

PART I.—PHYSIOGRAPHY AND LIFE ZONES OF NORTH DAKOTA

CHANGING CONDITIONS

North Dakota, like other great prairie States, has rapidly changed in character from a country of native grassland and abundant wild life to one of rich grainfields unsuited to wild life and from which much of it is being banished. With the ever-increasing diversity of crops and livestock and with more intensive methods of agriculture, the new conditions are being advanced, and some of the most desirable native species of both animals and plants are disappearing, while many of the undesirable are holding their own or increasing in numbers. These conditions are accompanied by many problems of animal protection and control, the wise solution of which depends largely upon our knowledge of the species in the past and present, and especially of their habits, distribution, and environment.

GENERAL PHYSIOGRAPHIC FEATURES

The surface of the State, while generally classed as prairie or plains, varies from vast level stretches and rolling hills to buttes, badlands, and mountains.

Glacial Remains

In the Red River Valley, formerly occupied by the waters of Lake Agassiz, the prairie is comparatively level and often stretches away beyond the horizon without a ripple on its surface (Pl. 2). Over much of the State, however, the prairie is irregular, hilly, and undulating, forming what in the common phrase of the country is called "rolling prairie." This hilly configuration is due to the enormous deposits of glacial drift made during the advance and recession of the great ice sheets, which at different times covered a large part of the State. The ridges, hills, hollows, and lake basins formed by the ice sheets where they dumped their moraines of soil and boulders in scattered heaps and long ridges, have been subjected to the rounding and leveling influence of the elements until the surface often suggests the billowy swells of midocean. Great numbers of marshes, sloughs, and lakes occupy the basins scooped out by the ice and often are left without possible drainage. The extensive inland lakes thus formed have disappeared in some cases and have left level areas of rich alluvial bottoms.

The later ice sheets stopped before reaching the Missouri River, piling up great terminal and lateral moraines along the northern and eastern margin of the river valley, still marked by the series of buttes and ridges known as the Coteau de Missouri, but one of the earlier sheets pushed across and unloaded its boulders and débris

well up the valleys to the west. This sheet was evidently of no great duration, for the course of the river was not materially changed. Over most of the country west of the river there is little trace of ice action, and the water-carved buttes of the Badlands stand high and sharp, with their flat tops dating back far beyond the glacial period.

While the great Missouri River flowing through the State defied this early continental ice sheet, resuming its course when this receded, and not being reached by the later ones, the streams east of it were greatly modified, and some were wiped out of existence by ice action. Those flowing northward were first blocked by the ice and forced to overflow to the south. Then, after deep channels had been cut and the sheet had receded, some returned to their old northward courses and drew back old tributaries, while others cut new channels in other directions or were blocked and filled until only chains of lakes remained.

Lowered Water Levels

The country east of the Missouri River is generally well watered, but the greater part of the surface water is standing in numerous lakes and sloughs rather than flowing in the limited drainage system. Many of the smaller sloughs and marshes have been drained and converted into rich agricultural land and many have dried up in recent years. Since the cultivation of the soil a great shrinkage of the lakes and streams has taken place. Where formerly the water ran quickly from the firm prairie turf into the streams and hollows, both the rain and snow water are now absorbed by the mellow surface of the plowed land. This absorption distributes a greater quantity of water through the soil, and at the same time the more extensive evaporation surface increases the humidity of the climate. A striking illustration of the decrease in the water levels is shown at Devils Lake, which at the time of the early settlement of the region in 1887, had a steamboat landing close to the town of the same name. In 1920 the water had receded about 2 miles from the town, and since 1879 the level has fallen approximately 18 feet. Many of the smaller lakes have disappeared, and the smaller streams are shrinking. The disappearance of the prehistoric glacial lakes, Agassiz (now the Red River Valley), Souris (now the Mouse River Valley), and Sargent (now the general district of the county of the same name), was due not to a decrease in humidity nor to absorption of rainfall, but to the opening of a direct drainage into Hudson Bay after the recession of the last ice sheet.

Drainage Systems

The present drainage of North Dakota lies mainly in four well-defined systems (see map, Plate 1): (1) In the southwest, the Missouri River, with its main western tributaries, the Yellowstone, Little Missouri, Heart, and Cannonball, pouring its waters eventually into the Mississippi and the Gulf of Mexico; (2) in the southeast, the Dakota, or James, River, which joins the Missouri in Nebraska; (3) in the east, the Red River of the North with its main western tributaries, the Sheyenne and Pembina, flowing northward into Lake Winnipeg and eventually reaching the waters of Hudson

