface, and the trees still are not as deeply rooted as those on upland areas.

FLOOD-PLAIN FORESTS (fig. 10) contain ash, elm, river birch, and other trees, as well as brush and grasses. These plants tolerate occasional flooding. The flood plain generally is comprised of mineral sediments, although muck may accumulate in closed depressions.

The flood-plain forests may have water several feet deep for short periods during flooding, but they are dry for most of the year. Where the flood plain soil is composed of silt or clay, the wetland may remain wet for some time after floodwaters recede, but where the soil is sand and gravel, the wetland may be dry in only a few days. In the well-drained areas, the water table may be several feet below the wetland during much of the year.

Floodwaters deposit sediment in flood-plain forests. Muck is not common, but it may accumulate where flow is slowed and water stagnates, particularly in depressions within the flood plain.

HARDWOOD SWAMPS (fig. 11) contain black ash, elm, yellow birch, and other trees, along with some brush and grasses. These plants generally occur on muck. They tolerate occasional flooding from precipitation and overland runoff. However, ground-water inflow can be a significant source of nutrients to the wetland.

Figure 11. A hardwood swamp containing ponded water just after the snowmelt.

Figure 12. A cedar swamp, covered by peat and moss, with an open area that traces the course of a springfed stream.

The hardwood forest may be flooded to depths of several feet for short periods, but the water drains quickly to surface drainageways. The wetland surface may become dry, but the underlying soil (muck) that fills the depression in which the wetland formed remains wet most of the year. The muck also may receive ground-water seepage, and these wetlands will typically be wet in the fall after the growing season as well as in the spring.

Muck may be more than 10 feet thick in these wetlands. The muck accumulates in depressions up to the level of the surface drainageways, but no higher. Overland flow deposits sediment, which is incorporated into the muck deposits.

CEDAR SWAMPS (fig. 12) contain cedar, spruce, balsam fir, and yellow birch, as well as brush, grass, and ferns. These plants favor sites that are wet most of the time but tolerate infrequent flooding. They root in mineral soils, although they also occur on thin muck or peat. In many cedar swamps the mineral soil is stony.

Cedar swamps are rarely flooded, but the underlying muck is wet throughout the year. They occur on slopes where water is allowed to drain to lakes and rivers. They require significant nutrient input, and, although the nutrients supplied by overland runoff may be adequate for the smaller, narrower swamps, they usually occur where they receive considerable ground-water inflow.

Muck and peat is generally no more than 2 or 3 feet thick, although it may exceed 10 feet thick in small isolated areas within the wetland, particularly near springs. Greater thicknesses of muck and peat occur where large ground-water inflow occurs and provides nutrients to the vegetation. If muck accumulation inhibits ground-water inflow, a hardwood swamp or forested bog may replace the cedar swamp.

FORESTED BOGS (fig. 13) contain tamarack, black spruce, jackpine, bog birch, leatherleaf, cranberries, cottongrass, and sphagnum moss. These plants are suited to sites where precipitation is the chief source of water and nutrients are scarce.

The forested bogs are rarely flooded but are wet most of the time. They occur along lakes and sluggish rivers and in depressions. The bogs occur on peat deposits many feet thick; so thick that they may swell or contract several feet as water content increases or decreases. Although the wetland may receive ground-water inflow, the peat is thick enough that the surface is well above ground-water levels and receives mostly direct precipitation and occasional overland flow.

Peat accumulates in forested bogs. Continual wetness, acids associated with the bog plants, and little movement of water through the wetland minimize decomposition of plant remains. The peat and muck may be more than 30 feet thick in some bogs. However, peat accumulation depends upon the balance between wet and dry periods because decomposition during prolonged drought may offset accumulation during wet periods.

WETLANDS AND CLIMATE

Precipitation provides water to Wisconsin wetlands, and climatic variations that affect precipitation also affect wetlands. Surface-water wetlands respond to climatic changes differently than ground-water wetlands. Surface-water wetlands are wettest in years when snowmelt produces much surface runoff and rains occur frequently throughout the summer. Ground-water wetlands are wettest in years when little surface runoff occurs during snowmelt but ground water is recharged and water tables are high.

