The Selection of Prairie Areas in Iowa Which Should Be Perserved

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Reprinted from the
PROCEEDINGS OF THE IOWA ACADEMY OF SCIENCE
Vol. 52: 1945

By the

IOWA CONSERVATION COMMISSION
Des Moines, Iowa

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THE RECOMMENDED PRAIRIE PRESERVE

In 1933, the Iowa Board of Conservation and the Iowa Fish and Game Commission now known as the Iowa State Conservation Commission prepared a report known as the *Iowa Twenty-Five Year Conservation Plan*. It was designated as a program for the judicious use of Iowa's natural resources. In the section of the Twenty-Five Year Plan listing and describing Scientific Preserves one type is recommended which had not been included previously. It is the Prairie Preserve. The following is the recommendation:

"Prairie Preserve—Recommended. Along the railroad rights-of-way, and here and there in small patches throughout the state, unbroken virgin prairie sod is still to be found. Some of these will be saved because they lie within protected areas, or simply because the ground cannot be used for farm purposes. But somewhere in Iowa a large enough original tract of prairie vegetation should be secured in order to save, under control of the state, the characteristic landscape, and wild flowers, and wild life of the native prairies. Several tracts ranging from forty to three hundred acres have been found by the survey. The Conservation Plan includes a Prairie Preserve which will be one of the remaining original areas, or which may be produced by purchase of semiwaste land and bringing it back to prairie condition in a few year's time."

Frequently since that time various recommendations for purchase have been made by citizens to the State Conservation Commission. Among objections raised by the public was that of taking potentially productive land out of cultivation, for the grassland is the most valuable of the arable lands in Iowa. However, it can be shown that maintenance of productivity and fertility in cultivated soils is attributable to scientific knowledge derived from the study of plants and soils. The production of cultivated crops requires persistent attention, but the native plants when undisturbed are able to establish, adjust, and reproduce themselves indefinitely without culture or reseeding. In the past twenty-five years researches on the contributions of native plants to soil making and studies concerning collective occupation of the soil has opened the way for application of these principles to grazing management. Only experimental beginnings have thus far been made in the economic use of native plants, yet the native plants constitute the vegetation which has through the ages been instrumental in impregnating the once sterile glacial and wind-laid rocks and minerals with organic matter. Practically all of Iowa's

*A report prepared for the Iowa State Conservation Commission relating to their program for conservation of prairie and also adopted by the Conservation Committee of the Iowa Academy of Science as a supplement to its Prairie Project.

crop plants are of Eur-Asian origin and are grown locally in environments foreign to them.

THE COVERLESS PRAIRIE SOIL

PRODUCTIVITY AND SOIL CONSERVATAON

When the pioneers first turned the sod of Iowa, they were thankful for a harvest which afforded a moderate living, for many had come from regions of earlier settlement depleted by the uncompensated tillage of many generations where the soils had at last lost such fertility as they had. In the past twenty years the productivity of crop plants has been improved by scientific workers who, through experiments in selection and crossing of cultivated plants, have developed strains which are adapted to diverse conditions, increased productivity, and resistance to attacks by parasites. However, as production increased failure to insure anchorage of the surface soils against depletion by sheet erosion and gullying resulted in the loss of organic matter in the top soils. To such an extent has the surface soil been removed in the earlier settled parts of the state that years will be required to restore its productivity, if it can be accomplished at all in certain areas.

Nevertheless ,improved methods of culture such as the introduction of hybrid corn seed has materially increased the harvest of corn. Yet of all the factors mentioned—selection of crop, adaptation of strain, controlled fertility, and improved production are variables approaching a limit—the limit of maximum production. Yet maximum production on virgin prairie soil is far different from maximum production on depleted soil. The former permits a high level of income, while the latter portends a decline in resources.

THE HAZARD OF EROSION

In the hundred years which have elapsed since the white man wrested the grassland from the red man relatively few people who tilled the soil realized that particle by particle the surface soil was slipping away, water transported beyond the bounds of Iowa. Though erosion is a process of nature long recognized by the geologist and the soil scientist, the layman is frequently unconscious of his contribution to this process. The seriousness of the depletion of the soil by erosion in Iowa has become widely realized only within a decade, though it has been continuous since the removal of the cover by the early settlers, and accelerated by ordinary cultivation. Stevenson (1910-1914) has discussed this subject in Reports of the Experiment Station as early as 1910. The greatest impetus to erosion in recent years has been the first world war whose food requirements stimulated increased food production leading to the cropping of even submarginal lands. The unprecedented acreage of soil bared of its grassy protective cover during a period of severe drought, demonstrated through the impressive action of the prolonged dust storm that a major error in land management had been made. And it will not be corrected in one lifetime. If knowledge of soil classification, composition, characteristics, and care will solve the problem of soil preservation, the literature of the Soil Survey of Iowa covering 82 of the 99 counties, the monographs of Iowa Soils (Brown, 1936) and Soil Erosion in Iowa (Brown and Walker, 1936) as well as a series of research bulletins should furnish ample information. But information does not disseminate itself. Nor do informed persons practice their doctrines as is commonly illustrated by scanning the landscape. A chance-made, unchecked cowpath may start a gully which will in time carry off the surface of the adjacent hillside. A path traced by the inertia-weighted feet of many pedestrians soon becomes an unsightly ditch across the grassy lawn. The straight coursed, silt-laden brook widens into a winding stream of increased transporting capacity. And so the soil slips away in a seemingly commonplace manner, when no one is looking. Unless the man is taught to see the dynamics of his environment in the days of youth perhaps there will be too few mature citizens who are trained to recognize vanishing soil and to exercise initiative in its preservation.

Trends in Conservation

With a second world war severely taxing our resources and world recovery in all probability setting a new level for food production, the comment of the Federal Secretary of Agriculture (Wickard, 1944) at the Ninth North American Wildlife Conference is timely:

> We are at the crossroads in our history in so far as our natural resources are concerned. Either we take the uphill road to conservation and restoration or the downhill road to further exploitation and eventual ruin. The decision as to which course we shall pursue is clearly up to us.