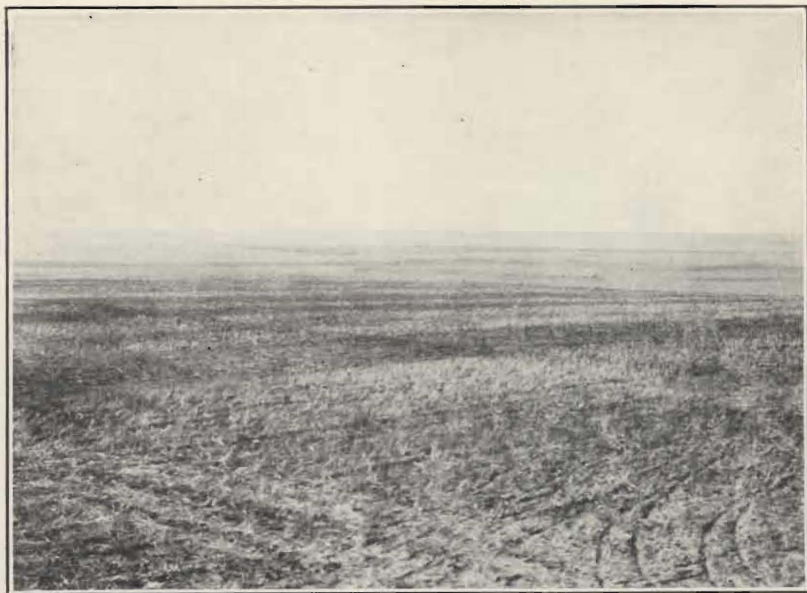


FIG. 1.—SHORT GRASS PRAIRIE OF WESTERN NORTH DAKOTA, SHOWING GRAINFIELDS AND PRAIRIE GRASS TO THE FAR HORIZON



FIG. 2.—PRAIRIE SLOUGH AND GLACIAL RIDGE OF CENTRAL NORTH DAKOTA, CHOICE BREEDING GROUNDS OF NATIVE WATERFOWL AND HOME OF THE MUSKRAT

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FIG. 1.—YELLOW PINES ON BUTTES SOUTH OF MEDORA



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FIG. 2.—BADLANDS AND SAGEBRUSH AT MEDORA

Bay; and (4) in the north, the Mouse or Souris River, with its chief tributary, the Riviere des Lacs, making a deep loop into the State and then turning north and east to join the Assiniboine in Manitoba.

Elevations and the Badlands

The variation of altitude within the State is comparatively slight and gradual, ranging from 753 feet above sea level on the Red River at Pembina, in the northeastern corner, to 3,463 feet on Black Butte, in the southwestern corner. The Turtle Mountains, midway of the northern boundary, are merely high moraine-covered hills, the greatest altitude being about 2,500 feet, while the highest point of the Pembina Hills, to the east, is given as 1,660 feet. West of the Missouri River, with a high-water mark near Bismarck of 1,646 feet, the country rises to a prairie level at Dickinson of 2,411 feet; at Sentinel Butte, 2,711; at Beach, 2,759; and at Summit, between the last two localities, 2,830 feet, while numerous buttes over the surface of the prairie rise only a few hundred feet higher. The Killdeer Mountains, a group of rounded hills with timber and brush in the gulches, lying in the bend of the Little Missouri northeast of Medora, are but a part of the Badlands plateau, rising about 700 feet above the surrounding prairie.

The great stretches of prairie west of the Missouri River show their age in the flat-topped ridges and wide sloping valleys of a lakeless and deep and well-worn drainage system. The greater part of this area is composed of level prairie or gentle slopes well suited to agriculture, but there are great numbers of sharp or flat-topped buttes or groups of buttes rising above the general surface, numerous deep ravines cutting through to lower levels, and brush or tree fringed streams tracing the bottoms of the valleys (Pl. 3). For a long time the region was considered too arid for uses other than stock raising, but with the improved farming methods of recent years demonstrating its value for grain and other crops, it has rapidly filled up with enterprising farms and towns. Most of the area is good farmland, but there are some parts so rough and steep that they can never be cultivated, and these will long remain in a primitive condition. These are the "Badlands" (Pl. 3).

The Badlands of the Missouri Valley and westward are not only a striking feature of the landscape, but they are of interest to the student of wild life, as they have had a marked influence on the distribution of species. They are most conspicuous and picturesque along the Little Missouri River Valley, but also occur in marked form along the banks and bluffs of the Missouri above the mouth of the Little Missouri, and especially from Little Knife River westward.

The presence of the Badlands is due to the reduced rainfall in this western part of the State, together with peculiar geological formations, soft rock, beds of lignite coal, the bright-colored scoria, and mineral-laden beds of clay with generally a dry, baked surface, which quickly sheds the little rain that falls. In texture as well as in form the land is in striking contrast with the glacier-plowed rolling prairies east of the river. Underneath the surface soil the older strata are generally impervious to water.

