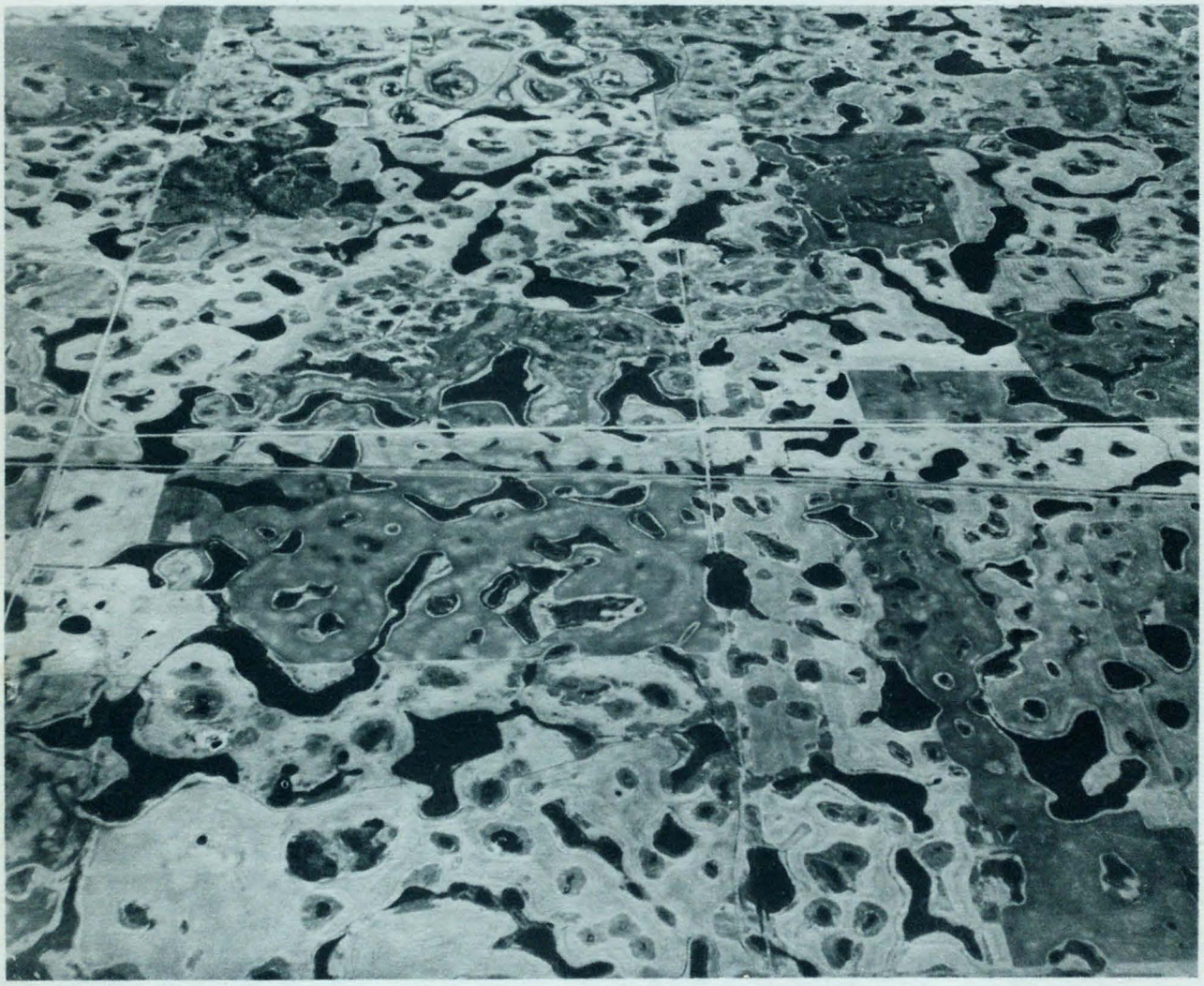
CLASSIFICATION OF NATURAL PONDS AND LAKES IN THE GLACIATED PRAIRIE REGION



UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

CLASSIFICATION OF NATURAL PONDS AND LAKES IN THE GLACIATED PRAIRIE REGION

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CLASSIFICATION OF NATURAL PONDS AND LAKES IN THE GLACIATED PRAIRIE REGION

INTRODUCTION

The wetland classification system for the United States adopted by the Bureau of Sport Fisheries and Wildlife in 1953 is described by Martin et al. (1953) and by Shaw and Fredine (1956). That classification has been followed by many biologists in recent years and is especially useful in categorizing in a general manner the wetlands throughout the country over a span of years. It has become apparent, however, that for research and intensive management a dynamic classification system that more precisely reflects seasonal, regional, and local variations in the environment is needed. To establish a detailed wetland classification system for all of North America will require intensive ecological investigation of wetlands in each of the major biogeographical regions.

During the past 40 years several classification systems have been applied to wetlands in the glaciated prairie region of the United States and Canada. Metcalf (1931) used a system based on salinity and vegetation to differentiate several types of prairie ponds and lakes in North Dakota. Hayden (1943) followed the concepts of ecological succession and classified Iowa wetland communities according to their position in the evolutionary sequence from early hydroseres to prairie climax. Bach (1950) described a system of wetland types in North Dakota on the basis of their longevity or permanency. Nord, Evans, and Mann (1951) evolved a "chain type" wetland classification using Bach's permanency types in combination with a series of other factors including density, distribution, and species composition of marsh plants when classifying wetlands in Minnesota, North Dakota, and South Dakota. Leitch (1966), using Bach's basic permanency types and the criteria employed in the system of Nord, Evans, and Mann, added various physical, ecological, and historical factors when describing wetlands in Canada.

Mason (1957) presented a classification outline for wetlands based on a sequence of environmental factors treated in order of decreasing importance and including water movement, water permanence, relation of cover to open water, and water chemistry. Millar (1964) proposed a complex system for the prairie wetlands of Canada which combined the vegetational factors used by Stewart and Kantrud (1963) with topographic features, including basin area, capacity, drainage, and configuration.

The system of Martin et al. (1953) currently used by the Bureau of Sport Fisheries and Wildlife is based primarily on water depths during the growing season, cover interspersion, and occurrence of certain groups or species of wetland plants. Evans and Black (1956) combined the system of Bach with that of Martin et al. for adaptation to South Dakota wetlands. Extensive field experience has shown that the classification system of Martin et al. is too general for detailed investigations of wetlands. It has often been misinterpreted by placing too much emphasis on water depth and cover interspersion. Water depth of a given wetland type varies considerably; by itself it is generally a poor indicator of prairie wetland types and should not be equated with water permanence. Water depths and related stages of cover interspersion often change drastically from year to year and season to season because of unstable climatic conditions. The descriptions by Martin et al. of water relationships of the designated types found in the glaciated prairie region do not always correspond to the habitat requirements of the characteristic plant species listed. Lastly, insufficient distinction is made of the complex of vegetational zones within wetlands and of the particu-

lar relations of vegetation to various environmental factors.

Our ecological investigations of wetlands in central North Dakota from 1961 through 1966 indicate that the use of prairie ponds and lakes by waterfowl is strongly influenced by water permanence, depth, and chemistry, and by land use. Although these factors are complex and interrelated, any marked variations are usually reflected in differences in life form, cover interspersion, species composition, and species dominance. These vegetational differences are readily discernible in the field, and they have been used as the principal criteria in the classification system described here. This publication supersedes a preliminary paper on this subject (Stewart and Kantrud, 1969).

For purposes of this publication, natural ponds and lakes refer to wetlands occurring in natural undrained basins or kettles. Ponds are arbitrarily defined as natural nonfluvial wetlands less than 50 acres in area; lakes are larger than 50 acres. Other wetland types in the glaciated prairie region are not covered by this classification; they include natural fluvial habitats and manmade wetlands such as stock ponds, dugouts, reservoirs, and sewage lagoons.

The glaciated prairie region includes parts of the northern prairies in the Central Lowland and Great Plains which were covered with glacial drift deposits during the middle advances of the Wisconsin stage glaciation (Lemke et al. 1965). It is characterized by numerous undrained depressions and is well represented in southern Alberta, southern Saskatchewan, extreme southwestern Manitoba, extreme northeastern Montana, northern and east-central North Dakota, eastern South Dakota, and small portions of western Minnesota and northwestern Iowa. The glaciated prairie region referred to here does not include the contiguous transitional belt of aspen parkland, which is usually considered to be an ecotone between prairie and boreal forest.

While the system of Martin et al. does not provide a precise, dynamic classification of prairie wetlands, it has been used to categorize in general terms the average long-term condition of the most common prairie wetlands. Furthermore, it is referred to in certain legal documents (Public Law 87–732 and the Reuss Proviso of the Agricultural and Related Agencies Appropriations Acts, 1963 et seq.) and must be used for classification purposes, until otherwise modified, in matters concerning Federal drainage referrals for all wetland types in the Dakotas and Minnesota and for Types 3, 4, and 5 wetlands nationwide. The system described here, however, can be applied in either a detailed or a broad manner, as explained in the section on Application of the Classification System. A broad interpretation of this classification would correspond to the system of Martin et al., and would be no more difficult to apply. It would also have the advantage of providing a more precise and realistic means of ecologically classifying wetlands in the glaciated prairie region. While most readily applied to conditions existing at the time of a survey, it can be used during the nongrowing season to interpret conditions during the previous growing season. When applied in a year of average water conditions or over a span of years encompassing the full range of conditions, it may be used to accurately determine the average class of a wetland and thus meet the classification requirements imposed by current legislation.

VEGETATIONAL ZONES IN PRAIRIE PONDS AND LAKES

Wetland vegetation in prairie ponds and lakes can be grouped into zones each characterized by a different community structure or life form and a distinct assemblage of plant species. These vegetational zones, which will be described presently, are designated as follows:

Wetland-low-prairie zone.
Wet-meadow zone.
Shallow-marsh zone.
Deep-marsh zone.
Permanent-open-water zone.
Intermittent-alkali zone.
Fen (alkaline bog) zone.

In each zone, characteristic plants may be found as a general mixture or may be represented by one or more distinct associations, each composed of one or more species. These zones are closely related to differences in water permanence, modified by permeability of bottom soils and influence of ground water. Certain wetlands contain only one zone; others contain two, three, or more zones. In wetlands with two or more

zones, one zone usually occupies the central, deeper part of the pond basin, while the others occur as concentric peripheral bands. **The presence or absence and the distributional pattern of the zones are the primary factors used in distinguishing the major classes of wetlands.**

PHASES OF THE VEGETATIONAL ZONES

In ponds and lakes with undisturbed bottom soils, most of the vegetational zones are each represented by two or three distinct phases that frequently alternate when there are appropriate fluctuations in water level or changes in intensity or frequency of certain land-use practices. Within each vegetational zone of a pond or lake, two or three phases may occur at the same time. These phases are as follows:

Normal emergent phase.—In deep-marsh and fen zones, and in normal untilled wetland-low-prairie, wet-meadow, and shallow-marsh zones, emergent vegetation composed chiefly of biennial or perennial species is usually of regular occurrence. Plant growth extends above the water surface or dry bottom soil and often forms a canopy or overstory. Subdominant species occur under the emergent cover.

Open-water phase.—Open water without vegetation or without emergent plants extending above the water surface may occur in all zones. In the open-water phase of shallow-marsh, deep-marsh, permanent-open-water, intermittent-alkali, and fen zones, submerged or floating aquatic plants are often present.

Drawdown bare-soil phase.—As surface water in the open-water phase gradually recedes and disappears, expanses of bare mud flats, which often become dry, are exposed. Ordinarily, this phase is of short duration, but in intermittent-alkali zones and occasionally in the more saline deep-marsh zones it may persist for considerable periods.

Natural drawdown emergent phase.—Undisturbed areas with emergent drawdown vegetation are considered to be in this phase. This growth is composed mostly of annual plants, including many forbs, that germinate on the exposed mud or bare soil of the drawdown bare-soil phase. After the drawdown emergents become established, surface water is occasionally restored by heavy summer rains.

A typical sequence of wetland phases as they occur under variable water conditions in undisturbed ponds is shown in figure 1.

In ponds and lakes in cropland areas, the wetland-low-prairie, wet-meadow, and shallow-marsh zones are frequently cultivated when they become dry. This results in the development of early successional plant communities that differ markedly from those of undisturbed soils. Following cultivation, these early seral communities often retain their characteristics for a year or two. The open-water phase and drawdown bare-soil phase are of common occurrence in vegetational zones that have been disturbed in this manner. In addition, a cropland drawdown phase and a cropland tillage phase are often present. These are as follows:

Cropland drawdown phase.—Tilled pond bottoms with drawdown vegetation characterize this phase. The plants include many coarse introduced annual weeds and grasses that normally develop on exposed mud flats during the growing season. These species appear as overwater emergents whenever surface water is restored by summer rains.

Cropland tillage phase.—In this phase are tilled bottom soils dominated by annual field weeds, characteristic of fallow or neglected low cropland. Tilled dry pond bottoms devoid of vegetation are also considered to be in this phase. Planted small grain or row crops are often present.