At the same conference Ira N. Gabrielson, Secretary of the Department of Interior stated:

> During recent years there has been increasing criticisms of the acquisition of lands for public purposes . . . it may nevertheless still be advisable for the general good for public agencies to acquire additional lands.

The resolve to acquire some tracts of native prairie with its typical soil associations in virgin state constitutes a safeguard to the welfare of the research program in Iowa which represents the cornerstone of her economic welfare. It is obviously in accord with the federal plan of conservation.

THE VALUE OF PRAIRIE PRESERVES

The Recommended Preserve

The original recommendation for prairie preserve specifies that the area should "save the characteristic landscape, wild flowers and wild life of the native prairies." This simple, objective statement is very comprehensive for the wild flowers include not only the grasses but the broad-leaved flowering herbs of the major types of vegetation on which the animal life depends for food and shelter. To the landscape belongs the soil in which the plants are anchored with its diverse topographic variations in slope, and conformity of the earth's surface. The particular location in which a plant may live depends on such environmental conditions as composition, structure, and moisture of the soil, the intensity of life, the exposure to wind, and competition with other plants for the essentials of life.

THE APPEARANCE OF PRAIRIE LANDSCAPE

The landscape of the prairie is characteristic. Though the topography is intact, few examples of the prairie vegetation remain. In the early days of spring when the last snowbank has melted away from the reddish-brown grassland, myriads of lavender pasque flowers lend a bluish cast to the gravelly knolls of the rolling northern prairies. Their arrival marks the end of the white expanse of winter.

Compared with the somberness of the woodland, the prairie landscape throughout the growing season exhibits constant change. On a breezy July day in early afternoon, rapidly rising miniature cloud forms assembling like flocks of butterflies on the horizon will expand in a few minutes into swiftly advancing cohorts of giant white clouds floating briskly through the vault of blue. Their flying forms momentarily darken with fast moving shadows the waving grasses, which rhythmically rise and fall with the touch of the wind.

At a time when the vegetation stands quietly, or is only slightly ruffled by the breeze one may perceive in the mosiac pattern of the prairie recurrent strips, patches, or spots whose various shades of green mark the boundaries of different communities of plants composing the vegetation. Throughout the season from April to October the colorful flowers of the grassland flora present a rainbow-hued sequence of bloom.

These brief descriptions serve merely to illustrate some of the external aspects of scattered remnants of the grassland vegetation of Iowa. It is identified with the open sky. It is the unprotected battleground of wind and weather. For the impressions of its former vastness and endless expanse now replaced by grove-dotted, fence-rowed fields of checkered green one must refer to the many records of history and literature.

PRAIRIE PLANTS AS A FACTOR IN SOIL MAKING

Without the residual deposits of the prairie herbage, to which Iowa soils owe their organic fertility, the rock materials would be as sterile as the freshly released till deposited by the receding glacier. It was the prairie vegetation evolved through centuries during the interglacial periods, which populated and repopulated the newly bared rocks and minerals after each of the several glacial recessions. In relatively recent times of the last postglacial period, the prarie vegetation has taken its present form. Through unmeasured time it has, season by season, incorporated with the earth its entire

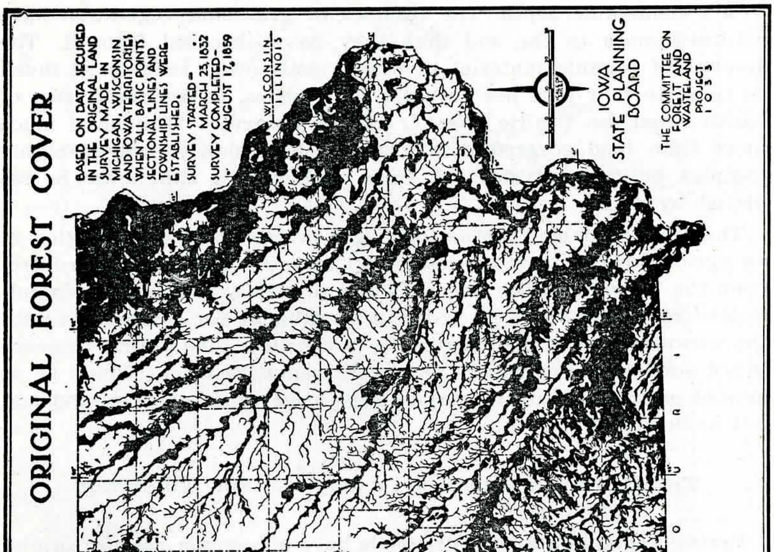

Figure 1. Areas occupied by forest and grassland based on data of the First U. S. Government Land Survey. By courtesy of the Iowa Planning Board.

above ground mass which dies down each year. Beneath the dense sod composed of short stems and finely divided roots of prairie plants the subterranean parts of sixty-five percent of the prairie species extend their roots beyond five feet, a maximum depth of eighteen to twenty-four feet some times being attained, according to Weaver (1944). The eventually dying roots thus contribute organic materials to a considerable depth. The residues of grassland vegetation have returned more to the soil than they have absorbed from it. The amount of organic material in prairie soils often reaches as much as three to four tons per acre per four inches. In his description of North American Prairie, Weaver (1944) observes: "Prairie is much more than land covered with grass, it is a slowly evolved highly complex entity, centuries old. Once destroyed it can never be replaced by man."

The most valuable function of virgin prairie to food production in an agricultural state is the use as an experimental check or control upon the known fertility and structure of soils which have been cultivated for many years. In order to be valuable for comparison with the various types of cultivated soils in the state, one prairie preserve is not sufficient. For this purpose representative tracts should be so located as to illustrate the major vegetative types of grassland and soil associations.

THE COMMON FACTORS OF PRAIRIE AND SOIL FORMATION

Prairie vegetation and prairie soils have a common basis of origin. Both are recognized products of climate, time, geological history, and topography. Vascular plants and soils are reciprocally dependent upon each other for the elements of their structure, since plants contribute organic materials to the soils which constitute the major part of their fertility and soils furnish the mineral elements of plant structures. The selection of representative prairie preserves will therefore require familiarity with (1) the location of the characteristic prairie vegetations, floras and associated faunas; (2) the representative types of soil associations of the prairie district; (3) the climatic aspects of Iowa; and (4) the topographic features which serve as indicators of soil and vegetation types.