In form, the Badlands are characterized by flat-topped or rounded buttes, abrupt walls, benches, terraces, and bottomland flats. In their most typical and picturesque form they are found along the steep slopes of the stream valleys, where their bare walls are carved and eroded into grotesque and striking shapes, suggesting ancient ruins. In many places the Badlands banks are too steep to be climbed even by mountain sheep, except on well-known and well-worn trails leading from shelf to shelf. When wet the alkaline slopes are as slippery as a piece of wet soap, and are then of necessity avoided by man and beast.

The steep slopes are generally devoid of vegetation, but the benches and flat tops are usually covered with the finest grasses, and many of the gulches are filled with dense tangles of brush and scrubby timber. The colors in the Badlands are in places as brilliant as those of the Painted Desert of Arizona, ranging from broad black bands of lignite coal, through the grays, browns, and yellows of various clay formations, and the bright brick-red and pink beds of scoria, to the brown or gray or chalky white of sandstone and limestone cliffs. Usually from the top of the cliffs and walls the level prairie stretches away to the far and treeless horizon.

Geologically the Badlands are ready-made cross sections of the earth's surface. For untold ages their strata were deposited in deep or shallow waters, along shores and estuaries, or in marshes and forests, layer after layer, each of which embedded and preserved in some form the plant and animal life of its time. Great logs and stumps of petrified trees crop out in places along the banks or lie scattered over the flats below, while fossil bones, teeth, and shells of ancient types of animal life are often found in abundance. Even at the present day the cliffs, caves, and gulches, and the sheltered valleys, warm nooks, and corners of these Badlands harbor many species of native animals that otherwise would not be found within the borders of the State.

Probably no area in North Dakota is better suited for game refuges and parks than the Killdeer Mountains. The need is not so great for the present as for 20, 50, and 100 years hence. The mountains stand on the edge of the Badlands like a cool, green, rugged island in the midst of a great prairie region of rich soil, good farms, good roads, and a good beginning toward a future teeming population. On pleasant Sundays 50 to 100 automobile parties even now visit the mountains for picnics in the cool shade, for drafts of pure, cold water, the sight of strange flowers, plants, trees, birds, and mammals, rugged climbs, and a glorious view over wide country. With greater attractions of native animals, well-selected picnic and camping grounds, and trails to the points of interest, the visitors would to-day number thousands instead of hundreds, and in a few years hard-working farm people and tired city people from all over the State would find an easily available health and pleasure ground.

The Turtle Mountains represent another type of country with a strong bearing on the distribution of animal life. Although merely a group of high, rough, glaciated hills, alternating with hollows and lakes, they stand up from the surrounding prairie dark and timbered in inviting contrast with the boundless open expanse. Their charm is not so much in height or roughness as in the oasis of forest and the

beautiful forest-bordered lakes which they offer in the midst of a great prairie region (Pl. 4). This timber body is practically isolated except for a scattered and broken connection eastward along the streams and hills to the strip of timber along the Red River. Fortunately much of the land is rough, steep, and stony, and so covered with scrub timber that it is not likely to be cleared off in the near future. Its chief value is for game refuges and for fishing and recreation grounds.

Prairie

The one striking feature of the country is the original boundless grassland prairie, which at the present time is largely under cultivation in almost equally boundless fields and crops. Over much of the State the uncultivated areas are coming to be so restricted that game birds have difficulty in finding suitable nesting places outside of the fields, while some of the mammals are equally shut out and others have taken up quarters within the cultivated areas, where they cause serious damage to crops.

Forest

The native forest of North Dakota may be placed in three groups—the Minnesota type, the Missouri-River type, and the Rocky-Mountain type.

The eastern or Minnesota type borders the streams in the Red River Valley, covers the Pembina Hills and Turtle Mountains, and skirts the snowdrift borders of the larger lakes, such as Devils Lake, Stump Lake, and the Sweetwater Lakes. (Pl. 5.) This consists mainly of a moderate growth of deciduous trees, such as American elm, red elm, white ash, boxelder, bur oak, ironwood, basswood, aspen, balsam poplar, and cottonwood, and such shrubs as hazel, alder, serviceberry, chokeberry, pin cherry, cornel, and rose.

The Missouri-River type is found along the Missouri and Little Missouri River bottoms and consists largely of the broad-leaved cottonwood, many willows, and scattered boxelder, elm, ash, buffaloberry, shrubby dogwoods, and flowering currants. (Pl. 6.)

A trace of the third type of forest is found in the Badlands and over the higher buttes along the Little Missouri River, where in places the Rocky Mountain yellow pine and Rocky Mountain juniper grow in considerable abundance and the western birch and shrubby cinquefoil come into the Killdeer Mountains.

Though more or less mixed, these three groups indicate types of climate and soil conditions that to some extent govern the distribution of the animal life. The forest growth is very restricted, covering only a small part of the surface of the State, lying mainly in narrow strips along the banks of streams, on the edges of lakes, in the gulches and on the steep slopes of the mountains and bluffs, where deep snowdrifts lie late into the spring. It is of great importance, however, not only for the use of the present inhabitants, but for the influence it has had on animal life, in the shelter, protection, and food afforded, without which many of the species would have been excluded from the State.