PLANT SPECIES COMPOSITION AND DIFFERENCES IN SALINITY OF SURFACE WATER

Important differences in species composition of the characteristic plant associations within zones are correlated with differences in average salinity of surface water. Distinctive associations of plants may be classified as fresh, slightly brackish, moderately brackish, brackish, subsaline, or saline, although measurements of specific conductance (micromhos/cm^3) used to indicate differences in salinity of water were found to fluctuate widely within many ponds or lakes. Reduction in specific conductance appeared to be related to dilution caused by increasing water depth and occasionally to periodic overflow. Rising water levels result from accelerated inflow from surface runoff in combination with precipitation directly on ponds. An increase in specific conductance was usually associated with losses in water depth caused by evapotranspira-

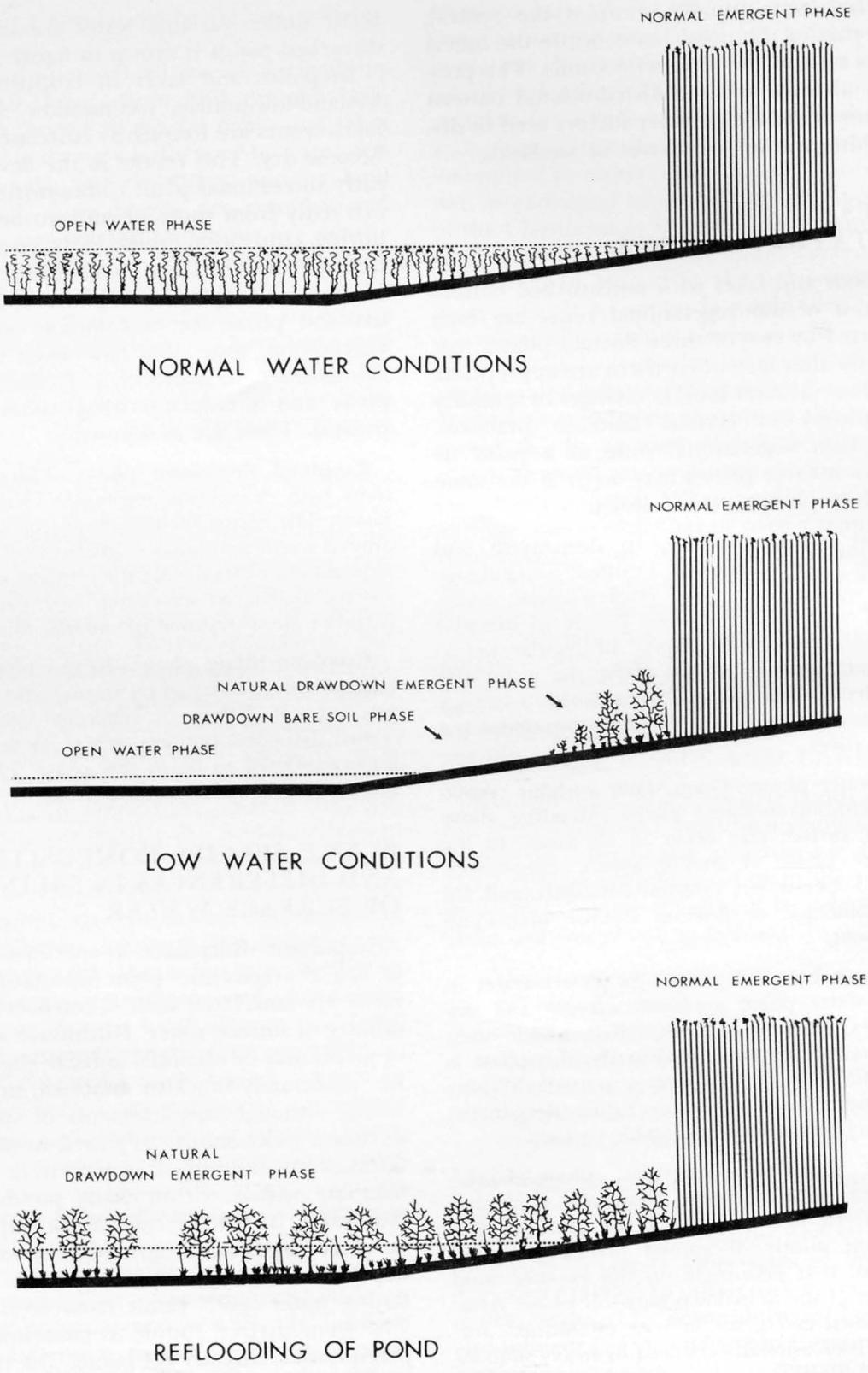

Figure 1.—A typical sequence of wetland phases as related to different water conditions.

tion, or with a greater inflow from ground-water seepage or springs resulting from rising water tables. Many of the plant associations that are indicative of average differences in salinity also persist temporarily over widely overlapping ranges of salinity. Since unstable water conditions are characteristic of most prairie ponds and lakes, plant associations proved to be more reliable indicators of average salinity than single measurements of specific conductance.

Fluctuations in specific conductance are less pronounced during average or normal water conditions than during periods of excessive water depth or extreme drought. The approximate normal and extreme ranges in specific conductance (micromhos/cm^3) of surface water in plant communities that are indicators of differences in average salinity are as follows:

Plant community:	*Normal range*	*Extreme range*
Fresh	<40– 500	<40– 700
Slightly brackish	500– 2,000	300– 2,200
Moderately brackish	2,000– 5,000	1,000– 8,000
Brackish	5,000– 15,000	1,600– 18,000
Subsaline	15,000– 45,000	3,500– 70,000
Saline	45,000–100,000+	20,000–100,000+

The influence of salinity and other environmental factors, including grazing, mowing, and burning, on vegetation of prairie ponds and lakes is treated in more detail by Stewart and Kantrud (in press).

DESCRIPTIONS OF THE VEGETATIONAL ZONES

The vegetational zones recognized in prairie ponds and lakes are described as follows:

Wetland-low-prairie zone.—In certain types of basin wetlands, low-prairie vegetation may occupy the central area of a pond. Occasionally in deeper ponds and lakes with other zones, a narrow border of surrounding low prairie is inundated during unusually high water. Because of the porous condition of the soil in this vegetational zone, the rate of bottom seepage is very rapid. As a result, surface water ordinarily is maintained for only a brief period in the early spring before the bottom ice seal disappears. Measurements of specific conductance (micromhos/cm^3) of surface water in low-prairie plant associations in central areas of pond basins indicate that these species are characteristic of fresh water.

In natural untilled low-prairie zones, a normal emergent phase, with low-prairie plants, occurs regularly. Occasionally in the early spring, when water levels rise above the tops of low-prairie plants, an open-water phase without submerged aquatic plants develops. Under agricultural use, the cropland tillage phase nearly always persists as dry tilled soil, with or without weedy plant growth or crops. Tilled low-prairie zones may also appear briefly in the open-water phase during extremely high water conditions. Typical plant species found in normal emergent and cropland tillage phases of wetland-low-prairie zones are listed under Class I in appendix A.

Wet-meadow zone.—Wet-meadow vegetation occupies the central areas of many of the shallower pond basins and commonly occurs as a peripheral band in most of the deeper ponds and lakes. Water loss from bottom seepage is fairly rapid in this zone, so that surface water usually is maintained for only a few weeks after the spring snowmelt and occasionally for several days after heavy rainstorms in late spring, summer, and fall. Wetland phases in untilled wet-meadow zones include a normal emergent phase with typical wet-meadow plants occurring as emergents, and an open-water phase that develops only when water levels rise above the tops of wet-meadow plants. Most of the more numerous plant species in the normal emergent phase are fine-textured grasses, rushes, and sedges of relatively low stature. Under cultivation a wet-meadow zone in early spring normally has an open-water phase without submerged aquatic plants; this is soon replaced by a drawdown bare-soil phase unless old-growth plants from previous years are present. Shortly afterwards, typical species of the cropland drawdown phase appear. A similar sequence of phases may take place later in the season, particularly when surface water is temporarily replenished or when there is repeated cultivation. Cultivation of dry bottom soils results in the appearance of the cropland tillage phase.

Wet-meadow zones in the central areas of shallow pond basins are restricted to fresh or slightly brackish wetlands, while peripheral bands of wet-meadow zone frequently occur in deeper, more permanent ponds or lakes with salinity ranging from fresh to subsaline. Characteristic species of plant associations in the normal emergent phase and cropland drawdown phase differ markedly, and major differences in species composition within the normal emergent phase may be correlated with variations in salinity (species listed in appropriate divisions under Classes II, III, and IV in appendix A.

Shallow-marsh zone.—Shallow-marsh vegetation dominates the central areas of pond basins that normally maintain surface water for an extended period in spring and early summer but frequently are dry during late summer and fall. In the deeper, more permanent ponds and lakes, this zone often occurs as a concentric band between wet-meadow and deep-marsh zones; in shallow alkali ponds and lakes it may occur as a band between wet-meadow and intermittent-alkali zones.

Under natural untilled conditions, this zone is represented by four wetland phases: a normal emergent phase of regular occurrence; an open-water phase, often with submerged aquatic plants, occurring during high water; and a natural drawdown emergent phase, occasionally preceded by a drawdown bare-soil phase that develops during periods of low precipitation. Typical dominant species in the normal emergent phase are grasses or grasslike plants that are intermediate in height in comparison with emergent plants in the normal emergent phase of wet-meadow and deep-marsh zones.

Wetland phases occurring when this zone is tilled include the following: an open-water phase, with or without submerged aquatic plants, which is generally present during the spring and occasionally present after heavy rainstorms in summer and fall; a drawdown bare-soil phase, developing as open surface water disappears; a cropland drawdown phase that becomes established on exposed mud flats, particularly during late summer and fall; and a cropland tillage phase immediately following cultivation. Whenever surface water is maintained for a considerable period in late spring and summer, a distinctive normal emergent phase characteristic of the tilled shallow-marsh zone occurs. This phase is composed of pioneering shallow-marsh species that also appear, although less commonly, in the normal emergent phase of natural untilled shallow-marsh zones.

Shallow-marsh zones occurring in central areas of pond basins are largely restricted to fresh, slightly brackish, or moderately brackish ponds or lakes. In the deeper, more permanent ponds and lakes, the concentric bands of shallow marsh adjoining the more centrally located deep-marsh zones are of regular occurrence throughout the range of salinity, from fresh to subsaline. Tillage of shallow-marsh zones ordinarily occurs only in fresh, slightly brackish, and moderately brackish ponds. Outer bands of shallow marsh in strongly saline alkali lakes are subsaline, in contrast to the greater salinity of the central open areas. Surface water in brackish and subsaline shallow marsh tends to be shallower and less permanent than surface water in shallow-marsh zones of the fresher ponds and lakes. Nevertheless, the spatial relation of shallow marsh to wet meadow and deep marsh remains the same, regardless of salinity.

Differences in species composition are quite pronounced between shallow-marsh plant associations characteristic of untilled and tilled conditions, and among emergent, open-water, natural drawdown, and cropland drawdown phases of this zone. More subtle differences within each phase may be represented as a continuum of overlapping species that is correlated with differences in salinity. The characteristic plant associations occurring under these variable conditions are listed in appropriate divisions under Classes III and IV in appendix A.

Deep-marsh zone.—Deep-marsh vegetation dominates the central areas of pond basins that ordinarily maintain surface water throughout the spring and summer and frequently maintain surface water into fall and winter. Deep-marsh zones usually occur also as marginal bands that adjoin the deep permanent-open-water zones of permanent ponds and lakes.

Four wetland phases are represented in this zone: a normal emergent and an open-water phase, both of regular occurrence, and a drawdown bare-soil (nonvegetated) phase and a natural drawdown emergent phase, both of which develop only during drought. In the deeper ponds, an alternation of the normal emergent phase and the open-water phase is common because of annual and seasonal changes in water depth. The normal emergent phase is generally present in the shallower areas of this zone, while the open-water phase occupies the deeper areas. In permanent lakes, marginal bands of deep marsh are usually represented by the normal emergent phase in the outer, shallower portions, while the open-water phase is typical of the deeper portions that adjoin the permanent-open-water zone. Submerged or floating plants are often found throughout this zone; certain species of these plants occur as subdominants in the normal emergent phase, while many other species are characteristic of the open-water phase. Dominant plant species in the normal emergent phase are in general coarser and taller than corresponding species in shallow-marsh zones.

Deep-marsh zones are nearly always present in the deeper ponds and lakes in which salinity ranges from slightly brackish to subsaline. During high water this zone may also be found locally in some of the deep fresh-water ponds. Species composition of plant associations differs noticeably in the three vegetational phases of deep marsh and under dif-

ferent ranges of salinity within each phase. Characteristic species of these associations are listed in appropriate divisions under Class IV in appendix A.