THE BASIS FOR SELECTION OF PRAIRIE TRACTS

THE MAJOR VEGETATIVE FORMATIONS—THE GRASSLAND AND THE FOREST

As the observer in the past hundred years has regarded the physiognomy in Iowa, its surface has appeared through the years in ever changing aspect to both the physical eye and the mind's eye. First, and most apparent to the traveller in the covered wagon was the vast expanse of grassland traversed by rivers and dotted with lakes and ponds. The grass, wagon-box tall, did not obscure the vista,

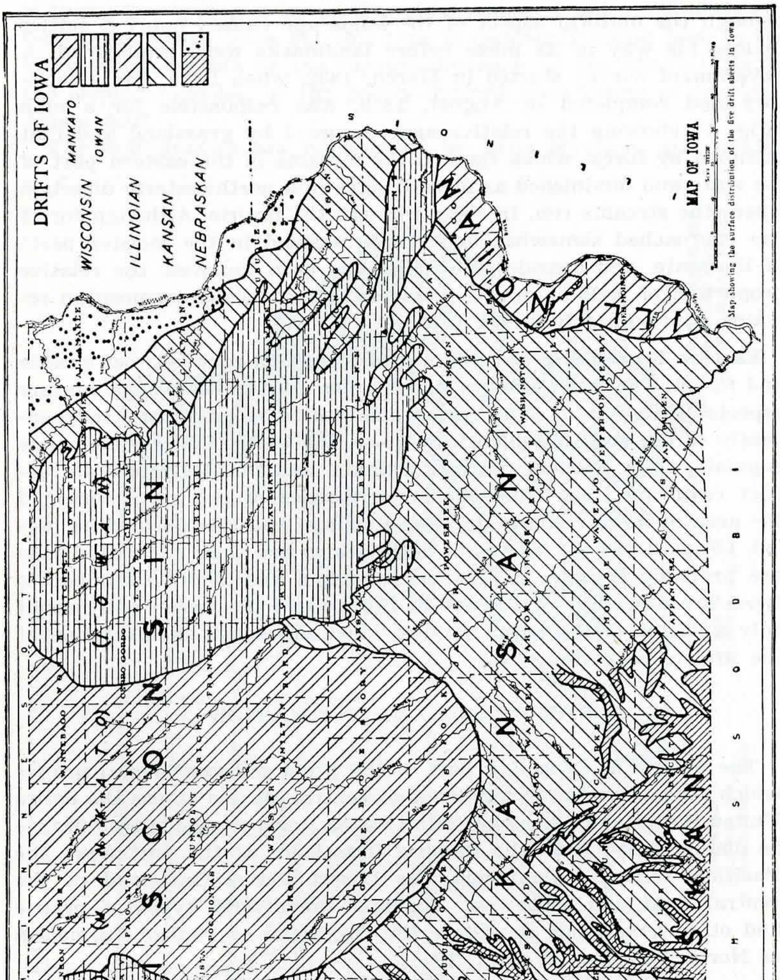

Figure 2. Map of the glacial drift sheets of Iowa. (From G. F. Kay and Paul T. Miller in the Pleistocene Gravels of Iowa. By courtesy of the Iowa Geological Survey). The parent soils are derived chiefly from the Mankato substage of the Wisconsin and wind-blown soil (loess) which covers the greater part of the other drifts.

through the uniform aspect of the landscape caused many a settler to lose his way in its maze before landmarks were established. A government survey started in March, 1832, when Iowa was a territory and completed in August, 1859, was responsible for a map (Fig. 1) showing the relative area occupied by grassland and that occupied by forest which flanked the streams in the eastern part of the state and diminished as mere fringes in a northwesterly direction where the streams run, treeless, through the prairie. Although forest has encroached somewhat upon the grassland in the moister parts of the state, and considerable forest has been removed, the relative proportion of soils of prairie origin to soil of forest composition remains approximately as six to one.

Eastern Iowa lies in the continental transition zone between prairie and forest. The latter fringes its water courses in their more mature aspects. These major plant formations cannot be considered independently of the soils in which they grow, the topographies which they populate, their present and past climate, and the developmental aspect requiring time. The older topographies of the state surround the area of more recently developed soils of the Wisconsin drift period. (Figs. 2 and 3.) The plant associations and their correlated soils are probably infinite in number, though a considerable number of types are described. The scope of the present discussion will permit only a sketch of the major factors which enter into the evolution of the prairie vegetation.

THE GRASSLAND FORMATION

The prairie of Iowa is a part of the great mid-continental prairie which reaches from the highlands of central Mexico across the entire United States and northward into Canada. Iowa prairie is true prairie as distinguished from the Palouse Grasslands of the northwest, the Pacific Prairie of California, the Desert Plains Grassland of the central west and southwest. Together the diverse types of prairie and other grasslands constitute the Grassland or Prairie Formation of North America (Weaver, 1944).

On the basis of climatic and vegetational soil groups of the United States (Marbut, 1935) the prairie soils are divided into northern and southern. Iowa, with the exception of its northeastern, northwestern, and southeastern corners, lies in the region of northern prairie soils.

GRASSLAND COMMUNITIES OR ASSCIATIONS

The main types of prairie plant associations or communities which occur in Iowa are determined by the annual precipitation.

The tall grasses are illustrated by big blue stem and slough grass which reach a height of six to eight feet. The tall grasses occur in the wetter eastern portions of the grassland where the precipitation is thirty-five inches or more. The chief range of tall grass prairie is farther east than Iowa but this type is commonly found here in the more moist aspects of the topography such as the alluvial plains, the sloping hillsides, or the poorly drained level plains of the Wisconsin drift.