In its restricted range along the immediate stream courses and in gulches and valley bottoms, the native forest is often hidden, and at a distance is less conspicuous than the planted groves scattered over the prairie. At the present time the artificially planted plots far exceed the native forests of the State both in abundance and in value. These, too, are beginning to show a marked influence on the distribution of species, attracting to the vicinity of homes many birds and mammals that otherwise would be absent. Thus physiography, forest and plant distribution, soil, and climate all bear a vital relation to the problems involved in a study of the animal life of the State.

LIFE ZONES OF NORTH DAKOTA

In a comparatively level prairie country there are no striking contrasts in the distribution areas, and the life zones blend almost insensibly into each other. The greater part of North Dakota lies in the Transition Zone, which, in crossing the continent as a broad band between the warm Upper Austral (Sonoran) and the cold Boreal Zones, spreads to its greatest width over the northern prairies of the Dakotas, Montana, and Saskatchewan. (See Plate 1.) It so nearly covers North Dakota that many of its species are found scattered over the limited areas of both the Canadian Zone of the Turtle Mountains on the north and the narrow tongues of Upper Austral Zone thrusting into parts of the Missouri River Valley from the south and west. These restricted areas of the Austral and Canadian Zones, however, are sufficiently marked to be of importance in giving to the State a wider range of crop, timber, and animal adaptations, and an interesting diversity of living conditions. For the best development of a State, it is necessary that every climatic and physiographic advantage be fully understood.

Upper Austral Zone

The Upper Austral Zone, the Upper Sonoran, or semiarid subdivision of which penetrates only into the warmest corners of the State, is in no part sufficiently extensive to be marked by entirely characteristic mammals, birds, or plants. In its narrow strips along the Missouri Valley below Bismarck, down the Missouri and Yellowstone Valleys to Williston, along the Little Missouri Valley above the Killdeer Mountains, and on many dry, warm slopes between these areas, it is strongly characterized. So near the edge of a zone, however, the slight inclination of a slope to the north reduces the heat received from the sun's rays sufficiently to change the flora and fauna in part or wholly to that of the colder, higher zone, while a steep slope facing the direct rays of the sun will attract many species of the warmer, lower zone above their normal limits. Hence, in a rough and broken country on the border of the two zones, conditions are so complicated and often confusing that the areas can be mapped in only a very general way.

In a study of the zones in this region the slope exposure and the heat-absorbing qualities of the surface (surface cover) are found more important than actual altitude, since the gradual increase in base level westward does not tend to lower the zones and nowhere is the altitude above base level sufficient to reduce noticeably the general temperature except by slope exposure.



FIG. 1.—A TYPICAL LAKE OF THE TURTLE MOUNTAINS

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FIG. 2.—TYPICAL ASPEN FOREST OF THE TURTLE MOUNTAINS

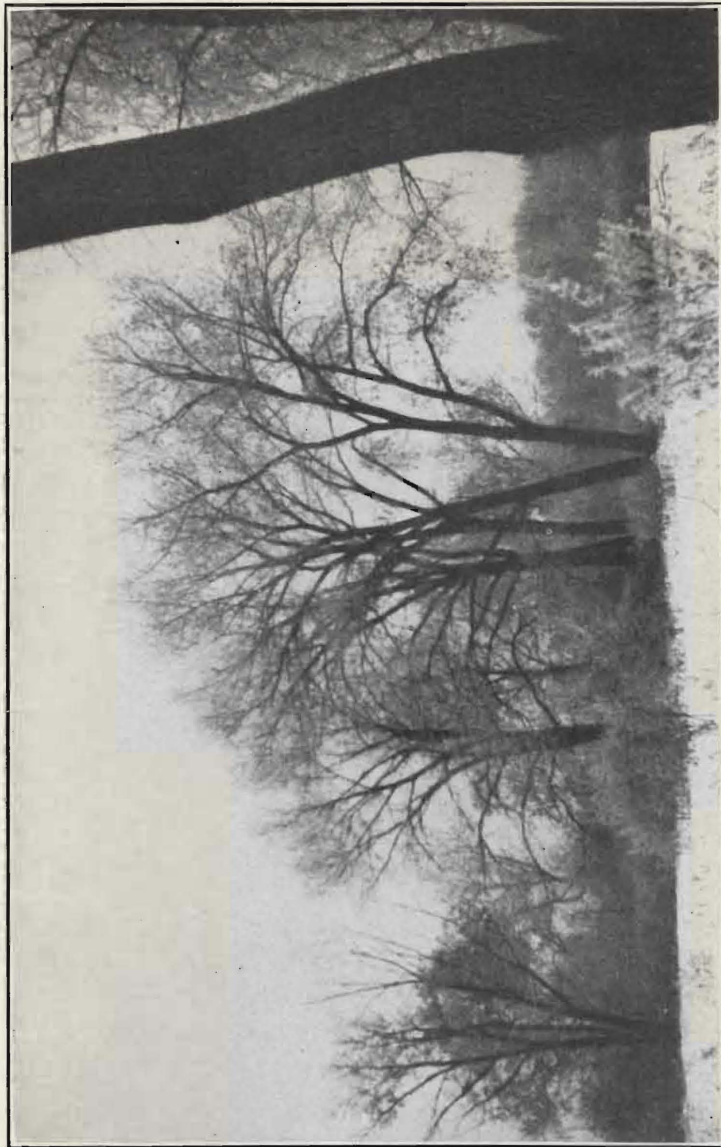
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FIG. 1.—RED RIVER WITH ITS FORESTED SHORES, NEAR FARGO