Permanent-open-water zone.—This deep-water zone, of local occurrence in a few ponds and lakes that maintain fairly stable water levels, is represented only by the open-water phase. Measurements of specific conductance (micromhos/cm^3) indicated that water in this zone may be classified as slightly brackish, moderately brackish, brackish, or subsaline. Only two species of vascular plants were found in this zone (see under Class V in appendix A). Western widgeongrass (*Ruppia occidentalis*) is quite regular in occurrence, and occasionally it is associated with big-sheath pondweed (*Potamogeton vaginatus*). In some lakes the deeper portions of this zone are completely devoid of submerged vegetation. Because of stability of water levels and greater water depth, emergent plants do not develop in this zone. Toward shore this zone is frequently bordered by a band of open water representing the open-water phase of the deep-marsh zone. Although superficially similar in appearance, this shallow open-water band differs in species composition of submerged plants (see under Class IV in appendix A).

Intermittent-alkali zone.—This zone is characterized by highly saline shallow water that frequently alternates with exposed glistening-white alkali saltflats. The principal salts represented are sulfates and chlorides of sodium and magnesium, which are termed alkali salts by common usage throughout the Great Plains. Under dry conditions this zone is frequently subject to wind erosion. On windy days it is not unusual for great clouds of white alkali dust to form.

Emergent plants do not develop in this zone, apparently because of the high salt content, but one submerged aquatic species, saltwater widgeongrass (*Ruppia maritima*), is frequently abundant whenever surface water is maintained for a few weeks during the summer (see under Class VI in appendix A).

Fen (alkaline bog) zone.—Vegetation characteristic of fens occasionally dominates the central areas of pond basins, but more frequently occurs as isolated pockets along the margins of typical ponds and lakes. Surface water is sometimes lacking in this zone, although the bottom soils are normally saturated by alkaline ground-water seepage. Most bottom soils in the deeper portions have the consistency of soft muck or ooze. In many cases, fen zones could be considered quagmires with floating or quaking surface mats of emergent vegetation. Springs are sometimes present, and these are usually on raised mounds of wet organic material that are covered with mats of dense vegetation. Specific conductance (micromhos/cm^3) measurements of surface water indicate that fen zones are in the slightly brackish salinity range.

Pockets of fen zones adjoining the more typical basin wetlands are most frequent along the margins of brackish, subsaline, and saline ponds and lakes. In these situations fen zones are often located on gently sloping terrain with a perceptible flow of ground water on or near the surface, extending from seepage inflow or spring sites to the ponded surface water below. Ordinarily, salinity increases as water moves down the slope, and this is reflected in changes in species composition of wetland plants. Typical fen species gradually merge with and are replaced by species characteristic of salinity ranges in other zones. Vegetation of fens is represented by a normal emergent phase and an open-water phase. Typical plant species for each of these are listed under Class VII in appendix A.

MAJOR CLASSES OF NATURAL PONDS AND LAKES

Seven major classes of wetlands in natural basins are recognized on the basis of ecological differentiation. **Each class is distinguished by the vegetational zone occuring in the central or deeper part and occupying 5 percent or more of the total wetland area being classified.** The plant species characteristic of these classes are listed in appendix A. The classes are designated as follows:

Class I—ephemeral ponds.—The wetland-low-prairie zone dominates the deepest part of the pond basin. A pond of this class is illustrated in plate 1.

Class II—temporary ponds.—The wet-meadow zone dominates the deepest part of the wetland area. A peripheral low-prairie zone is usually present. Ponds of this class are illustrated in plates 2 to 5.

Class III—seasonal ponds and lakes.—The shallow-marsh zone dominates the deepest part of the wetland area. Peripheral wet-meadow and low-prairie zones are usually present. Ponds of this class are illustrated in plates 6 to 12.

Class IV—semipermanent ponds and lakes.—The deep-marsh zone dominates the deepest part of the wetland area. Shallow-marsh, wet-meadow, and

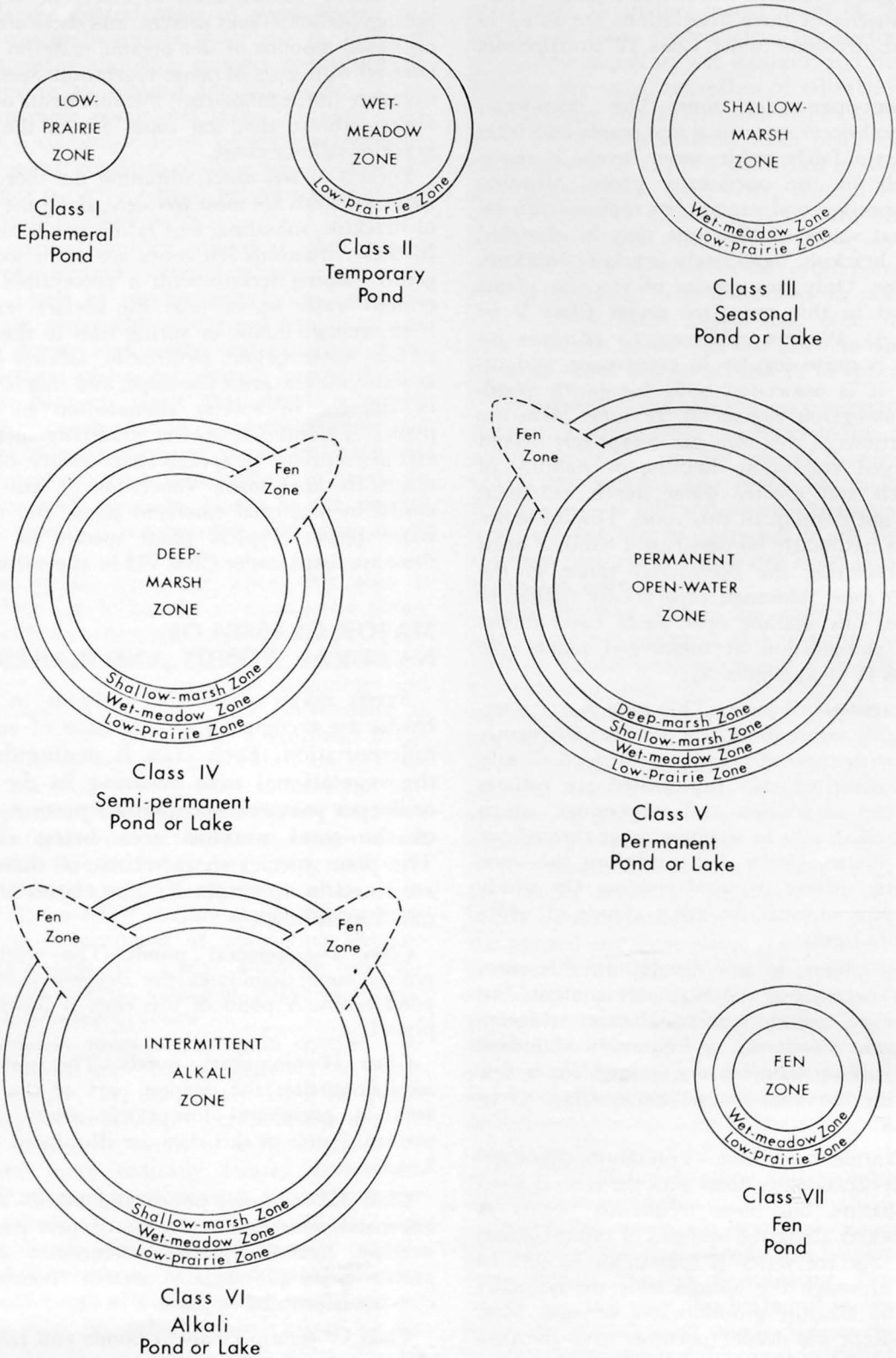

Figure 2.—Spatial relation of vegetational zones in major classes of natural ponds and lakes.

low-prairie zones are usually present, and isolated marginal pockets of fen zones occasionally occur. Ponds or lakes of this class are illustrated in plates 13 to 23.

Class V—permanent ponds and lakes.—The permanent-open-water zone dominates the deepest part of the wetland area. Peripheral deep-marsh, shallow-marsh, wet-meadow, and low-prairie zones are often present, and isolated marginal pockets of fen zone occasionally occur. Permanent lakes are illustrated in plates 24 to 26.

Class VI—alkali ponds and lakes.—The intermittent-alkali zone dominates the deepest part of the wetland area. Peripheral shallow-marsh, wet-meadow, and low-prairie zones are usually present. A deep-marsh zone is normally absent except occasionally for isolated patches near marginal seepage areas. A few isolated pockets of fen zone are normally present along the margins. Alkali lakes are illustrated in plates 27 and 28.

Class VII—fen (alkaline bog) ponds.—The fen zone dominates the deepest part of the wetland area. Peripheral wet-meadow and low-prairie zones are often present. The central part of a large fen is illustrated in plate 29.

Illustrations of the spatial relations of vegetational zones in the major classes of ponds and lakes are shown in figure 2. Normally, wetland classes are easily distinguished in the field. Occasionally, a pond or lake intermediate between two classes will be encountered in which the deepest part of the wetland area is occupied by a mixture of species characteristic of two different zones (plates 10 and 11). In such a case the class designation would depend on which characteristic species group represents more than 50 percent of the vegetational growth in the deeper central area.

During extended periods of abnormal water conditions, certain ponds and lakes may shift from one class to another. For example, in Stutsman County, N. Dak., in 1966, many shallow-marsh species, responding to extremely high water levels, invaded typical wet-meadow zones. During this period, some wetlands were transformed from temporary (Class II) to seasonal (Class III) ponds. Conversely, extreme drought in 1961 allowed wet-meadow vegetation to become established in many zones formerly dominated by shallow-marsh species, converting these wetlands from seasonal (Class III) to temporary (Class II) ponds. Immediately after the transition from one class to another, there may be a temporary reversal in the usual spatial relations of vegetational zones. For instance, stands of shallow-marsh emergents may develop in the deeper parts of a pond formerly occupied by the deep-marsh open-water phase, while surrounding bands of deep-marsh emergents may persist for a time in shallower water (plate 12).

Seasonal (Class III) and semipermanent (Class IV) ponds and lakes are the predominant wetlands in terms of total acreage throughout the glaciated prairie region. Large numbers of ephemeral ponds (Class I) and temporary ponds (Class II) are present, but their total acreage is somewhat less. Permanent and alkali ponds and lakes (Classes V and VI), although often quite large individually, are few in number and therefore only of secondary significance. Fen ponds (Class VII) are usually small and quite local in occurrence.

SUBCLASSES OF NATURAL PONDS AND LAKES

Distinct subclasses may be recognized within several of the major classes of wetlands, including temporary, seasonal, semipermanent, and permanent ponds and lakes. **These subclasses are based on differences in species composition of plant communities within wet-meadow, shallow-marsh, or deep-marsh zones that are correlated with variations in average salinity of surface water.** The subclasses are designated as follows:

Subclass A—fresh.
Subclass B—slightly brackish.
Subclass C—moderately brackish.
Subclass D—brackish.
Subclass E—subsaline.

Normal and extreme ranges in specific conductance (micromhos/cm^3) of surface water in plant communities that characterize these varying degrees of salinity are shown in the section on Plant Species Composition and Differences in Salinity of Surface Water.

Subclasses represented (prevalent subclasses in bold face) in the four major classes referred to are as follows:

	Subclasses
Class II—temporary ponds	**A**, B
Class III—seasonal ponds and lakes	**A**, **B**, C

Class IV—semipermanent ponds and lakes ____A, **B**, C, D, E

Class V—permanent ponds and lakes _____ **B**, C, D, E

Plant communities of each subclass differ with respect to occurrence or abundance of various plant species. The principal species in each subclass for temporary (Class II), seasonal (Class III), semipermanent (Class IV), and permanent (Class V) ponds and lakes are listed in appendix A. Subclasses are also indicated for many of the illustrations of major classes of wetlands (plates 2 to 26).

Recognition of subclasses requires a visual appraisal of the abundance of various wetland plants, especially primary emergent species in the wet-meadow, shallow-marsh, and deep-marsh zones. The prevalent species of these zones in a particular pond or lake may be compared with the principal species listed under each subclass for the zones being considered. A subclass designation can then be assigned on the basis of similarity.

COVER TYPES IN NATURAL PONDS AND LAKES

Cover interspersion within zones containing emergent phases of wetland vegetation is related to average water depth. Closed stands of emergents are found in comparatively shallow water, open stands in deep water, and semiopen stands in intermediate depths. Expanses of open water, when present, are normally found in the deepest part of a pond or lake, but during unusually high water or under certain land-use practices such as heavy grazing, mowing, burning, and cultivation, expanses of open water may occur in any part of a wetland area.

Cover types, as referred to in this report, represent differences in the spatial relation of emergent cover to open water or exposed bottom soil. Emergent plants used to describe cover types include species of low-prairie and wet-meadow zones in ephemeral (Class I) and temporary (Class II) ponds, but are restricted to species of shallow-marsh and deep-marsh zones in seasonal (Class III), semipermanent (Class IV), permanent (Class V), and alkali (Class VI) ponds and lakes. In cultivated ephemeral (Class I), temporary (Class II), and seasonal (Class III) ponds, cover may also be represented by planted crops including small grain, row crops, and forage species used for hay. Cover in fen (Class VII) ponds is represented by typical emergent fen species. Cover interspersion in natural ponds and lakes can be one of four types:

Cover type 1.—Closed stands of emergents with open water or bare soil covering less than 5 percent of the wetland area.