The mid grasses are represented by little bluestem and needle-

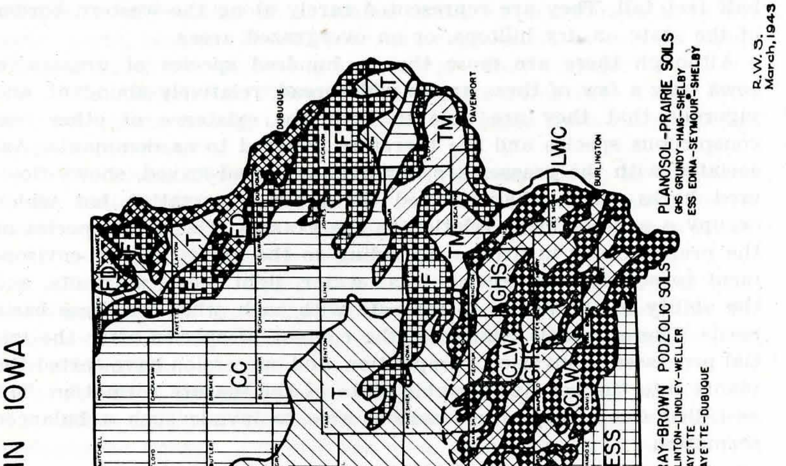

Figure 3. The soil associations in Iowa. The Prairie Series, include (1) Prairie soils, (2) Alluvial soils, and (3) Planosol-prairie soils. The map was prepared by R. W. Simonson. Soils Subsection, Iowa Agricultural Experiment Station. (Unpublished manuscript.)

grass, which vary from two to four feet in height. The mid grasses grow on the uplands of Iowa, though they mingle with the tall grasses on the lower slopes but are unable to withstand the shading of the tall grasses on low, wet soil. They occur in areas of twenty-three to thirty-four inches of precipitation in Iowa.

A third type of grassland which reaches Iowa only in traces on dry hilltops is the *short grass* which includes buffalo grass and blue grama. They are low in stature and are only one-half to one and one-half feet tall. They are represented rarely along the western border of the state on dry hilltops, or on overgrazed areas.

Although there are more than a hundred species of grasses in Iowa only a few of these are so widespread, relatively abundant, and vigorous that they are able to limit the existence of other less conspicuous species and are therefore referred to as dominants. Associated with the grasses are hundreds of broad-leaved, showy-flowered herbs which characterized the prairie vegetation but which occupy a sub-dominant relation to the grasses. The plant species of the prairie occur in groups according to the ability of the environment to supply such essentials as water, light, heat, nutrients, and the ability of the plants to compete with each other for these basic needs. There is little change in the content of species after the initial processes of invasion, competition, and succession have sorted the plants into the relatively stable state of the mature formation. The so-called weedy plants are seldom able to invade such a balanced formation.

GRASSLAND FLORAS

The use of the term, flora, is somewhat varied in literature. It may serve to distinguish the plants of a region from the animals. It sometimes designates a list of plants of a geological, climatic, or political unit such as a county or state. It will be used here with reference to the plant groups of the grassland which are either native to the grassland, or which have migrated from other climatic life zones and have become naturalized.

Of the known prairie plants of Iowa, only a few can be said to have developed since the close of the last glacial period (Wisconsin). Many aspects of the Iowa flora require further investigation. Representatives of several floral groups known to exist outside of the glaciated parts of North America have by migration found their way into Iowa. The names of the life zones which described the floras are those used by Merriam (1898) in connection with his articles on life zones and crop zones. The extent of territory occupied by these floras is known on the vegetation maps of Shantz and Zon (1924) in the Atlas of Natural Vegetation and on the map of Rydberg (1931), which supplements a short Phytogeography of the Prairies and Great Plains of Central North America.

The major floras which mingle in the prairies of Iowa include:

1. *The northern prairies* of the Boreal or Cold Temperate Zone of which the grasses are mostly eastern or transcontinental. Here occur the *fen* or peat floras.

2. *The central prairies* of the Middle Temperate Zone. This type also known as the true prairie is characterized by mid-grasses. It is difficult to draw a boundary line between the northern and central prairies, partly because the predominant grasses are mostly eastern and are found in both the Alleghanian and Canadian provinces. Rydberg has placed the line where the 120-day frost-free line crosses the prairie. *Secondary floras* whose center of distribution is to the north, south, east, or west of Iowa are represented by certain plants which are near the borders of their range. They include:

3. *The Alleghanian Flora* of the Middle Temperate Zone. Most of these plants belong to the forest, but some herbaceous species occur in the prairie.

4. *The Plains Flora* of the Middle Temperate Zone. Most species of the Plains Flora are found in Iowa only in the western tier of counties especially on the loess mantled bluffs of the Missouri River. Some occur throughout the state.

5. *The Southern Prairies* of the Warm Temperate or Upper Austral Zone. Species from the southern prairies occur chiefly in the grasslands of the southern half of Iowa, though some penetrate farther northward.

Local Floras of special interest include species referred to:

1. *Flora of the Driftless Area* which includes plants of ancient phylogenetic lineage. The driftless area, once thought to extend into Iowa, is an area of more than 6000 square miles not passed over by any of the four glacial drifts. It lies without the boundaries of Iowa to the northeast. However, many plants of northeastern Iowa are species characteristic of the driftless area.

2. *The Sand Flora,* which includes notable plants of lacustrine and fluviatile sands. The plants of lake sands are found north in the Wisconsin Lake Regions as well as in the vicinity of Lake Calvin. Examples of dunes derived from river sands occur on the upper Iowa, the Missouri, and the Mississippi Rivers.

SOME CLIMATIC ASPECTS OF IOWA

Climate is essentially concerned with temperature, moisture, and air movements resulting from changes in temperature expressed to some degree by a summary of factors relating to heat. The interaction of moisture and temperature working together may be expressed as humidity, evaporation, or precipitation. Thornthwaite (1931) stated that some climatic influences must have determined soil formation, each climatic province should have its own climax vegetation type. Iowa has a climate essentially favorable to a prairie vegetation. Though the greater area of prairie occurs in the northwestern fourth of the state, native grassland occurs elsewhere on the upland and on sand terraces of the larger rivers throughout the state.