FIG. 2.—TYPE OF FOREST ALONG THE RED RIVER, NEAR FARGO



COTTONWOOD TIMBER ALONG THE MISSOURI RIVER BOTTOMS NEAR MANDAN IN EARLY WINTER AFTER THE
LEAVES HAVE FALLEN

Some of the very highest parts of the State, in the extreme southwestern corner, lie mainly within the Upper Austral Zone. The Little Missouri Valley above and below Medora (2,270 feet above sea level, and almost as high as the tops of the Turtle Mountains) is the nearest to pure Upper Austral and zonally the lowest point in the State. The aridity, causing scanty soil cover and thus allowing the greatest absorption of heat by the soil, adds to the purity of the zone here, as also may the warm western winds.

Along the Missouri River Valley from Bismarck to Williston many Austral species have a continuous range, but seem generally to be secondary to the Transition Zone or neutral species. The broad-leaved cottonwood and the long-tailed chat have a practically continuous range along the river valley, but other species, such as the little chipmunk and dwarf lupine, seem to drop out of sections of it.

Farther east local traces of Upper Austral Zone species may be found on the warm slopes of the sand dunes near Hankinson, and in the Dakota and Maple River Valleys at Ludden and Ellendale. These are mere traces overlapping from the zone farther south in the Dakota River Valley. The zone is indicated at Hankinson by the harvest mouse, little dusky pocket mouse, and sand cherry, and at Oakes and Ludden by at least the harvest mouse.

Following are characteristic species of the Upper Austral Zone in North Dakota:

CHARACTERISTIC MAMMALS—UPPER AUSTRAL ZONE

Badlands mountain sheep (<i>Ovis canadensis auduboni</i>).	Maximilian pocket mouse (<i>Perognathus fasciatus fasciatus</i>).
Badlands chipmunk (<i>Eutamias pallidus pallidus</i>).	Dusky pocket mouse (<i>Perognathus flavescens perniger</i>).
Pale thirteen-lined ground squirrel (<i>Citellus tridecemlineatus pallidus</i>).	Kansas pocket mouse (<i>Perognathus hispidus paradoxus</i>).
Black-tailed prairie dog (<i>Cynomys ludovicianus ludovicianus</i>).	Richardson kangaroo rat (<i>Perodipus montanus richardsoni</i>).
Osgood white-footed mouse (<i>Peromyscus maniculatus osgoodi</i>).	Sagebrush pocket gopher (<i>Thomomys talpoides bullatus</i>).
Badlands white-footed mouse (<i>Peromyscus leucopus aridulus</i>).	Black Hills cottontail (<i>Sylvilagus nuttalli grangeri</i>).
Pale bushy-tailed wood rat (<i>Neotoma cinerea rupicola</i>).	Black-footed ferret (<i>Mustela nigripes</i>).
Prairie harvest mouse (<i>Reithrodontomys megalotis dychei</i>).	Merriam shrew (<i>Sorex merriami</i>).
Western upland mouse (<i>Microtus ochrogaster haydenii</i>).	

CHARACTERISTIC BREEDING BIRDS—UPPER AUSTRAL ZONE

Western mourning dove (<i>Zenaidura macroura marginella</i>).	Indigo bunting (<i>Passerina cyanea</i>) (also Transition).
Burrowing owl (<i>Speotyto cunicularia hypugaea</i>).	Lazuli bunting (<i>Passerina amoena</i>).
Poor-will (<i>Phalaenoptilus nuttallii nuttallii</i>).	Dickcissel (<i>Spiza americana</i>).
Say phoebe (<i>Sayornis sayus</i>).	Long-tailed chat (<i>Icteria virens longicauda</i>).
Bullock oriole (<i>Icterus bullockii bullockii</i>).	Rock wren (<i>Salpinctes obsoletus obsoletus</i>).
Lark sparrow (<i>Chondestes grammacus grammacus</i>).	Long-tailed chickadee (<i>Penthestes atricapillus septentrionalis</i>).
Western lark sparrow (<i>Chondestes grammacus strigatus</i>).	