Cover type 2.—Open water or bare soil covering 5 to 95 percent of the wetland area, with scattered dense patches or diffuse open stands of emergent cover. Closed stands of emergents, located in the central portion of a pond or lake and surrounded by open water along the shallow margins, are included in this cover type.

Cover type 3.—Central expanses of open water or bare soil (comprising more than 5 percent of the wetland area) surrounded by peripheral bands of emergent cover averaging 6 feet or more in width.

Cover type 4.—Open water or bare soil covers more than 95 percent of the wetland area. This cover type also includes small ponds in which emergent cover is restricted to marginal bands less than 6 feet in average width.

The basic cover types, showing common variations, are illustrated in figure 3.

All cover types are represented in ephemeral (Class I), temporary (Class II), seasonal (Class III), and semipermanent (Class IV) ponds or lakes, although their frequency of occurrence varies considerably. Except for brief periods in the spring, cover type 1 is prevalent in undisturbed ponds or lakes of Classes I to III, while cover types 2 and 3 are frequent in Class IV. Cover types 2, 3, and 4 are quite common in cropland ponds or lakes of Classes I to III that have been disturbed by intensive cultivation. Only two cover types (3 and 4) are represented in permanent (Class V) and alkali (Class VI) ponds and lakes. Fen ponds (Class VII) include cover types 1, 2, and 3. Cover type variations are illustrated in plates 1 to 31.

Changes in cover type occur frequently in many ponds and lakes in this region owing in large part to variable climatic conditions and resulting fluctuations in water levels. Alternations in the type and intensity of land use may occasionally be important causes. Other phe-

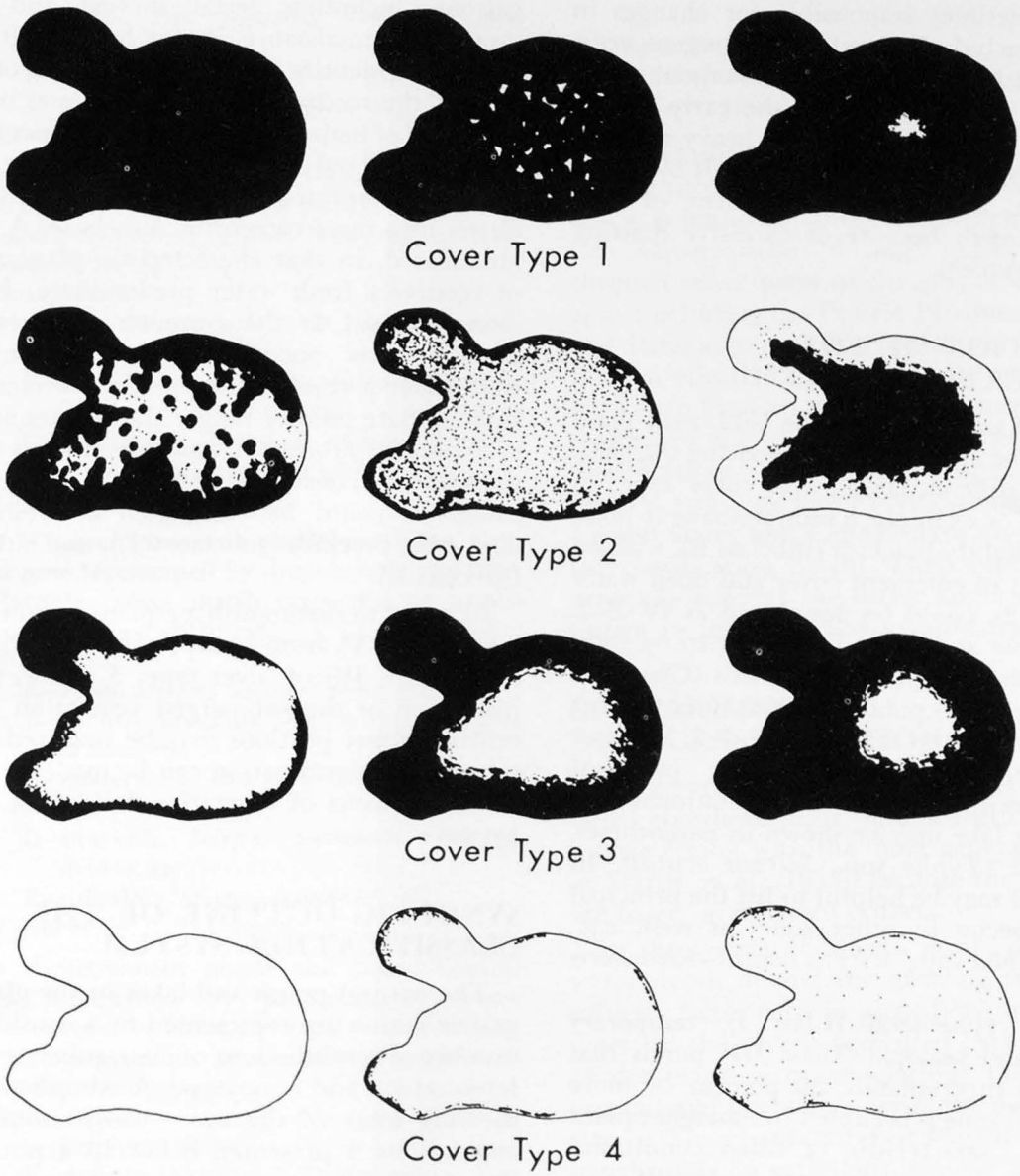

Figure 3.—Basic cover types of natural ponds and lakes showing common variations in aspect. White areas indicate open water or exposed bare soil; shaded areas indicate emergent vegetation.

nomena sometimes responsible for changes in cover type include "eat-outs" of emergent vegetation by muskrats, uprooting of emergent plants by flotation of bottom ice in the early spring, thinning of emergent growth by heavy siltation of ponds or by scouring of bottom soils by severe wave action, and poor development of new emergent growth because of excessive matting of dead vegetation.

APPLICATION OF THE CLASSIFICATION SYSTEM

For use of this system in the field, each pond or lake may be classified by designating the class, subclass (if differentiated), and cover type, in that order. For example, a semipermanent pond (Class IV), slightly brackish (subclass B), with an interspersion of emergent cover and open water (cover type 2), could be designated as IV–B–2. Only the class and cover type need to be indicated for ephemeral (Class I), alkali (Class VI), and fen (Class VII) ponds or lakes, since distinct subclasses are not recognized, e.g., I–2, VI–4, or VII–1. Whenever desirable, the principal emergent species in the central vegetational zone of a pond or lake may be shown in parentheses, e.g., IV–B–2 (*Typha* spp., *Scirpus acutus*). In some cases, it may be helpful to list the principal emergent species in other zones as well, e.g., IV–B–2 (*Typha* spp., *Scirpus acutus–Eleocharis palustris*).

In many ephemeral (Class I), temporary (Class II), and seasonal (Class III) ponds that are situated in croplands, 50 percent or more of the central zone is occupied by emergent plant associations characteristic of tilled conditions. Whenever these associations can be identified as phases of wet meadow or shallow marsh, the disturbed land-use condition can be specified by adding a small letter "t" as a superscript after the class number, e.g., III^{t}–B–2 or II^{t}–4. However, if the central zone is in the open-water phase, drawdown bare-soil phase, or cropland tillage phase, it may be difficult to determine which class the pond belongs to. For these ponds, a large letter "T" can be substituted for the class number. A pond of this type without emergent vegetation could be designated as T–4 (plate 30), while one located in a stubble field could be designated as T–2 (plate 31) or T–3.

In certain extensive types of wetland investigations, including aerial surveys and rapid ground reconnaissance, it may be difficult or infeasible to identify wetland subclasses. For these studies, the recognition of major classes or combinations of major classes and cover types should suffice. Wetland subclasses can also be more broadly interpreted by combining the five subclasses into three categories. Subclasses A and B are related, in that characteristic plant species of relatively fresh water predominate. In subclasses C and D the common occurrence of brackish-water species in combination with fresh-water and salt-water species represents the intermediate salinity range. Halophytes are predominant in subclass E, and this subclass should therefore be considered separately. These three categories could be designated as fresh (subclass AB), brackish (subclass CD), and subsaline (subclass E).

In order to distinguish permanent ponds and lakes (Class V) from semipermanent ponds and lakes (Class IV) of cover types 3 and 4, a close inspection of the submerged vegetation in the central deeper portions may be required. Occasionally, a determination can be made by examining windrows of vegetative debris cast ashore by wave action.

SYNOPTIC OUTLINE OF THE CLASSIFICATION SYSTEM

The natural ponds and lakes in the glaciated prairie region are represented by a considerable number of combinations of class, subclass (if differentiated), and cover type. A synoptic outline showing some of the more conspicuous plant associations is presented below in a resumé of the classification system. While only the more usual characteristic plants are given, it should be recognized that in certain ponds other primary species listed in appendix A may be the prevalent vegetation.

Class I—ephemeral ponds. Central zone represented by low-prairie vegetation (*Poa pratensis, Solidago altissima,* etc.).
Subclasses: None
Cover types: 1, 2, 3, and 4.

Class II—temporary ponds. Central zone represented by wet-meadow vegetation (generally fine-stemmed grasses and sedges with associated forbs).

Subclasses:

A—fresh. *Poa palustris, Boltonia latisquama,* etc.

B—slightly brackish. *Hordeum jubatum, Calamagrostis inexpansa,* etc.

Cover types: 1, 2, 3, and 4.

Class III—seasonal ponds and lakes. Central zone represented by shallow-marsh vegetation (moderately coarse grasses and sedges with associated forbs).

Subclasses:

A—fresh. *Carex atherodes, Glyceria grandis,* etc.

B—slightly brackish. *Scolochloa festucacea, Eleocharis palustris,* etc.

C—moderately brackish. *Alisma gramineum, Beckmannia syzigachne,* etc.

Cover types: 1, 2, 3, and 4.

Class IV—semipermanent ponds and lakes. Central zone represented by deep-marsh vegetation (relatively coarse marsh emergents or associated submerged aquatics).

Subclasses:

A—fresh. *Scirpus heterochaetus,* etc.

B—slightly brackish. *Typha* spp., *Scirpus acutus,* etc.

C—moderately brackish. *Scirpus acutus,* etc.

D—brackish. *Scirpus paludosus, Scirpus acutus,* etc.

E—subsaline. *Scirpus paludosus,* etc.

Cover types: 1, 2, 3, and 4.

Class V—permanent ponds and lakes. Central area represented by permanent-open-water zone (devoid of emergent vegetation, but submerged vegetation, particularly *Ruppia occidentalis,* often present).

Subclasses (based on species composition of peripheral zones):

B—slightly brackish. *Typha* spp., *Scolochloa festucacea,* etc.

C—moderately brackish. *Scirpus acutus, Hordeum jubatum,* etc.

D—brackish, *Scirpus paludosus, Scirpus americanus,* etc.

E—subsaline. *Puccinellia nuttalliana, Salicornia rubra,* etc.

Cover types: 3 and 4.

Class VI—alkali ponds and lakes. Central area represented by intermittent-alkali zone (devoid of emergent vegetation; *Ruppia maritima* often common).

Subclasses: None

Cover types: 3 and 4.

Class VII—fen ponds. Central zone represented by fen vegetation (*Glyceria striata, Carex aquatilis,* etc.).

Subclasses: None

Cover types: 1, 2, and 3.

This classification system was tested repeatedly during intensive field studies in North Dakota and was found to be both expedient and realistic. Observations during exploratory trips through other parts of the glaciated prairie region (including the Prairie Provinces of Canada and States adjoining North Dakota) indicate that it is an effective method for the entire region. In certain local areas, particularly those near the margin of the glaciated prairie region, minor modifications may be required. A number of Federal and State and Provincial agencies in the United States and Canada have also field-tested the classification system. Their findings to date generally support the direct application of this system in their wetland investigations.

COMPARISON OF TWO CLASSIFICATION SYSTEMS

There are difficulties in comparing this detailed classification of wetlands in the glaciated prairie region with the more generalized system of Martin et al. (1953), because the two systems are based on different criteria.

In the system of Martin et al., difference in water depth during the growing season is the primary factor used in identifying most wetland types; in the system presented here, occurrence of dominant plant associations in the central vegetational zone characterize the major wetland classes. The classification of Martin et al. is also based partly on variations in cover interspersion which are treated secondarily as cover types in this system. For example, Types 3, 4, and 5 wetlands as described by Martin et al. could correspond to cover types 1, 2, and 3 of semipermanent (Class IV) wetlands in this classification when the relation between cover and open water is considered.

Some plants listed by Martin et al. are common to several of their wetland types. For instance, bulrushes may occur in Types 3, 4, and 5 of Martin et al., whereas in this system most species of bulrush would be considered members of the plant association used to indicate the sub-

class of a semipermanent (Class IV) or permanent (Class V) pond or lake.