The climatic past of Iowa has been marked by a series of far reaching changes, the climates of which are recorded mainly by fossil remains, during glacial and inter-glacial periods. The climatic variables which have maintained the vegetative types in recent times, based on years of scientific records are designated by the Weather Bureau in descriptive summaries; the average annual temperature for the state as a whole is 48°F. ranging from 44°F. along the north line to 52°F. at Keokuk. The length of growing season over a thirty-

AVERAGE LENGTH OF GROWING SEASON

State Average, 158 days

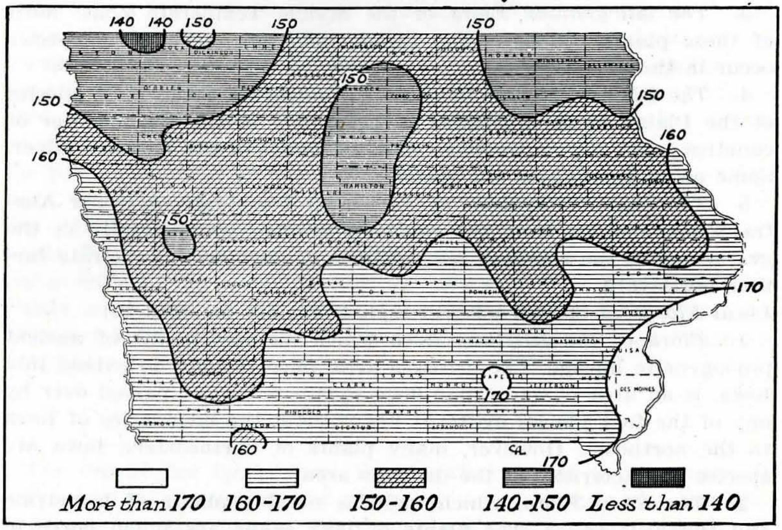

Figure 4. Number of days between average date of last killing frost in spring and average date of first killing frost in autumn; based on records of 40 years, 1899-1938. By permission of the Iowa Section of U. S. Weather Service.

five year period should give a comparative impression of the range of variation of temperature in the state as shown by figure 4. It may be noted that there is approximately a difference of 30 days in the length of the growing season in northwestern Iowa in comparison with that of the southwestern corner of the state.

The average rainfall is approximately 32 inches ranging from slightly more than 36 inches in a few stations in the extreme southeast to slightly less than 26 inches in the extreme northwest. The normal annual precipitation based on 35 years of data from 1898 to 1932, is shown in figure 5. Northwest winds prevail most of the time in winter in Iowa, except in the extreme southeast where southwest winds are about equally frequent, and the two directions combined prevail more than one-third of the time. From April to October southerly winds predominate, with almost the certainty of monsoons. (U. S. Weather Bureau, 1933.)

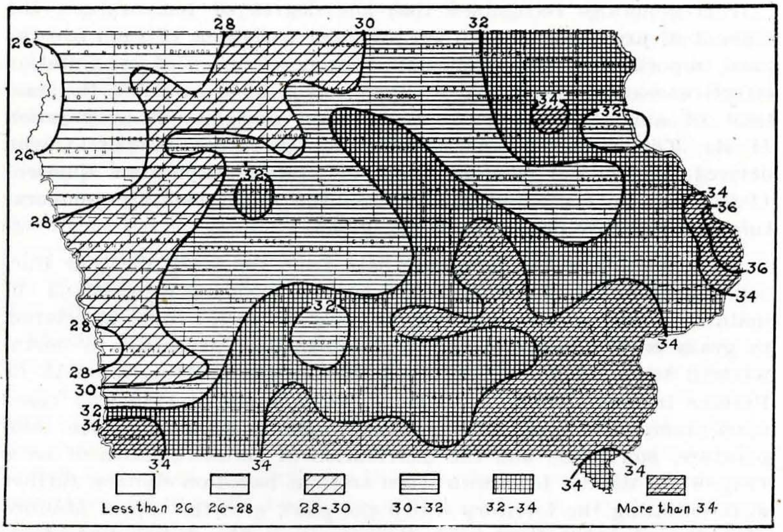

Figure 5. The normal annual precipitation based on 35 years of data from 1898 to 1932. State average 31.56 inches. By permission of the Iowa Section of U. S. Weather Service.

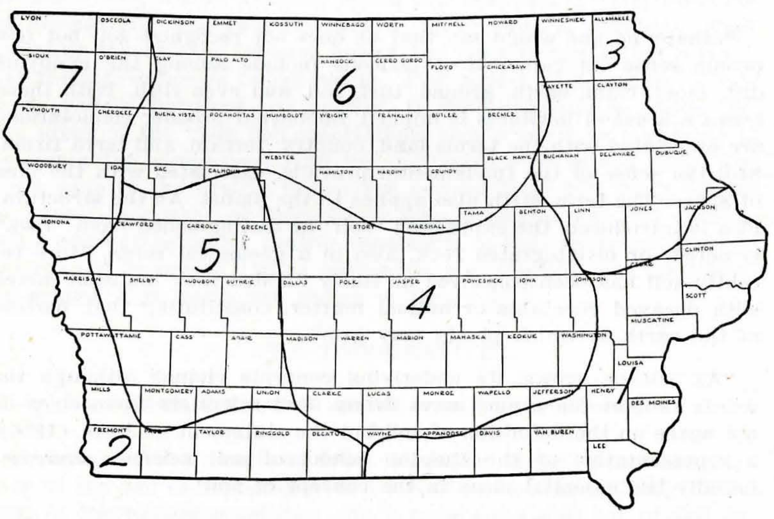

Figure 6. Plant growth regions of Iowa, based upon precipitation, evaporation ratios, length of growing season, temperature, soil types, and the distribution of sixteen species of plants. From unpublished manuscript of J. M. Aikman and H. O. Perkins.