Figure 13. A forested bog with a transition fringe of brushy bog between it and upland.

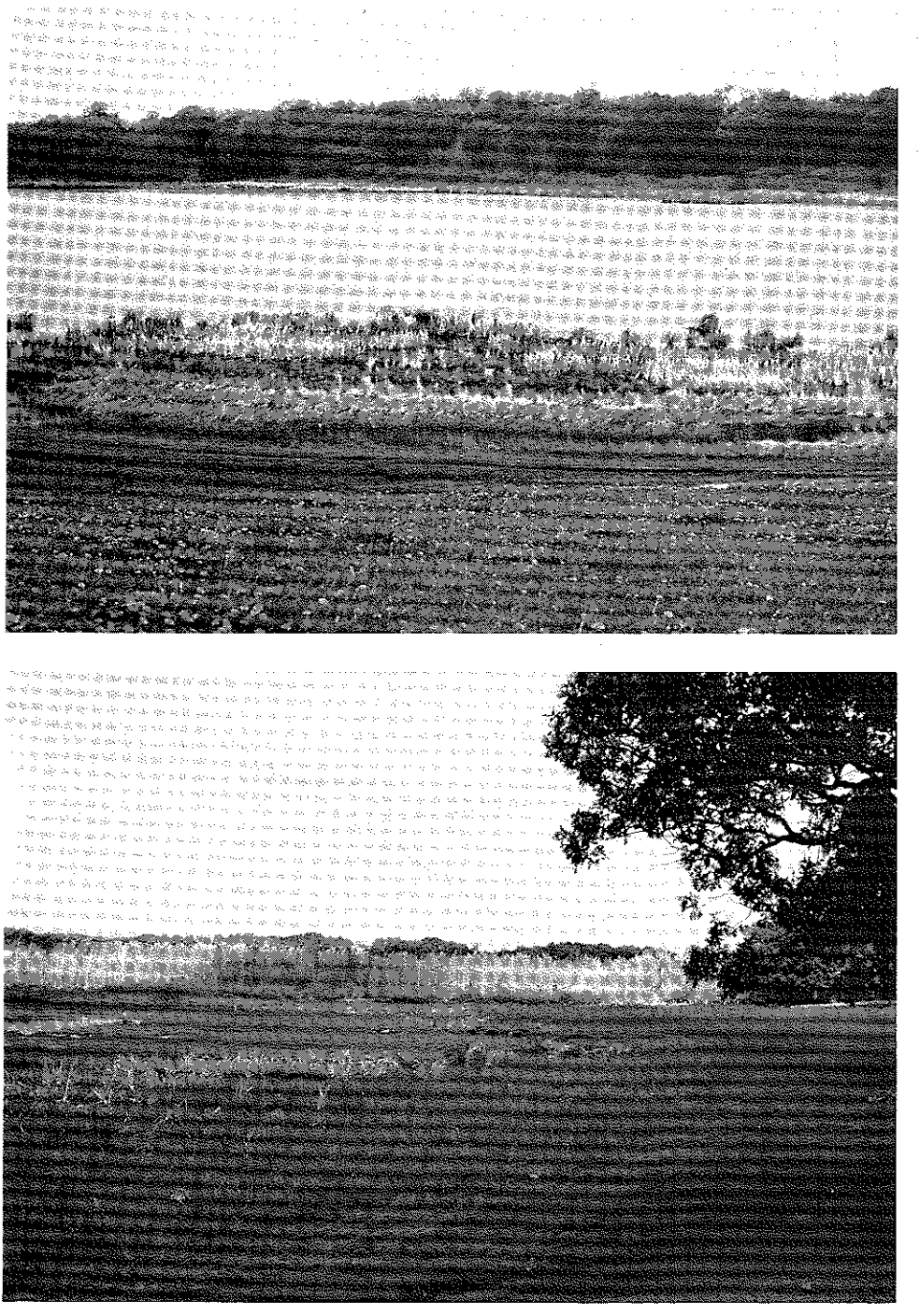

Figure 14. A lake-edge marsh during high water 1975 and low water 1977.