CHARACTERISTIC PLANTS—UPPER AUSTRAL ZONE

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|---|---|
| <p>Broad-leaved cottonwood (<i>Populus deltoides</i>).²
 Sand cherry (<i>Prunus pumila</i>).
 Flowering currant (<i>Ribes aureum</i>).
 Skunk bush (<i>Rhus trilobata</i>).
 Gray shadscale (<i>Atriplex canescens</i>).
 Low shadscale (<i>Atriplex confertifolia</i>).
 Nuttall shadscale (<i>Atriplex nuttallii</i>).
 Greasewood (<i>Sarcobatus vermiculatus</i>).
 Winterfat (<i>Eurotia lanata</i>).
 Gray sagebrush (<i>Artemisia cana</i>).
 Rabbitbrush (<i>Chrysothamnus graveolens</i>).
 Tipsin (<i>Psoralea esculenta</i>).
 Prairie-clover (<i>Psoralea tenuiflora</i> and <i>Psoralea lanceolata</i>).
 Dalea (<i>Parosela enneandra</i>).
 Dwarf lupine (<i>Lupinus pusillus</i>).
 Painted milk-vetch (<i>Astragalus pictus</i>).
 Slender milk-vetch (<i>Astragalus gracilis</i>).
 Bird's-foot trefoil (<i>Hosackia americana</i>).</p> | <p>Winged abronia (<i>Tripterocalyx micranthus</i>).
 Snow-on-the-mountain (<i>Euphorbia marginata</i>).
 Mentzelia (<i>Mentzelia decapetala</i>).
 Bee plant (<i>Cleome serrulata</i>).
 Spiny solanum; buffalo-bur (<i>Solanum rostratum</i>).
 Indian plantain (<i>Plantago purshii</i>).
 Large-flowered beardtongue (<i>Pentstemon grandiflorus</i>).
 Prickly-pear cactus (<i>Opuntia polyacantha</i>).
 Slender cactus (<i>Opuntia fragilis</i>).
 Spanish bayonet (<i>Yucca glauca</i>).
 Low evening primrose (<i>Pachylophus caespitosus</i>).
 Sand verbena (<i>Abronia micrantha</i>).
 Wild sunflower (<i>Helianthus annuus</i>).
 Dropseed grass (<i>Oryzopsis micrantha</i> and <i>Oryzopsis cuspidata</i>).
 Grama grass (<i>Bouteloua gracilis</i>).
 False buffalo grass (<i>Munroa squarrosa</i>).</p> |
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CROP ADAPTATIONS OF THE UPPER AUSTRAL ZONE

The variation in climate in North Dakota is so slight and gradual, and the greater part of the State lies so fully within the Transition Zone, that the raising of a comparatively limited variety of crops has been customary over most of the State. The great success of the small grains has encouraged their production to the exclusion of many others that might be cultivated in certain sections with equal success. The early explorers found the Indians raising an abundance of corn (Will and Hyde, 1917), squashes, beans, and native tobacco on the fertile bottoms along the Missouri River, where also the comparatively mild climate rendered living conditions comfortable for these poorly equipped and half-housed people. Many of these long-tested and thoroughly acclimated varieties of vegetables have been adopted into general cultivation and have helped to increase the crop resources of the State; varieties from other parts of the Upper Austral Zone have also been found to thrive in these mild valleys.

Although no attempt is made in the present report to indicate the particular kinds and varieties of crops adapted to the different life zones and their subdivisions in the State, it is evident from the distribution of native species and the climatic areas which they dominate that certain crops will thrive in one part of the State and not in others. Only by careful study of local conditions and by careful testing of different varieties of seeds can safe recommendations be made and the best results obtained from diversified agriculture. With the increasing necessity of bringing the producing quality of

² This upper Missouri form is so different in characters and growth from the Carolina cottonwood that the necessity of calling it *deltoides* is regrettable.

the land to the highest standard, and the more intelligent study being given to farm problems, the value of a reliable map of the life zones and subdivisions of these zones is apparent.

The intrusion of narrow areas of a southern zone into a northern one, as pointed out by Doctor Merriam (1898, p. 15) many years ago, adds a distinct advantage in marketing the crops by saving long transportation and thus increasing their value. The possibility of raising southern crops and fruits within an area of unusually rich grain production is self-evident. Although not always the richest in soil and natural resources, the warmest sections of the State, with their climatic advantages, should, if wisely used, be of special value.