Prairie wetlands are designated in the classification of Martin et al. as either inland fresh (Types 1 to 5) or inland saline (Types 9 to 11). No mention is made of the important brackish-water environments that lie between the two extremes. The plant lists accompanying the descriptions for the types of Martin et al. indicate that subclasses A and B and subclasses C to E of the present classification would generally correspond to "fresh" and "saline" categories, respectively.

The shallower wetland types of Martin et al. may form peripheral borders around deeper types in the same spatial arrangement as vegetational zones listed in this classification. Thus, a Type 3 (shallow fresh marsh) wetland in the classification of Martin et al. would correspond to a shallow-marsh zone in the classification here described and could occupy the central area of a pond basin or border deep marsh on the landward side. In the former case it would be considered a Class III (seasonal) pond or lake, while in the latter situation it would be designated as one peripheral zone of a Class IV, V, or VI pond or lake.

With due regard for these qualifications, the following rough correlation of the two systems may be made:

"Classification of Natural Ponds and Lakes in the Glaciated Prairie Region" (Stewart and Kantrud, 1971) Class	*"Classification of Wetlands of the United States" (Martin et al., 1953)* Type
I—Ephemeral ponds	1.
II—Temporary ponds	1, 2.
III—Seasonal ponds and lakes	3, 4.
IV—Semipermanent ponds and lakes	3, 4, 5, 10, 11.
Subclasses A and B—cover type 1	3.
Subclasses A and B—cover type 2	4.
Subclasses A and B—cover types 3 and 4	4, 5.
Subclasses C, D, and E—cover types 1 and 2	10.
Subclasses C, D, and E—cover types 3 and 4	11.
V—Permanent ponds and lakes	5, 11.
Subclass B—cover types 3 and 4	5.
Subclasses C, D, and E—cover types 3 and 4	11.
VI—Alkali ponds and lakes	9.
VII—Fen (alkaline bog) ponds	8.

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APPENDIX A.—CHARACTERISTIC PLANT SPECIES IN PRAIRIE PONDS AND LAKES

The more important plant species characteristic of classes and subclasses of prairie ponds and lakes are listed here. Major groupings are the vegetational zones and phases. In Classes III, IV, and VII, dominant and subdominant categories are referred to. Dominant species are relatively tall emergents that form the canopy, or overstory, of plant associations; subdominants are submerged, floating, or short emergent species that ordinarily compose the understory. Plants are grouped as primary and secondary species to show their prevalence as related to cover under normal conditions within a plant community. A more detailed description of wetland vegetation in northern prairie ponds and lakes may be found in Stewart and Kantrud (in press).

Except for a few extralimital species, the identification of vascular plants is according to the eighth edition of Gray's Manual (Fernald, 1950). A few western species of vascular plants not treated in Gray's Manual follow the nomenclature used by Stevens (1963). References to algae are according to Smith (1950), while names of mosses and liverworts follow Conard (1956). Altogether, 174 plant species are listed here. Scientific and common names of all plants referred to are listed in appendix B. Voucher specimens for all of these are preserved in the herbarium at the Northern Prairie Wildlife Research Center.

Class I—ephemeral ponds:
- Central wetland-low-prairie zone:
  - Normal emergent phase:
    - Primary species:
      - *Poa pratensis*
      - *Agropyron trachycaulum*
      - *Anemone canadensis*
      - *Symphoricarpos occidentalis*
      - *Solidago altissima*
      - *Aster ericoides*
      - *Ambrosia psilostachya*
    - Secondary species:
      - *Panicum virgatum*
      - *Andropogon gerardi*
      - *Carex brevior*
      - *Zigadenus elegans*
      - *Lilium philadelphicum*
      - *Rosa woodsii*
      - *Glycyrrhiza lepidota*
      - *Zizia aptera*
      - *Helianthus maximiliani*
      - *Artemisia ludoviciana*
      - *Taraxacum officinale*
      - *Agoseris glauca*
      - *Crepis runcinata*
  - Cropland tillage phase:
    - Primary species:
      - *Setaria glauca*
      - *Polygonum convolvulus*
      - *Kochia scoparia*
    - Secondary species:
      - *Agropyron smithii*
      - *Agropyron repens*
      - *Salsola kali*
      - *Amaranthus retroflexus*
      - *Thlaspi arvense*
      - *Brassica kaber*
      - *Descurainia sophia*
      - *Rosa arkansan*
      - *Androsace occidentalis*
      - *Ellisia nyctelea*
      - *Erigeron canadensis*
      - *Iva xanthifolia*

Class II—temporary ponds:
- Subclass A—fresh:
  - Central wet-meadow zone:
    - Normal emergent phase:
      - Primary species:
        - *Poa palustris*
        - *Carex praegracilis*
        - *Carex sartwellii*
        - *Carex lanuginosa*
        - *Boltonia latisquama*
        - *Aster simplex*
      - Secondary species:
        - *Hordeum jubatum*
        - *Calamagrostis canadensis* var. *macouniana*
        - *Calamagrostis inexpansa*
        - *Spartina pectinata*
        - *Hierochloe odorata*
        - *Carex vulpinoidea*
        - *Carex laeviconica*
        - *Juncus balticus*
        - *Juncus dudleyi*
        - *Juncus interior*
        - *Rumex mexicanus*
        - *Rumex occidentalis*
        - *Ranunculus macounii*

Rorippa islandica
Potentilla norvegica
Epilobium glandulosum
Lysimachia hybrida
Apocynum sibiricum
Asclepias speciosa
Teucrium occidentale
Stachys palustris
Mentha arvensis
Vernonia fasciculata
Helenium autumnale
Artemisia biennis
Cirsium arvense
Sonchus arvensis

Cropland drawdown phase:
Primary species:
Agropyron repens
Echinochloa crusgalli
Polygonum lapathifolium
Veronica peregrina

Secondary species:
Hordeum jubatum
Plagiobothrys scopulorum
Xanthium italicum
Bidens frondosa

Peripheral wetland-low-prairie zone:
The species composition is the same as that of the central wetland-low-prairie zone of ephemeral ponds (Class I).

Subclass B—slightly brackish:
Central wet-meadow zone:
Normal emergent phase:
Primary species:
Hordeum jubatum
Calamagrostis inexpansa
Spartina pectinata
Carex sartwellii
Juncus balticus
Aster simplex

Secondary species:
Poa palustris
Carex praegracilis
Carex lanuginosa
Juncus interior
Juncus dudleyi
Juncus torreyi
Rumex mexicanus
Epilobium glandulosum
Stachys palustris
Lycopus asper
Mentha arvensis
Artemisia biennis
Cirsium arvense
Sonchus arvensis

Cropland drawdown phase:
The species composition is the same as that of the cropland drawdown phase of the central wet-meadow zone in fresh temporary ponds (Class II–A).

Peripheral wetland-low-prairie zone:
The species composition is the same as that of the central wetland-low-prairie zone of ephemeral ponds (Class I).

Class III—seasonal ponds and lakes:
Subclass A—fresh:
Central shallow-marsh zone:
Normal emergent phase:
Dominants:
Primary species:
Sparganium eurycarpum
Alisma triviale
Glyceria grandis
Beckmannia syzigachne
Carex atherodes
Polygonum coccineum

Secondary species:
Alopecurus aequalis
Phalaris arundinacea
Sium suave

Subdominants:
Primary species:
Riccia fluitans
Lemna trisulca
Utricularia vulgaris

Secondary species:
Drepanocladus spp.
Lemna minor

Open-water phase:
Primary species:
Potamogeton gramineus
Callitriche palustris
Utricularia vulgaris

Secondary species:
Drepanocladus spp.
Potamogeton pusillus
Eleocharis acicularis, submerged form.
Ranunculus trichophyllus

Natural drawdown phase:
Primary species:
Eleocharis acicularis, terrestrial form.

Secondary species:
Rumex maritimus
Kochia scoparia
Xanthium italicum
Senecio congestus

Cropland drawdown phase:

Primary species:
Eleocharis engelmanni
Eleocharis acicularis
Gratiola neglecta

Secondary species:
Marsilea mucronata
Cyperus acuminatus
Bacopa rotundifolia
Lindernia dubia

Peripheral wet-meadow zone:
The species composition is the same as that of the central wet-meadow zone of fresh temporary ponds. (Class II–A).

Peripheral wetland-low-prairie zone:
The species composition is the same as that of the central wetland-low-prairie zone of ephemeral ponds (Class I).

Subclass B—slightly brackish:
Central shallow-marsh zone:
Normal emergent phase:
Dominants:
Primary species:
Alisma triviale
Scolochloa festucacea
Beckmannia syzigachne
Eleocharis palustris
Carex atherodes
Polygonum coccineum

Secondary species:
Sparganium eurycarpum
Alisma gramineum
Sagittaria cuneata
Alopecurus aequalis
Phalaris arundinacea
Polygonum amphibium, terrestrial form
Sium suave

Subdominants:
Primary species:
Drepanocladus spp.
Ricciocarpus natans
Lemna trisulca
Lemna minor
Utricularia vulgaris

Secondary species:
Riccia fluitans
Ranunculus sceleratus
Ranunculus cymbalaria

Open-water phase:
Primary species:
Drepanocladus spp.
Ranunculus trichophyllus
Utricularia vulgaris

Secondary species:
Potamogeton pusillus
Eleocharis acicularis, submerged form.
Polygonum amphibium, aquatic form

Natural drawdown phase:
Primary species:
Eleocharis acicularis

Secondary species:
Hordeum jubatum
Rumex maritimus
Chenopodium rubrum
Kochia scoparia
Xanthium italicum
Senecio congestus

Cropland drawdown phase:
The species composition is the same as that of the cropland drawdown phase of fresh seasonal ponds (Class III–A).

Peripheral wet-meadow zone:
The species composition is the same as that of the central wet-meadow zone of slightly brackish temporary ponds (Class II–B).

Peripheral wetland-low-prairie zone:
The species composition is the same as that of the central wetland-low-prairie zone of ephemeral ponds (Class I).

Subclass C—moderately brackish:
Central shallow-marsh zone:
Normal emergent phase:
Dominants:
Primary species:
Alisma gramineum
Scolochloa festucacea
Beckmannia syzigachne
Eleocharis palustris

Secondary species:
Scirpus americanus
Carex atherodes

Subdominants:
Primary species:
Lemna minor

Secondary species:
Drepanocladus spp.
Lemna trisulca
Ranunculus cymbalaria
Utricularia vulgaris

Open-water phase:
Primary species:
None

Secondary species:
Chara spp.
Drepanocladus spp.

Ranunculus trichophyllus
Utricularia vulgaris

Natural drawdown phase:
Primary species:
Hordeum jubatum
Secondary species:
Eleocharis acicularis
Rumex maritimus
Chenopodium rubrum
Kochia scoparia

Cropland drawdown phase:
Primary species:
Eleocharis acicularis
Secondary species:
Gratiola neglecta

Peripheral wet-meadow zone:
Normal emergent phase:
Primary species:
Hordeum jubatum
Calamagrostis inexpansa
Spartina pectinata
Juncus balticus
Secondary species:
Distichlis stricta
Atriplex patula
Potentilla anserina
Glaux maritima
Lycopus asper
Plantago eriopoda
Aster simplex
Artemisia biennis

Cropland drawdown phase:
Primary species:
Agropyron repens
Secondary species:
Hordeum jubatum
Echinochloa crusgalli
Xanthium italicum

Peripheral wetland-low-prairie zone:
The species composition is the same as that of the central wetland-low-prairie zone of ephemeral ponds (Class I).

Class IV—semipermanent ponds and lakes:

Subclass A—fresh:
Central deep-marsh zone:
Normal emergent phase:
Dominants:
Primary species:
Scirpus heterochaetus
Secondary species:
Typha latifolia
Scirpus fluviatilis

Subdominants:
Primary species:
Riccia fluitans
Lemna trisulca
Utricularia vulgaris
Secondary species:
Drepanocladus spp.
Ricciocarpus natans
Lemna minor

Open-water phase:
Primary species:
Potamogeton pusillus
Utricularia vulgaris
Secondary species:
Potamogeton richardsonii
Ceratophyllum demersum
Ranunculus trichophyllus
Myriophyllum exalbescens

Natural drawdown phase:
Primary species:
Eleocharis acicularis
Senecio congestus
Secondary species:
Kochia scoparia

Peripheral shallow-marsh zone:
The species composition is the same as that of the central shallow-marsh zone of fresh seasonal ponds and lakes (Class III–A).

Peripheral wet-meadow zone:
The species composition is the same as that of the central wet-meadow zone of fresh temporary ponds (Class II–A).

Peripheral wetland-low-prairie zone:
The species composition is the same as that of the central wetland-low-prairie zone of ephemeral ponds (Class I).