It is generally recognized that the degree of temperature, the amount of precipitation, and the seasonal variations of each are the most important climatic elements. A proposed index of precipitation effectiveness was originated by Transeau in 1905 by using the quotient of annually measured precipitation and annual evaporation (P/E). This principle was modified by Thornthwaite (1931) who devised the method whereby the precipitation-evaporation quotient (P/E) can be computed, where only the mean monthly temperature and monthly precipitation are given.

An inspection of the foregoing data from the Iowa Weather Bureau indicates that the northwestern part of Iowa has a grassland climate. The map of Iowa showing the original forest cover in relation to grass cover illustrates the predominance of grassland in northwestern Iowa. (Fig. 1). An unpublished map constructed by H. O. Perkins in collaboration with Dr. J. M. Aikman in 1940 was based upon precipitation-evaporation ratios, length of growing season, temperature, soil types, and the distribution of sixteen species of trees (Fig. 6). It divides Iowa into seven sections based on climate, further differentiating the territory which the plant growth map of Mulford (Van Dersal, 1938) divides into three sections. The distribution of native plants of Iowa, particularly those which have indicator values, warrants further inquiry into the delineation of climatic sections of the state.

THE CONCEPT OF SOILS

Perhaps no one would say that he does not recognize soil but few people sense its value. Most lexicons include among the synoyms dirt, mold, loam, earth, ground, turf, sod, and even filth. With these terms a sense of lowliness is implied. Somewhat broader connotations are associated with the terms land, country, terrain, and terra firma. Still the sense of the fundamental prevails, associated with the idea of space. The term earth also applies to the planet. As the structural idea is introduced, the expression "soil" as distinguished from "rock" is noted; or disintegrated rock, also in a geological sense. More recently soil has been conceived as finely divided rock material mixed with decayed vegetable or animal matter, constituting that portion of the earth in which plants may grow.

"As science grows, its underlying concepts change although the words remain the same," says Jenny. Soil scientists themselves do not agree on the definition of soil but the statement of Joffe (1936), a representative of the Russian school of soil science, expresses broadly the essential ideas in the concept of soil:

> The soil is a natural body, differentiated into horizons of mineral and organic constituents, usually unconsolidated, of variable depth, which differs from the parent material below in morphology, physical properties, and constitution, chemical properties and composition, and biological characteristics.

The pioneering stages of soil study are past. A century of investigation in this subject in all parts of the world has placed Soil Science among the exact sciences. The effort to coordinate the great mass of detailed descriptions of soil types investigated has led to various classifications of soils which facilitates convenience in referring to them. The more recent trends of inquiry have accumulated a body of knowledge through the employment of the underlying principles used in the science of chemistry and physics. It is now understood that the soil forming factors include climate, organisms (biological), topography, parent material (rock), and time. They have but one feature in common. They are independent variables that define the soil system.

Though it is not essential for the layman to follow each step in the interpretation of soil phenomena, it is imperative that each one be in some degree aware of the accumulated knowledge of soil scientists and the significance of soils in problems of nutrition of animals and plants. Hopkins (1910) stated that for normal soils in the United States and especially for those in the central states there are only three constituents which must be supplied in order to adopt a system of farming which, if continued, will increase or at least permanently maintain the productive power of soil; these are calcium, phosphorus, and the nitrogen of organic matter. However, attention is directed by Albrecht (1944) to disorders restricting growth, fecundity and to other deficiency diseases resulting from consumption by animals of vegetable foods lacking some of the thirteen mineral elements supplied by the soil which are essential for the functions of animal life. The requirements of these mineral elements which maintain the balance between health and malnutrition is but a trace, yet their presence is indispensable. This aspect of nutrition is now being widely discussed and applied. In such problems as these, virgin areas of the main soil associations should serve as standards of reference for comparison with the cultivated soils in the state. The Iowa soils of the prairie region are derived from two main classes of parent materials, of glacial and loessial origin. The soil associations originating under prairie vegetation include those specified in the map of Simonson (1944) as Prairie, the Alluvial, and the Planosol-prairie soils which are shown in figure 3.

THE TOPOGRAPHY

PRAIRIE VEGETATION IN RELATION TO TOPOGRAPHY

Prairie occurs throughout Iowa. However, the shape of the surface of the soil or topography is a reliable indicator not only of the type of the prairie vegetation which covers the soil, but of the soil type itself when the parent material is known. The more common descriptions of topography include level or flat (the plain), undulating, rolling, or hilly. Within an upland plain there may occur slight variations such as knolls, slopes, and depressions which will result in moisture conditions differing from the normal of the greater part of the level area. Grasslands occur on the exposed ridges of forest, alluvial, and interfluviatile plains. Of great biological interest, also, is the transition area between two contrasting zones or communities of living things. The transition zone or ecotone between prairie and forest may be broad or narrow, indefinite, or sharply defined. It is characterized by an abundance of species of both animals and plants because of the variety of habitats afforded.

Though soil supplies the mineral elements and compounds for metabolic elaboration in plants, the physical characteristics of the surface conformity modify the primary habitat factors such as range of temperature, intensity of light, and relative humidity. The angle of slope and the relative elevation affects the water supply, the incidence of light, and the force of the wind. The vegetations which grow on the north and south slopes of a hill are markedly different in character. So different are the local environmental conditions that they are sometimes referred to as microclimate. For instance, the tall grasses which are restricted to moist slopes and valley plains of Iowa, in moister climates farther east have a broader climatic range.

GLACIAL TOPOGRAPHY OF IOWA

The sculpturing of the surface of Iowa may be summarized as the work of two agencies, the depositional and the erosional, effected through the combined action of ice sheet, wind, and water. The unconsolidated surface rocks which constitute a mantle of glacial origin are underlaid by indurated bed rock laid down by pre-glacial seas. So smoothed were the eroded surfaces of the bedrock by the opening of the glacial period, that the contour of their surface was a broad level plain with shallow valleys, in which no elevation reached more than 200 feet.