Transition Zone

The Transition Zone covers the whole of North Dakota with the exception of the Turtle Mountains and various cold slopes and gulches in other elevated areas, where Canadian Zone conditions prevail, and the warmer Upper Austral valleys of the Missouri and Little Missouri Rivers. Its range of climate shows no marked variation over the State, except for a slight decrease in temperature northward and a gradual decrease in rainfall westward. The annual rainfall, as given in the Climatology Report of the Weather Bureau (U. S. Dept. Agr., 1919) for 1918, a nearly typical year, varies from 25 inches in the eastern to 15 inches in the western part of the State. The westward decrease is so gradual that no sharp line can be drawn between the humid eastern and semiarid western subdivisions of the zone. Doctor Merriam (1898, map) places the dividing line a little east of the one-hundredth meridian.³ The change from humid to semiarid is noticeably marked by the shortening of the prairie grasses and the appearance of western drought-resistant species.

The humid Transition Zone covers practically all of the State west to and including the Dakota (James) and Mouse (Souris) River Valleys. It is generally characterized by a heavy growth of prairie grasses, by strips of timber along the streams, and by thickets of brush in protected locations.

The semiarid Transition Zone covers most of the western half of the State, including the high country on both sides of the Missouri River Valley and much of the Badlands region. It is generally characterized by short-grass plains and a limited mixture of Rocky Mountain species of mammals, birds, and plants.

The following lists contain the chief characteristic animals and plants of the Transition Zone in North Dakota:

CHARACTERISTIC MAMMALS—TRANSITION ZONE

(a) Both Eastern and Western Divisions

Richardson ground squirrel (<i>Citellus richardsoni richardsoni</i>).	Prairie jumping mouse (<i>Zapus hudsonius campestris</i>).
Loring red-backed mouse (<i>Evotomys gapperi loringi</i>).	White-tailed jack rabbit (<i>Lepus townsendii campanius</i>).

³ See also Fourth Provisional Zone Map of North America, by the Biological Survey, 1910 (included in A. O. U. Check-List of Birds).

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| Yellow-red fox (<i>Vulpes fulva regalis</i>). | Northern skunk (<i>Mephitis hudsonica hudsonica</i>). |
| Long-tailed weasel (<i>Mustela longicauda</i>). | Hayden shrew (<i>Sorex cinereus haydeni</i>). |
| Bonaparte weasel (<i>Mustela cicognanii cicognanii</i>). | Large brown bat (<i>Eptesicus fuscus fuscus</i>). |
| Minnesota mink (<i>Lutreola vison letifera</i>). | |

(b) Eastern (Humid) Division

- | | |
|---|---|
| Minnesota gray squirrel (<i>Sciurus carolinensis hypophacus</i>). | Little upland mouse (<i>Microtus minor minor</i>). |
| Gray chipmunk (<i>Tamias striatus griseus</i>). | Mississippi Valley pocket gopher (<i>Geomys bursarius</i>). |
| Thirteen-lined ground squirrel (<i>Citellus tridecemlineatus tridecemlineatus</i>). | Dakota pocket gopher (<i>Thomomys talpoides rufescens</i>). |
| Gray ground squirrel (<i>Citellus franklinii</i>). | Nebraska cottontail (<i>Sylvilagus floridanus similis</i>). |
| Rufescent woodchuck (<i>Marmota monax rufescens</i>). | Brush wolf (coyote) (<i>Canis latrans latrans</i>). |
| Northern white-footed mouse (<i>Peromyscus leucopus noveboracensis</i>). | Short-tailed shrew (<i>Blarina brevicauda brevicauda</i>). |
| Baird white-footed mouse (<i>Peromyscus maniculatus bairdii</i>). | Little brown bat (<i>Myotis lucifugus lucifugus</i>). |
| Eastern meadow mouse (<i>Microtus pennsylvanicus pennsylvanicus</i>). | Say bat (<i>Myotis subulatus subulatus</i>). |

(c) Western (Semiarid) Division

- | | |
|---|--|
| Pale mouse (<i>Microtus pallidus</i>). | Plains coyote (<i>Canis latrans nebrascensis</i>). |
| Drummond meadow mouse (<i>Microtus pennsylvanicus drummondi</i>). | Yellowstone bat (<i>Myotis lucifugus carissima</i>). |
| Northern bobcat (<i>Lynx uinta</i>). | |
| Kit fox, swift (<i>Vulpes velox hebes</i>). | |

CHARACTERISTIC BREEDING BIRDS—TRANSITION ZONE

(a) Both Eastern and Western Divisions

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|---|--|
| Franklin gull (<i>Chroicocephalus pepiscan</i>). | Upland plover (<i>Bartramia longicauda</i>). |
| Forster tern (<i>Sterna forsteri</i>). | Ferruginous rough-leg (<i>Buteo ferrugineus</i>). |
| Canvasback duck (<i>Aristonetta valisineria</i>). | Bobolink (<i>Dolichonyx oruzivorus</i>). |
| Redhead (<i>Nyroca americana</i>). | Chestnut-collared longspur (<i>Calcarius ornatus</i>). |
| Ring-necked duck (<i>Perissonetta collaris</i>). | Baird sparrow (<i>Centronyx bairdii</i>). |
| Wilson phalarope (<i>Steganopus tricolor</i>). | Nelson sparrow (<i>Ammodramus caudacuta nelsoni</i>). |
| Marbled godwit (<i>Limosa fedoa</i>). | |