Subclass B—slightly brackish:
Central deep-marsh zone:
Normal emergent phase:
Dominants:
Primary species:
Typha "glauca"
Scirpus acutus
Scirpus fluviatilis
Secondary species:
Typha latifolia
Scirpus validus

Subdominants:
Primary species:
Drepanocladus spp.
Ricciocarpus natans
Lemna trisulca
Lemna minor
Utricularia vulgaris

Secondary species:
Riccia fluitans

Open-water phase:
Primary species:
Potamogeton richardsonii
Potamogeton pusillus
Ceratophyllum demersum
Ranunculus trichophyllus
Myriophyllum exalbescens
Utricularia vulgaris
Secondary species:
Chara spp.
Drepanocladus spp.
Zannichellia palustris
Potamogeton pectinatus
Callitriche hermaphroditica

Natural drawdown phase:
Primary species:
Eleocharis acicularis
Rumex maritimus
Chenopodium rubrum
Kochia scoparia
Senecio congestus
Secondary species:
Hordeum jubatum

Peripheral shallow-marsh zone:
The species composition is the same as that of the central shallow-marsh zone of slightly brackish seasonal ponds and lakes (Class III–B).

Peripheral wet-meadow zone:
The species composition is the same as that of the central wet-meadow zone of slightly brackish temporary ponds (Class II–B).

Peripheral wetland-low-prairie zone:
The species composition is the same as that of the central wetland-low-prairie zone of ephemeral ponds (Class I).

Subclass C—moderately brackish:
Central deep-marsh zone:
Normal emergent phase:
Dominants:
Primary species:
Scirpus acutus
Secondary species:
Scirpus paludosus

Subdominants:
Primary species:
Lemna minor
Secondary species:
Drepanocladus spp.
Lemna trisulca
Utricularia vulgaris

Open-water phase:
Primary species:
Chara spp.
Zannichellia palustris
Potamogeton pectinatus
Secondary species:
Ranunculus trichophyllus
Myriophyllum exalbescens

Natural drawdown phase:
Primary species
Hordeum jubatum
Rumex maritimus
Chenopodium rubrum
Kochia scoparia
Secondary species:
Panicum capillare
Eleocharis acicularis
Chenopodium salinum
Aster brachyactis

Peripheral shallow-marsh zone:
The species composition is the same as that of the central shallow-marsh zone of moderately brackish seasonal ponds and lakes (Class III–C).

Peripheral wet-meadow zone:
The species composition is the same as that of the peripheral wet-meadow zone of moderately brackish seasonal ponds and lakes (Class III–C).

Peripheral wetland-low-prairie zone:
The species composition is the same as that of the central wetland-low-prairie zone of ephemeral ponds (Class I).

Peripheral fen zone (marginal pockets):
The species composition is the same as that of the central fen zone of fen ponds (Class VII).

Subclass D—brackish:
Central deep-marsh zone:
Normal emergent phase:
Dominants:
Primary species:
Scirpus paludosus
Secondary species:
Scirpus acutus

Subdominants:
None.

Open-water phase:
Primary species:
Chara spp.
Zannichellia palustris
Potamogeton pectinatus
Secondary species:
None.

Natural drawdown phase:
Primary species:
Hordeum jubatum
Chenopodium salinum
Kochia scoparia
Aster brachyactis
Secondary species:
Panicum capillare
Rumex maritimus

Peripheral shallow-marsh zone:
Normal emergent phase:
Dominants:
Primary species:
Scirpus americanus
Secondary species:
Puccinellia nuttalliana
Eleocharis palustris
Salicornia rubra
Subdominants:
None.

Open-water phase:
Primary species:
Zannichellia palustris
Secondary species:
Chara spp.

Natural drawdown phase:
Primary species:
Hordeum jubatum
Aster brachyactis
Secondary species:
Chenopodium salinum
Kochia scoparia

Peripheral wet-meadow zone:
Normal emergent phase:
Primary species:
Distichlis stricta
Hordeum jubatum
Secondary species:
Triglochin maritima
Muhlenbergia asperifolia
Juncus balticus
Polygonum prolificum
Atriplex patula
Potentilla anserina
Lactuca scariola

Peripheral wetland-low-prairie zone:
The species composition is the same as that of the central wetland-low-prairie zone of ephemeral ponds (Class I).

Peripheral fen zone (marginal pockets):
The species composition is the same as that of the central fen zone of fen ponds (Class VII).

Subclass E—subsaline:
Central deep-marsh zone:
Normal emergent phase:
Dominants:
Primary species:
Scirpus paludosus
Secondary species:
None.
Subdominants:
None.

Open-water phase:
Primary species:
Ruppia maritima
Secondary species:
Chara spp.
Potamogeton pectinatus

Natural drawdown phase:
Primary species:
None.
Secondary species:
Kochia scoparia

Peripheral shallow-marsh zone:
Normal emergent phase:
Dominants:
Primary species:
Puccinellia nuttalliana
Salicornia rubra
Secondary species:
Scirpus nevadensis
Scirpus americanus
Suaeda depressa
Subdominants:
None.

Open-water phase:
None.

Natural drawdown phase:
None.

Peripheral wet-meadow zone:
Normal emergent phase:
Primary species:
Distichlis stricta
Secondary species:
Triglochin maritima
Hordeum jubatum
Muhlenbergia asperifolia
Spartina gracilis
Atriplex patula

Peripheral wetland-low-prairie zone:
The species composition is the same as that of the wetland-low-prairie zone of ephemeral ponds (Class I).

Peripheral fen zone (marginal pockets):
The species composition is the same as that of the central fen zone of fen ponds (Class VII).

Class V—permanent ponds and lakes:

Subclass B—slightly brackish:

Central permanent-open-water zone:

Primary species:

Ruppia occidentalis

Secondary species:

None.

Peripheral deep-marsh zone:

The species composition is the same as that of the central deep-marsh zone of slightly brackish semipermanent ponds and lakes (Class IV–B).

Peripheral shallow-marsh zone:

The species composition is the same as that of the central shallow-marsh zone of slightly brackish seasonal ponds and lakes (Class III–B).

Peripheral wet-meadow zone:

The species composition is the same as that of the central wet-meadow zone of slightly brackish temporary ponds (Class II–B).

Peripheral wetland-low-prairie zone:

The species composition is the same as that of the central wetland-low-prairie zone of ephemeral ponds (Class I).

Peripheral fen zone (marginal pockets):

The species composition is the same as that of the central fen zone of fen ponds (Class VII).

Subclass C—moderately brackish:

Central permanent-open-water zone:

Primary species:

Ruppia occidentalis

Secondary species:

None.

Peripheral deep-marsh zone:

The species composition is the same as that of the central deep-marsh zone of moderately brackish semipermanent ponds and lakes (Class IV–C).

Peripheral shallow-marsh zone:

The species composition is the same as that of the central shallow-marsh zone of moderately brackish seasonal ponds and lakes (Class III–C).

Peripheral wet-meadow zone:

The species composition is the same as that of the peripheral wet-meadow zone of moderately brackish seasonal ponds and lakes (Class III–C).

Peripheral wetland-low-prairie zone:

The species composition is the same as that of the central wetland-low-prairie zone of ephemeral ponds (Class I).

Peripheral fen zone (marginal pockets):

The species composition is the same as that of the central fen zone of fen ponds (Class VII).

Subclass D—brackish:

Central permanent-open-water zone:

Primary species:

Ruppia occidentalis

Secondary species:

Potamogeton vaginatus

Peripheral deep-marsh zone:

The species composition is the same as that of the central deep-marsh zone of brackish semipermanent ponds and lakes (Class IV–D).

Peripheral shallow-marsh zone:

The species composition is the same as that of the peripheral shallow-marsh zone of brackish semipermanent ponds and lakes (Class IV–D).

Peripheral wet-meadow zone:

The species composition is the same as that of the peripheral wet-meadow zone of brackish semipermanent ponds and lakes (Class IV–D).

Peripheral wetland-low-prairie zone:

The species composition is the same as that of the central wetland-low-prairie zone of ephemeral ponds (Class I).

Peripheral fen zone (marginal pockets):

The species composition is the same as that of the central fen zone of fen ponds (Class VII).

Subclass E—subsaline:

Central permanent-open-water zone:

Primary species:

None.

Secondary species:

None.

Peripheral deep-marsh zone:

This zone is often poorly represented; when present, the characteristic species are the same as those of the central deep-marsh zone of subsaline semipermanent ponds and lakes (Class IV–E).

Peripheral shallow-marsh zone:

The species composition is the same as that of the peripheral shallow-marsh zone of subsaline semipermanent ponds and lakes (Class IV–E).

Peripheral wet-meadow zone:

The species composition is the same as that of the peripheral wet-meadow zone of subsaline semipermanent ponds and lakes (Class IV–E).

Peripheral wetland-low-prairie zone:
The species composition is the same as that of the central wetland-low-prairie zone of ephemeral ponds (Class I).
Peripheral fen zone (marginal pockets):
The species composition is the same as that of the central fen zone of fen ponds (Class VII).

Class VI—alkali ponds and lakes:
Central intermittent-alkali zone:
Primary species:
Ruppia maritima
Secondary species:
None.
Peripheral shallow-marsh zone:
The species composition is the same as that of the peripheral shallow-marsh zone of subsaline semipermanent ponds and lakes (Class IV–E).
Peripheral wet-meadow zone:
The species composition is the same as that of the peripheral wet-meadow zone of subsaline semipermanent ponds and lakes (Class IV–E).
Peripheral wetland-low-prairie zone:
The species composition is the same as that of the central wetland-low-prairie zone of ephemeral ponds (Class I).
Peripheral fen zone (marginal pockets):
The species composition is the same as that of the central fen zone of fen ponds (Class VII).

Class VII—fen ponds:
Central fen zone:
Normal emergent phase:
Dominants:
Primary species:
Typha latifolia
Glyceria striata
Phragmites communis
Scirpus validus
Carex aquatilis
Salix interior
Salix candida
Cicuta maculata
Aster junciformis
Secondary species:
Triglochin maritima
Deschampsia caespitosa
Calamagrostis inexpansa
Muhlenbergia glomerata
Eleocharis calva
Eriophorum angustifolium
Scirpus atrovirens
Carex sartwellii
Carex interior
Carex aurea
Carex lanuginosa
Carex rostrata
Juncus torreyi
Hypoxis hirsuta
Ranunculus septentrionalis
Epilobium leptophyllum
Lysimachia thrysiflora
Gentiana procera
Asclepias incarnata
Scutellaria epilobiifolia
Lobelia kalmii
Eupatorium maculatum
Solidago graminifolia
Helianthus rydbergii
Subdominants:
Primary species:
Drepanocladus spp.
Secondary species:
Lemna minor
Parnassia palustris
Viola nephrophylla
Open-water phase:
Primary species:
Chara spp.
Drepanocladus spp.
Secondary species:
Zannichellia palustris
Ceratophyllum demersum
Ranunculus gmelini
Hippuris vulgaris
Utricularia vulgaris
Peripheral wet-meadow zone:
The species composition is the same as that of the central wet-meadow zone of slightly brackish temporary ponds (Class II–B).
Peripheral wetland-low-prairie zone:
The species composition is the same as that of the central wetland-low-prairie zone of ephemeral ponds (Class I).

APPENDIX B.—GLOSSARY OF NAMES OF PLANTS

Plants mentioned in the report are listed alphabetically by scientific names.