Derived chiefly from the four great ice sheets, the series of rock mantle included the deposits of the Nebraskan, the Kansan, the Illinoian, and the Wisconsin Ages. (Fig. 2). The three earlier drifts, with the exception of the Kansan, have little bearing on the composition of the soil except locally, where their exposure in river valleys, or through sheet erosion has made them a part of surface materials; yet in some instances they are thought to give character to the surface contours (Gwynne, 1942). The greater part of their surface is covered with a mantle of wind laid soil. The older drifts have a more mature erosional topography, in that the land is rougher and rolling to steep. The natural drainage systems are well developed with streams and their tributaries extend into all parts of the upland with the exception of some of the flat divides.

After more than forty years of research by investigators on the glacial history of Iowa, the Wisconsin Glacial Age is nof interpreted as including the Iowan drift (early Wisconsin), the Peorian Loess of interglacial origin, and the Mankato drift (late Wisconsin). These deposits as well as the Kansan, where the top soil has eroded away, constitute chiefly the parent materials from which present soils were derived. (Figs. 2 and 3). In many counties of southern Iowa the Kansan till has an important influence on the soils. In Ringgold County, for example, fifty percent of the soils are derived from Kansan till. (Stevenson and Brown, 1919).

THE WISCONSIN AGE

SURFACE ASPECTS OF THE MANKATO DRIFT.

The Wisconsin is the only area of distinctly drift depositional topography in the state. The Late Wisconsin, or Mankato deposits extend across the state as a lobe reaching from the Minnesota line to Des Moines. It includes 29 counties (Fig. 2). Around the borders of the drift lobe piles of glacial debris, the terminal moraines, mark the farthest advance of the ice. The surface of the drift is a generally flat or slightly undulating plain according to Kay and Graham (1943), except for low-lying mound-like hills and depressions on the surface of the ground moraine. The Mankato includes four terminal moraines which mark the periodic rests in the receding drift material by melting as the glacial epoch was approaching its close. They are known as the Bemis (Altamont of Chamberlain), the Altamont (Gary of Chamberlain), the Humboldt, and the Algona moraines from south to north. The moraine in Iowa seldom attains a height of more than 50 feet above the surrounding terrain, though Ocheydan mound in Osceola county, which reaches the highest elevation in Iowa, rises to 150 feet above the valley bottoms and covers an area of 40 acres. From the conspicuous highlands of the terminal moraines of the Mankato, the slope is gradual to the southward; the landscape is irregular, dotted with pools, ponds, and kettle holes. Chains of low hills extend as ranges across the country or enclose lakes. Shallow streams connecting the ponds here and there widen into marshes and gradually deepen into well defined channels coursing through the drift. In the western part of Dickinson County beyond Lake Okoboji remain a number of large expanses or prairie-covered, knob-like hills and ridges bordered with terrace-like gradations along the valley of the Little Sioux. Included within these prairies are the kettleholes, ponds, shallow streams, and peaty marshes, so characteristic of the immature drift surface.

SURFACE ASPECTS OF THE PEORIAN DEPOSITS

It is noted by Kay (1943) that the many persons who have studied Peorian loess have differed in their interpretation with regard to its origin and age. At present there is agreement as to its eolian origin but some difference in belief as to its relation to Iowan till. The more recent view concerning the time of loess deposition is that it took place after the Iowan ice had retreated to a greater or less extent, after an interglacial interval had actually begun. By such retreat extensive mud flats were left, and as they dried, before becoming covered with vegetation, strong winds which came, probably from the ice fields farther north, carried fine sands and silt from the bare surfaces and deposited them beyond the edge of the Iowan area, out upon the old eroded Kansan. The two main sources of loess were (1) the mud flats of the Missouri River, (2) the mud flats in front of the Iowan glacier, and (3) minor sources which occur along some of the larger mud flats of the Des Moines, Skunk, and Iowa Rivers.

Two deposits of windblown soil are recognized in Iowa: (1) the Peorian loess and the Loveland loess, both of the Peorian sub-age. The Peorian attains a maximum depth of 90 to 100 feet in western Iowa, and is the most widely distributed. With the exception of the area of the Mankato lobe of the Wisconsin glacier, loess of Peorian age occurs in the upper part of nearly every Pleistocene section in the state. The Loveland loess reaches 20 to 30 feet in thickness in western Iowa.

The Peorian loess of Iowa has not been distributed evenly over all of the state. Because of the localization of the two main source areas of the loess material, namely the mud flats in the valley of the Missouri River and the Iowan drift sheet, certain sections of the state have received a considerable thickness of the windblown material, while other regions more removed from the important sources received only a thin mantle over the surface of the drift or bedrock. Smith (1941) advanced the theory that winds of a northwesterly direction were chiefly responsible for the thinning of the loess deposits in a southeasterly direction. In considerable areas of the southern counties the loess has eroded away baring the Kansan drift. The types of erosional topography in Iowa are described by Kay and Graham (1943).

A GUIDE TO THE SELECTION OF PRAIRIE AREAS FOR PRESERVATION

In a broad sense the climate, the biological elements, and the soils derived from the parent material of a region as well as the topographic conformity during any period of time are very closely correlated. The vegetative types, topographies, and soils mature together. The original character of the surface rock parent materials determines the mineral constituents of the soils derived from it. The plant and animal forms of past ages determine its organic content or fertility. Time permits changes to take place in the chemical composition and textures of the soils which are accelerated by moisture, changes in temperature, and weathering. As previously stated, the factors of topography may be regarded as a descriptive indicator of the distribution of vegetation types within the Prairie Formation.

In order that representative types of prairie may be selected from the few remaining in various aspects of the state (see Figs. 1-6) the following procedure is recommended:

1. In general perspective, topography should serve as a descrip-

tive indicator for the identification of the vegetative types growing upon it such as the upland or alluvial plains, rolling drift surfaces, and ridges.

2. Areas known to support certain flora and fauna of significance should be selected on the basis of already acquired records or on the judgment of a plant or an animal ecologist.

3. Prairie typical of representative soil types when located in the field should be inspected and tested by a soil scientist.

The following list includes the recommended types of grassland essential to illustrate the principal biological and soil types of Iowa prairie. This classification was made by Shimek (1911). The known areas are to be classified with descriptive data, photographs, and points of historic interest.