Large changes in water supply to a wetland site significantly affect the wetland plants. Trees were drowned and died in many wetlands in central Wisconsin during the years of high ground-water levels (1973-75). Conversely, some wetland sites were very dry during the drought from mid-1975 to early 1977, and cattails, marsh grasses, and sedges dried out and were replaced by upland grasses and weeds. Figure 14 shows a lake-edge marsh during wet and dry periods. The cattails that are in standing water in May 1975 are left nearly 100 feet from the lake edge by August 1977. Fires are more frequent and more intense during droughts. Figure 15 shows a marsh fire that occurred during the drought (1976). The fire has burned down to the sand beneath the muck.

Changes in wetland plants and wetland boundaries must be expected as climate changes. However, these changes are cyclical, whereas manmade changes, particularly damming or draining, may cause permanent changes in the hydrologic characteristics, vegetation, and soil formation process at the site.

WETLAND FUNCTIONS

Most wetlands, whether surface-water or ground-water supported, occur in low areas where they receive precipitation and overland flow and possibly floodwaters from lakes and rivers. Water stored in wetlands reduces flood peaks in rivers; however, much of the water from river-edge and lake-edge wetlands drains back to the river or lake as stages fall. Wetlands retain much of the sediment carried into them. Nutrients are retained in those wetlands where muck or peat accumulates (they are recycled in those where decomposition releases nutrients for new plant growth).

Figure 15. A marsh fire in early fall during the 1976 drought.

Most wetlands in Wisconsin appear to occur in contact with the ground-water system. Wetland occurrence often indicates an available ground-water supply. These wetlands may not use all the water available, and the excess water may discharge as streamflow out of the wetland. However, this streamflow comes from the ground-water system, not from the wetland itself.

Wetlands are water-use areas. Evapotranspiration rates in wetland areas may be twice as great as those in upland or open-water areas. Under some conditions, the ground-water system may receive limited recharge from wetlands. However, wetland soils are typically less permeable than the sandy soils associated with ground-water-recharge areas, so recharge from wetland areas will be less than from other areas. Most wetlands occur where water is discharging to the surface from the ground-water system.

CONCLUSIONS

Different wetland plant communities result from hydrologic differences at the wetland site. Wisconsin's wetlands are supported by precipitation, either directly by surface water or indirectly by ground water. Wetlands receive precipitation and water discharged from the ground-water system, as well as some water trapped in depressions or temporarily stored in flood plains during lake or river flooding. Wetlands rarely are ground-water recharge areas.

Wetlands are constantly adjusting to variations in precipitation, lake and river stages, and ground-water levels. Most of Wisconsin's wetlands represent a balance between the natural factors that affect the hydrology, the vegetation, and peat and muck accumulation at each wetland site. The factors in balance include water-level fluctuations, cycles of wet and dry periods, relative amounts of surface-water and ground-water inflow and outflow, nutrient transport into and out of the wetland, water movement through the wetland, frequency and intensity of fires, as well as others. Although these balances shift naturally, if man causes unnatural shifts, a change in the wetland can be expected. We still have a great deal to learn about how wetlands function and how they respond to change.

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Additional wetland information is contained in two series of publications, "Surface-Water Resources of ——— County" or "——— County Wetlands", available through the Wisconsin Department of Natural Resources, Madison, Wisconsin 53705.

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This report is a product of the Geological and Natural History Survey Water Resources Program which includes: systematic collection, analysis, and cataloguing of basic water data; impartial research and investigation of Wisconsin's water resources and water problems; publication of technical and popular reports and maps; and public service and information. Most of the work of the Survey's Water Resources Program is accomplished through state-federal cooperative cost sharing with the U.S. Geological Survey, Water Resources Division.

Available from University of Wisconsin—Extension, Geological and Natural History Survey, 1815 University Avenue, Madison, Wisconsin 53706.