Agoseris glauca (Pursh) Raf. ——— Prairie False Dandelion
Agropyron repens (L.) Beauv. ——— Quackgrass
Agropyron smithii Rydb. ——— Western Wheatgrass
Agropyron trachycaulum (Link) Malte ——— Slender Wheatgrass
Alisma gramineum K. C. Gmel. ——— Narrowleaf Waterplantain
Alisma triviale Pursh ——— Western Waterplantain
Alopecurus aequalis Sobol. ——— Shortawn Foxtail
Amaranthus retroflexus L. ——— Rough Pigweed
Ambrosia psilostachya DC. ——— Perennial Ragweed
Androsace occidentalis Pursh ——— Fairy Candelabra
Anemone canadensis L. ——— Canada Anemone
Apocynum sibiricum Jacq. ——— Claspingleaf Dogbane
Artemisia biennis Willd. ——— Biennial Wormwood
Artemisia ludoviciana Nutt. ——— White Sage
Asclepias incarnata L. ——— Swamp Milkweed
Asclepias speciosa Torr. ——— Showy Milkweed
Aster brachyactis Blake ——— Rayless Aster
Aster ericoides L. ——— Smallflower Aster
Aster junciformis Rydb. ——— Rush Aster
Aster simplex Willd. ——— Lowland White Aster
Atriplex patula L. ——— Orach
Bacopa rotundifolia (Michx.) Wettst. ——— Waterhyssop
Beckmannia syzigachne (Nutt.) Fern. ——— Sloughgrass
Bidens frondosa L. ——— Common Beggarticks
Boltonia latisquama Gray ——— False-aster
Brassica kaber (DC.) L. C. Wheeler ——— Field Mustard
Calamagrostis canadensis (Michx.) Nutt. var. *macouniana* (Vasey) Stebbins ——— Bluejoint Reedgrass
Calamagrostis inexpansa Gray ——— Northern Reedgrass
Callitriche hermaphroditica L. ——— Northern Waterstarwort
Callitriche palustris L. ——— Common Waterstarwort
Carex aquatilis Wahlenb. ——— Water Sedge
Carex atherodes Spreng. ——— Slough Sedge
Carex aurea Nutt. ——— Golden Sedge
Carex interior Bailey ——— Sedge
Carex laeviconica Dew. ——— Sedge
Carex lanuginosa Michx. ——— Sedge
Carex praegracilis W. Boott ——— Sedge
Carex rostrata Stokes ——— Beaked Sedge
Carex sartwellii Dew. ——— Sedge
Carex vulpinoidea Michx. ——— Fox Sedge
Ceratophyllum demersum L. ——— Coontail
Chara spp. Valliant ——— Muskgrass
Chenopodium rubrum L. ——— Red Goosefoot
Chenopodium salinum Standl. ——— Oakleaf Goosefoot
Cicuta maculata L. ——— Common Waterhemlock
Cirsium arvense (L.) Scop. ——— Canadian Thistle
Crepis runcinata (James) T. & G. ——— Scapose Hawksbeard
Cyperus acuminatus Torr. & Hook. ——— Cyperus
Deschampsia caespitosa (L.) Beauv. ——— Tufted Hairgrass
Descurainia sophia (L.) Webb ——— Flixweed
Distichlis stricta (Torr.) Rydb. ——— Saltgrass
Drepanocladus spp. C. M. ——— Aquatic Moss
Echinochloa crusgalli (L.) Beauv. ——— Wild Millet
Ellisia nyctelea L. ——— Waterpod
Eleocharis acicularis (L.) R. & S. ——— Needle Spikerush
Eleocharis calva Torr. ——— Slender Spikerush
Eleocharis engelmanni Steud. ——— Engelmann's Spikerush
Eleocharis palustris (L.) R. & S. ——— Common Spikerush
Epilobium glandulosum Lehm. ——— Northern Willowherb
Epilobium leptophyllum Raf. ——— Willowherb
Erigeron canadensis L. ——— Horseweed
Eriophorum angustifolium Honckeny ——— Tall Cottongrass
Eupatorium maculatum L. ——— Joe-pye Weed
Gentiana procera Holm ——— Small Fringed Gentian

Glaux maritima L. ——— Sea Milkwort
Glyceria grandis S. Wats. — Tall Mannagrass
Glyceria striata (Lam.) Hitchc. ——— Fowl Mannagrass
Glycyrrhiza lepidota (Nutt.) Pursh ——— Wild Licorice
Gratiola neglecta Torr. — Hedge Hyssop
Helenium autumnale L. — Sneezeweed
Helianthus maximiliani Schrad. ——— Narrowleaf Sunflower
Helianthus rydbergii Britton ——— Clustered Sunflower
Hierochloe odorata (L.) Beauv. ——— Sweetgrass
Hippuris vulgaris L. ——— Marestail
Hordeum jubatum L. ——— Wild Barley
Hypoxis hirsuta (L.) Coville ——— Yellow Stargrass
Iva xanthifolia Nutt. ——— False Ragweed
Juncus balticus Willd. ——— Baltic Rush
Juncus dudleyi Wieg. ——— Dudley's Rush
Juncus interior Wieg. ——— Rush
Juncus torreyi Coville ——— Torrey's Rush
Kochia scoparia (L.) Roth ——— Kochia
Lactuca scariola L. ——— Prickly Lettuce
Lemna minor L. ——— Common Duckweed
Lemna trisulca L. ——— Star Duckweed
Lilium philadelphicum L. — Red Lily
Lindernia dubia (L.) Pennell ——— False Pimpernel
Lobelia kalmii L. ——— Kalm's Lobelia
Lycopus asper Greene ——— Western Water-horehound
Lysimachia hybrida Michx. ——— Lanceleaf Loosestrife
Lysimachia thrysiflora L. — Tufted Loosestrife
Marsilea mucronata A. Br. ——— Water Fern
Mentha arvensis L. ——— Wild Mint
Muhlenbergia asperifolia (Nees & Meyen) Parodi — Scratchgrass
Muhlenbergia glomerata (Willd.) Trin. ——— Marsh Muhly
Myriophyllum exalbescens Fern. ——— Common Watermilfoil
Panicum capillare L. ——— Witchgrass
Panicum virgatum L. ——— Switchgrass
Parnassia palustris L. ——— Bog Star
Phalaris arundinacea L. — Reed Canarygrass
Phragmites communis Trin. ——— Phragmites
Plagiobothrys scopulorum (Greene) I. M. Johnston ——— False-purslane
Plantago eriopoda Torr. — Alkali Plantain
Poa palustris L. ——— Fowl Bluegrass
Poa pratensis L. ——— Kentucky Bluegrass
Polygonum amphibium L. — Water Smartweed
Polygonum coccineum Muhl. ——— Marsh Smartweed
Polygonum convolvulus L. ——— Black Bindweed
Polygonum lapathifolium L. ——— Nodding Smartweed
Polygonum prolificum L. — Longbranch Knotweed
Potamogeton gramineus L. ——— Variableleaf Pondweed
Potamogeton pectinatus L. ——— Sago Pondweed
Potamogeton pusillus L. — Grassleaf Pondweed
Potamogeton richardsonii (Ar. Benn.) Rydb. ——— Claspingleaf Pondweed
Potentilla anserina L. ——— Silverweed
Potentilla norvegica L. — Rough Cinquefoil
Puccinellia nuttalliana (Schultes) Hitchc. ——— Alkaligrass
Ranunculus cymbalaria Pursh ——— Seaside Buttercup
Ranunculus gmelini DC. — Bog Watercrowfoot
Ranunculus macounii Britt. ——— Macoun's Buttercup
Ranunculus sceleratus L. — Cursed Buttercup
Ranunculus septentrionalis Poir. ——— Swamp Buttercup
Ranunculus trichophyllus Chaix ——— White Watercrowfoot
Riccia fluitans L. ——— Aquatic Liverwort
Ricciocarpus natans (L.) Corda ——— Aquatic Liverwort
Rorippa islandica (Oeder) Borbas ——— Marsh Cress
Rosa arkansana Porter — Prairie Rose
Rosa woodsii Lindl. ——— Western Rose
Rumex maritimus L. ——— Golden Dock
Rumex mexicanus Meisn. — Narrowleaf Dock
Rumex occidentalis S. Wats. ——— Western Dock
Ruppia maritima L. ——— Saltwater Widgeongrass
Ruppia occidentalis S. Wats. ——— Western Widgeongrass
Sagittaria cuneata Sheldon ——— Arumleaf Arrowhead
Salicornia rubra Nels. ——— Samphire
Salix candida Flugge ——— Hoary Willow
Salix interior Rowlee ——— Sandbar Willow
Salsola kali L. ——— Russian Thistle
Scirpus acutus Muhl. ——— Hardstem Bulrush
Scirpus americanus Pers. — Common Threesquare
Scirpus atrovirens Willd. — Dark-green Bulrush

Scirpus fluviatilis (Torr.) Gray ---- River Bulrush
Scirpus heterochaetus Chase ---- Slender Bulrush
Scirpus nevadensis S. Wats. ---- Nevada Bulrush
Scirpus paludosus A. Nels. ---- Alkali Bulrush
Scirpus validus Vahl. ---- Softstem Bulrush
Scolochloa festucacea (Willd.) Link ---- Whitetop
Scutellaria epilobiifolia A. Hamilton ---- Marsh Skullcap
Senecio congestus (R. Br.) DC. ---- Marsh Ragwort
Setaria glauca (L.) Beauv. ---- Yellow Foxtail
Sium suave Walt. ---- Water-parsnip
Solidago altissima L. ---- Tall Goldenrod
Solidago graminifolia (L.) Salisb. ---- Narrowleaf Goldenrod
Sonchus arvensis L. ---- Sow-thistle
Sparganium eurycarpum Engelm. ---- Giant Burreed
Spartina gracilis Trin. ---- Alkali Cordgrass
Spartina pectinata Link. ---- Prairie Cordgrass
Stachys palustris L. ---- Marsh Hedgenettle
Suaeda depressa (Pursh) S. Wats. ---- Western Seablite
Symphoricarpos occidentalis Hook. ---- Wolfberry
Taraxacum officinale Weber ---- Common Dandelion
Teucrium occidentale Gray ---- Germander
Thlaspi arvense L. ---- Field Pennycress
Triglochin maritima L. ---- Common Arrowgrass
Typha "glauca" Godr.[1] ---- Hybrid Cattail
Typha latifolia L. ---- Common Cattail
Utricularia vulgaris L. ---- Common Bladderwort
Vernonia fasciculata Michx. ---- Western Ironweed
Veronica peregrina L. ---- Purslane Speedwell
Viola nephrophylla Greene ---- Kidneyleaf Violet
Xanthium italicum Moretti ---- Cocklebur
Zannichellia palustris L. ---- Horned Pondweed
Zigadenus elegans Pursh ---- White Camas
Zizia aptera (Gray) Fern. ---- Golden Alexanders

[1] Recent investigations show this to be a hybrid between *Typha latifolia* and *Typha angustifolia*.

Plate 1.—Ephemeral pond, cover type 1 (I–1), early spring aspect shortly after surface water had disappeared. Last year's growth of low-prairie species include Kentucky bluegrass (*Poa pratensis*), switchgrass (*Panicum virgatum*), white sage (*Artemisia ludoviciana*), Canada anemone (*Anemone canadensis*). May 7, 1963, Stutsman County, N. Dak.

Plate 2.—Temporary pond, fresh, cover type 1 (II–A–1). Central wet-meadow zone dominated by old-growth fowl bluegrass (*Poa palustris*). May 8, 1963, Stutsman County, N. Dak.

Plate 3.—Temporary pond, fresh, cover type 2 (II–A–2). Old-growth wet-meadow vegetation composed chiefly of scattered false-aster (*Boltonia latisquama*) in open central portion, surrounded by a dense stand of fowl bluegrass (*Poa palustris*). May 7, 1963, Stutsman County, N. Dak.

Plate 4.—Temporary pond, slightly brackish, cover type 1 (II–B–1). Central wet-meadow zone dominated by wild barley (*Hordeum jubatum*), associated with scattered biennial wormwood (*Artemisia biennis*). July 28, 1964, Stutsman County, N. Dak.

Plate 5.—Temporary pond, slightly brackish, cover type 4 (II–B–4). Wet-meadow emergent vegetation submersed by high water from spring runoff. May 5, 1966, Stutsman County, N. Dak.

Plate 6.—Seasonal pond, fresh, cover type 1 (III–A–1). Giant bur-reed (*Sparganium eurycarpum*) and slough sedge (*Carex atherodes*) are predominant emergent species in central shallow-marsh zone. July 13, 1964, Stutsman County, N. Dak.

Plate 7.—Seasonal pond, slightly brackish, cover type 2 (III–B–2). Common spikerush (*Eleocharis palustris*) and slough sedge (*Carex atherodes*) are prevalent emergent species in central shallow-marsh zone. July 13, 1964, Stutsman County, N. Dak.

Plate 8.—Seasonal pond, slightly brackish, cover type 3 (III–B–3). Shallow-marsh zone composed of central open-water phase surrounded by normal emergent phase that is dominated by slough sedge (*Carex atherodes*) and whitetop (*Scolochloa festucacea*). June 25, 1964, Stutsman County, N. Dak.

Plate 9.—Seasonal pond, slightly brackish, cover type 4 (III–B–4). The extensive, open-water phase is the result of mowing the emergent, shallow-marsh vegetation, composed chiefly of slough sedge (*Carex atherodes*) and whitetop (*Scolochloa festucacea*). May 5, 1966, Stutsman County, N. Dak.

Plate 10.—Slightly brackish pond (intermediate between III–B–2 and IV–B–2) with emergent vegetation of central zone, composed of a mixture of shallow-marsh and deep-marsh associations. Dominant shallow-marsh species include slough sedge (*Carex atherodes*), whitetop (*Scolochloa festucacea*) and common spikerush (*Eleocharis palustris*). Dominant deep-marsh species include hybrid cattail (*Typha "glauca"*), river bulrush (*Scirpus fluviatilis*) and hardstem bulrush (*Scirpus acutus*). July 15, 1965, Stutsman County, N. Dak.

Plate 11.—Slightly brackish pond (intermediate between III–B–2 and IV–B–2) with emergent vegetation of central zone, composed of a mixture of deep-marsh species, dominated by hardstem bulrush (*Scirpus acutus*), and shallow-marsh species, dominated by slough sedge (*Carex atherodes*). July 13, 1964, Stutsman County, N. Dak.

Plate 12.—Slightly brackish pond, cover type 1 (III–B–1) showing temporary reversal of usual spatial relationship of shallow-marsh and deep-marsh zones resulting from shallow reflooding of central bare mud flats following drought conditions. Common spikerush (*Eleocharis palustris*) is the dominant species in the central shallow-marsh zone, and hybrid cattail (*Typha "glauca"*) is the dominant in the peripheral deep-marsh zone. August 4, 1961, Stutsman County, N. Dak.