Character of Grassland Required

1. Climatic including northern, central, and southern prairie types, and special floras, such as sand floras, those of the "driftless area" and the northern fen.
2. Soil types derived from the major glacial drifts, interglacial loess, and peat deposits.

Figure 7. The first state-owned prairie preserve located in the northeast quarters and southeast of Chester Township in Howard County. In the foreground are blazing star (*Liatrus pycnostachya*), button snakeroot (*Eryngium yuccifolium*), and Culver's root (*Veronicastrum virginisum*) among bluestem grasses. July 30, 1944.

3. Various topographic types should be represented:

a. The broad flat plains which characterized the Wisconsin and Iowan* drift areas and a part of the un-eroded Kansan* drift area such as may be observed in Osceola County and southward.

b. The more rolling drift surfaces such as are presented by the greater part of the Kansan* area and more or less distinct moraines bordering the Wisconsin and Iowan* areas.

c. The very rough loess ridges which border the Missouri Valley and which present the most extreme xerophytic conditions in Iowa.

d. The well-drained alluvial plains such as are shown at their best along the Missouri, but which are more or less developed along all of the larger streams.

e. The prairie ridges which appear in all of the forested rougher parts of the state, but are most striking in the more heavily timbered eastern parts where they have been known as "oak openings" because the surrounding forest, consisting largely of oaks, encroached upon them.

f. The sand-dune areas. These are usually considered distinct from the prairie but a comparison of the floras show that they differ but little.

*Loess mantled.

PERTINENT LITERATURE

Aikman, J.M. and Perkins, H. O.
1940. The distribution of native trees in Iowa in relation to the ecological factors of the state. (Unpublished manuscript).

Aikman, J. M.
1940. The effect of aspect of slope on climatic factors. Iowa State College Jour. Science. 15:161-167.

Albrecht, William A.
1944. Soil fertility and wildlife—cause and effect. Ninth N. A. Wildl. Conf. American Wildlife Institute, Washington, D. C.

Anderson, W. A.
1943. A fen in northwestern Iowa. Am. Midl. Nat. 29:787-791.

Brown, P. E.
1936. Soils of Iowa, Spec. Rept. No. 3. Soils Subsection, Iowa Agr. Exp. Sta.
1936. Soil Erosion in Iowa. Soils Subsection Iowa Agr. Exp. Sta. Conserv. Serv. U.S.D.A. Co-op.

Gabrielson, Ira N.
1944. Conservation in the future. Ninth N. A. Wildl. Conf. American Wildlife Institute, Washington, D. C.

Gwynne, C. S.
1942. Swell and swale pattern of the Mankato lobe of the Wisconsin drift plain in Iowa. Jour. Geol. 50:2z0-209.

Hopkins, Cyril G.
1910. Soil fertility and permanent agriculture. Ginn and Co. New York.

Iowa Board of Conservation and Iowa Fish and Game Commission.

1933. Report on the Iowa twenty-five year conservation plan. 176 pp. Des Moines. (Prepared by Jacob Crane, Jr. and George Wheeler Olcott.)

Iowa State Planning Board
1935. Restore the forest cover. 24 pp. Des Moines. (With map showing forest cover).

Jenny, Hans
1941. Factors of soil formation. McGraw-Hill Book Co. New York, N. Y.

Joffe, J. S.
1936. Pedology. Rutgers Univ. Press, New Brunswick.

Kay, G. F. and Apfel, E. T.
1929. The Pre-Illinoian Pleistocene geology of Iowa. Iowa Geol. Surv. 34:9-289.

Kay, G. F. and Miller, Paul T.
1941. The Pleistocene gravels of Iowa. Iowa Geol. Surv. 37:9-219.

Kay, G. F. and Graham, Jack B.
1943. The Illinoian and Post-Illinoian Pleistocene geology of Iowa. Iowa Geol. Surv. 37-11-255.

Marbut, C. F.
1935. Soils of the United States. Atlas of American Agriculture. Pt. III. U.S.D.A. Bur. Chem. and Soils. Washington, D. C.

Merriam, C. Hart.
1898. Life zones and crop zones of the United States. U.S.D.A. Div. Biol. Surv. Bull. 10:1-78. (With map showing the life zones of U. S.)

Rydberg, P. A.
1931. A short phytogeography of the prairies and great plains of Central North America. Brittonia 1:57-66.

Shantz, H. L. and Zon, Raphael.
1924. Natural vegetation. Atlas Am. Agr. Pt. I, Sec. E, U.S.D.A. Bur. Agr. Econ. Washington, D. C.

Shimek, B.
1911. The prairies. Lab. Nat. Hist. State Univ. of Iowa. 6(2):169-240.
1934. The Shimek Plan. A statement of Grassland (Prairie) problems, with particular reference to Iowa. (An unpublished manuscript consisting of a report prepared by a committee of which Dr. B. Shimek of the University of Iowa was chairman. Maps included.)

Simonson, R. W.
1945. Know your Iowa soils. Soils Subsection. Iowa Agr. Exp. Sta. Ames.

Smith, G. D.
1942. Illinois loess. Bull. 490. Illinois Agr. Exp. Sta., Urbana.

Stevenson, W. H.
1910-1914. Annual Rept. Iowa Agr. Exp. Sta. Ames.

Thornthwaite, C. W.
1931. The climates of North America. Geog. Rev. 21:633-655.

Transeau, Edgar N.
1905. Forest centers of Eastern America. Am. Nat. 39:875-889.

U. S. Weather Bureau
1933. Secs. 50, 51, and 52. Iowa. Climatic summary of the United States.
1939. Climatological data. Iowa Section.

U. S. Government
1868. First survey of the State of Iowa. Plats deposited in the State House, Des Moines.

Weaver, J. E.
1944. North American Prairie. N. A. Scholar. 13:329-339.

Weaver, J. E. and F. E. Clements.
1938. Plant ecology. 2 ed. McGraw-Hill Book Co. New York, N. Y.

Wickard, Claude R.
1944. Conservation—A sound basis for future greatness. Trans. Ninth N. A. Wildl. Conf. American Wildlife Institute, Washington, D. C.