Plate 13.—Semipermanent pond, fresh, cover type 3 (IV–A–3). Deep-marsh zone represented by central open-water phase surrounded by emergent vegetation, composed chiefly of common cattail (*Typha latifolia*). May 7, 1963, Stutsman County, N. Dak.

Plate 14.—Portion of a large semipermanent pond, slightly brackish, cover type 3 (IV–B–3). Open-water phase of deep-marsh zone, surrounded by band of deep-marsh emergents, composed chiefly of hybrid cattail (*Typha "glauca"*). July 24, 1965, Stutsman County, N. Dak.

Plate 15.—Portion of a large semipermanent pond, slightly brackish, cover type 1 (IV–B–1). Shallow-marsh zone (in foreground) consisting of slough sedge (*Carex atherodes*), adjoins central deep-marsh zone, composed chiefly of river bulrush (*Scirpus fluviatilis*). May 7, 1963, Stutsman County, N. Dak.

Plate 16.—Semipermanent pond, slightly brackish, cover type 2 (IV–B–2). Central deep-marsh zone represented by open-water phase, interspersed with emergent associations composed of hybrid cattail (*Typha "glauca"*) and hardstem bulrush (*Scirpus acutus*). August 10, 1965, Stutsman County, N. Dak.

Plate 17.—Semipermanent pond, slightly brackish, cover type 1 (IV–B–1). Predominant emergent vegetation of central deep-marsh zone is composed chiefly of hardstem bulrush (*Scirpus acutus*), associated with a few small patches of hybrid cattail (*Typha "glauca"*). August 1, 1962, Stutsman County, N. Dak.

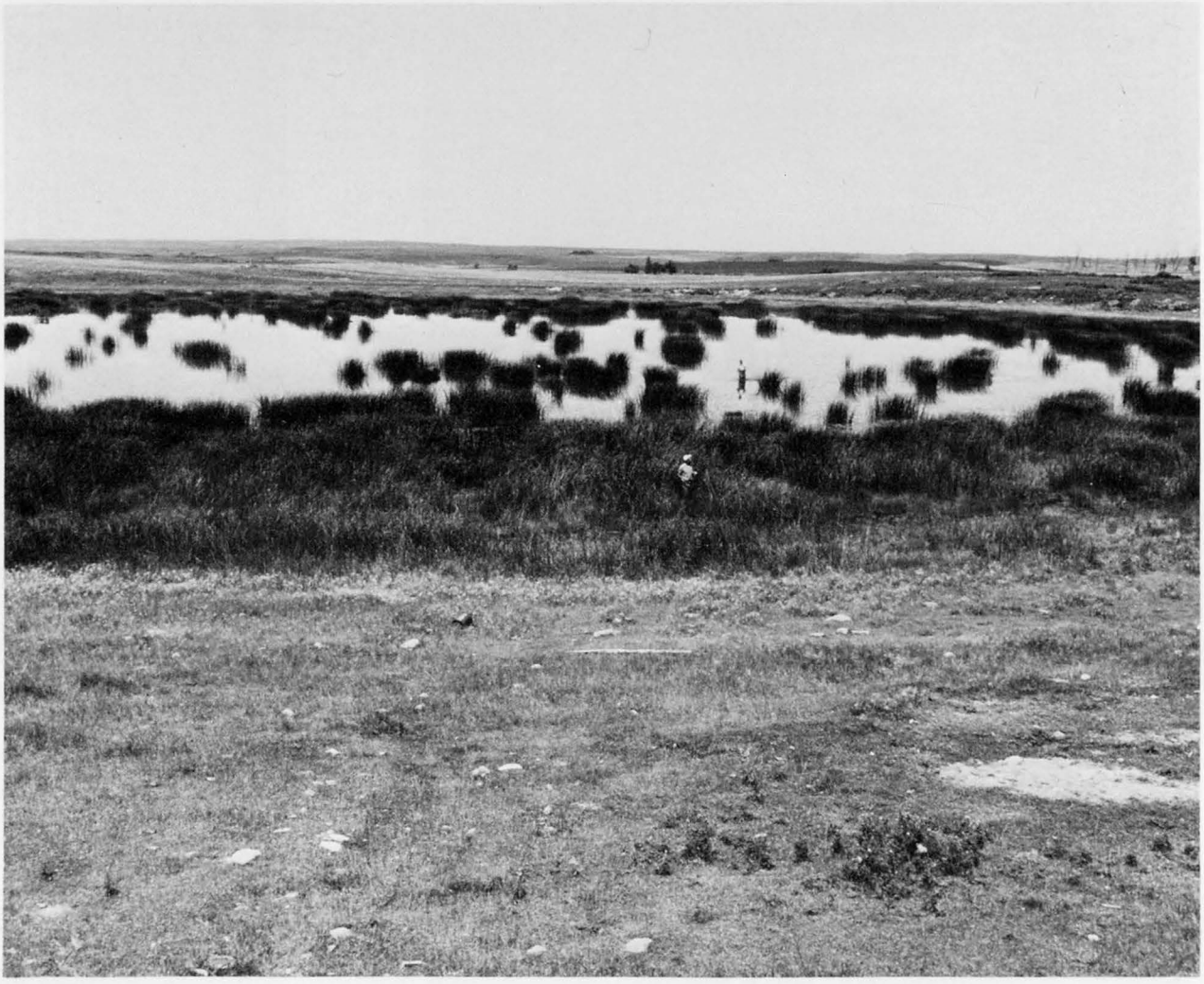

Plate 18.—Semipermanent pond, slightly brackish, cover type 2 (IV–B–2). Deep-marsh zone represented by open-water phase interspersed with and surrounded by emergent vegetation composed of a mixture of hardstem bulrush (*Scirpus acutus*) and slender bulrush (*Scirpus heterochaetus*). August 20, 1965, Stutsman County, N. Dak.

Plate 19.—Central portion of a large semipermanent pond, moderately brackish, cover type 2 (IV–C–2), during severe drought conditions. Deep-marsh zone represented by drawdown bare-soil phase, interspersed with clumps of emergent vegetation composed of hardstem bulrush (*Scirpus acutus*). August 4, 1961, Stutsman County, N. Dak.

Plate 20.—Changes in vegetative deep-marsh cover in a semipermanent pond, moderately brackish, cover type 3 (IV–C–3), due to rising water levels. Hardstem bulrush (*Scirpus acutus*) is the predominant emergent species. From top to bottom, photographs were taken in the summers of 1962, 1964, and 1966. This pond was dry during the extreme drought of 1961. Stutsman County, N. Dak.

Plate 21.—Semipermanent pond, brackish, cover type 2 (IV–D–2). Central deep-marsh zone represented by open-water phase interspersed with and surrounded by emergent vegetation composed of a mixture of hardstem bulrush (*Scirpus acutus*) and alkali bulrush (*Scirpus paludosus*). August 7, 1962, Stutsman County, N. Dak.

Plate 22.—Aspect of central portion of a semipermanent pond, brackish, cover type 3 (IV–D–3), following drought. Deep-marsh zone represented by open-water phase, surrounded by band of drawdown emergent vegetation composed of wild barley (*Hordeum jubatum*). August 3, 1962, Stutsman County, N. Dak.

Plate 23.—Semipermanent pond, subsaline, cover type 2 (IV–E–2). Deep-marsh zone represented by open-water phase, drawdown bare-soil phase, and emergent vegetation composed entirely of alkali bulrush (*Scirpus paludosus*). Adjoining, light-colored band of shallow-marsh emergent vegetation is composed of alkaligrass (*Puccinellia nuttalliana*). July 24, 1964, Stutsman County, N. Dak.

Plate 24.—Portion of a permanent lake, slightly brackish, cover type 4 (V–B–4). May 7, 1963, Stutsman County, N. Dak.

Plate 25.—Portion of a permanent lake, slightly brackish, cover type 4 (V–B–4). June 2, 1964, Stutsman County, N. Dak.

Plate 26.—Shoreline of a permanent lake, moderately brackish, cover type 4 (V–C–4). Vegetative debris in windrows on shore is composed of western widgeongrass (*Ruppia occidentalis*) from central permanent-open-water zone, and sago pondweed (*Potamogeton pectinatus*) and claspingleaf pondweed (*Potamogeton richardsonii*) from open-water phase of marginal deep-marsh zone. August 20, 1965, Kidder County, N. Dak.

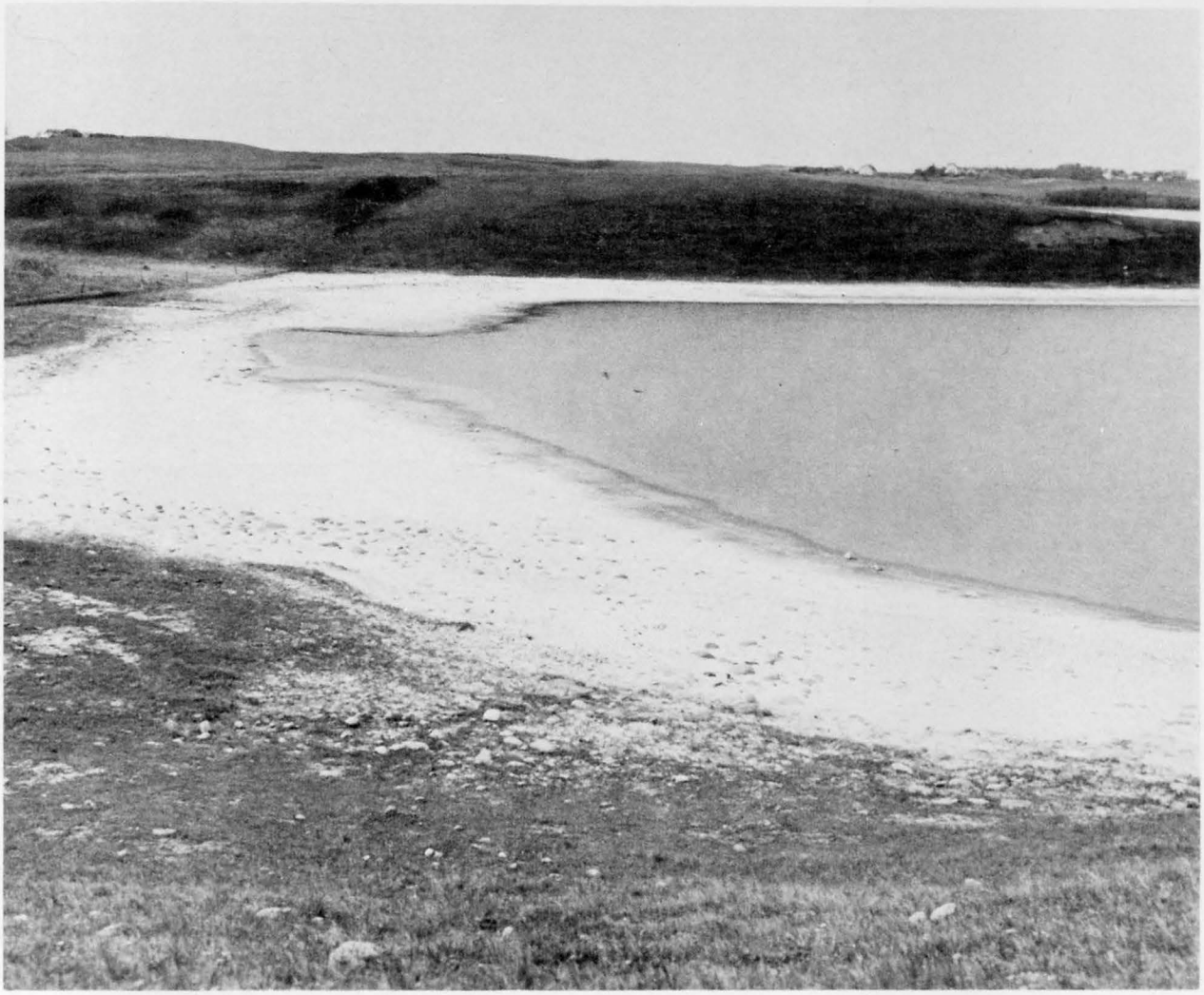

Plate 27.—Alkali lake (VI–4). Intermittent-alkali zone is represented by shallow open-water phase bordered by exposed glistening-white alkali mud flats. May 27, 1968, Sheridan County, N. Dak.

Plate 28.—Alkali lake (VI–4). Intermittent-alkali zone is represented by shallow open-water phase and exposed alkali mud flats. Surface salts on mud flats in the foreground have been largely removed by wind erosion. August 3, 1962, Stutsman County, N. Dak.

Plate 29.—Central portion of a large fen or alkaline bog (VII–1). Vegetation is primarily aquatic sedge (*Carex aquatilis*) and northern reedgrass (*Calamagrostis inexpansa*) with scattered hoary willow (*Salix candida*). This association is typical of many fens found in North Dakota. September 8, 1964, Clearwater County, Minn.

Plate 30.—Tillage ponds (T–4) in cultivated cropland. Indicator plant species were not present. June 14, 1968, Barnes County, N. Dak.

Plate 31.—Tillage pond (T–2) in wheat stubble. Indicator plant species were not present. May 5, 1966, Stutsman County, N. Dak.

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