(b) Eastern (Humid) Division

- | | |
|---|--|
| Woodcock (<i>Rubicola minor</i>). | Baltimore oriole (<i>Icterus galbula</i>). |
| Broad-winged hawk (<i>Buteo platypterus platypterus</i>). | Vesper sparrow (<i>Pooecetes gramineus gramineus</i>). |
| Yellow-bellied woodpecker (<i>Sphyrapicus varius varius</i>). | Swamp sparrow (<i>Melospiza georgiana</i>). |
| Yellow-shafted flicker (<i>Colaptes auratus luteus</i>). | Chewink, towhee (<i>Pipilo erythrophthalmus erythrophthalmus</i>). |
| Whip-poor-will (<i>Setochoalcis vocifera vocifera</i>). | Rose-breasted grosbeak (<i>Hedymeles ludovicianus</i>). |
| Blue jay (<i>Cyanocitta cristata brodia</i>). | |

(c) Western (Arid) Division

Avocet (<i>Recurvirostra americana</i>).	Black-headed grosbeak (<i>Hedymeles melanocephalus papago</i>).
Sage grouse (<i>Centrocercus urophasianus</i>).	McCown longspur (<i>Rhynchophanes mccownii</i>).
Red-shafted flicker (<i>Colaptes cafer collaris</i>).	Western vesper sparrow (<i>Poocetes gramineus confinis</i>).
Magpie (<i>Pica pica hudsonia</i>).	Sprague pipit (<i>Anthus spragueii</i>).
Arctic towhee (<i>Pipilo maculatus arcticus</i>).	

CHARACTERISTIC PLANTS—TRANSITION ZONE

(a) Eastern (Humid) Division

Bur oak (<i>Quercus macrocarpa</i>).	Cornel (<i>Cornus femina</i>).
Basswood (<i>Tilia americana</i>).	Black haw; nanny-berry (<i>Viburnum lentago</i>).
Ironwood (<i>Ostrya virginiana</i>).	Sumac (<i>Rhus glabra</i>).
White ash (<i>Fraxinus pennsylvanica</i>).	Honeysuckle (<i>Lonicera dioica glaucescens</i>).
White elm (<i>Ulmus americana</i>).	Red raspberry (<i>Rubus strigosus</i>).
Red elm (<i>Ulmus fulva</i>).	Prairie rose (<i>Rosa pratincola</i>).
Hackberry (<i>Celtis occidentalis</i>).	Pale rose (<i>Rosa blanda</i>).
Red maple (<i>Acer rubrum</i>).	Bittersweet (<i>Celastrus scandens</i>).
Sugar maple (<i>Acer saccharum</i>).	Black currant (<i>Ribes americanum</i>).
Hawthorn (<i>Crataegus chrysoarpa</i> and <i>Crataegus succulenta</i>).	Smooth gooseberry (<i>Ribes gracile</i>).
Wild plum (<i>Prunus americana</i>).	Prickly ash (<i>Xanthoxylum americanum</i>).
Hazel (<i>Corylus americana</i>).	
Alder (<i>Alnus incana</i>).	
Missouri willow (<i>Salix missouriensis</i>).	

(b) Western (Semiarid) Division

Yellow pine (<i>Pinus scopulorum</i>).	Sagebrush (<i>Artemisia tridentata</i>).
Rocky Mountain juniper (<i>Juniperus scopulorum</i>).	Silver sage (<i>Artemisia frigida</i>).
Creeping juniper (<i>Juniperus horizontalis</i>).	Yellow willow (<i>Salix lutea</i>).
Western birch (<i>Betula fontinalis</i>).	Green ash (<i>Fraxinus lanceolata</i>).
Silver-leaf (<i>Elaeagnus argentea</i>).	Shrubby cinquefoil (<i>Potentilla fruticosa</i>).
Buffaloberry (<i>Lepargyrea argentea</i>).	Bearberry (<i>Arctostaphylos uva-ursi</i>).
	False lupine (<i>Thermopsis rhombifolia</i>).

Bergman (1918, p. 162) has made essentially this same division under *mesophytic* and *xerophytic* prairie, well characterizing each by its grasses and "more abundant secondary species" as follows:

(a) Mesophytic, or Andropogon, Prairie (Eastern)

Forked beardgrass; Big blue-stem (<i>Andropogon furcatus</i>).	Closed gentian (<i>Gentiana puberula</i>).
Broom beardgrass; Little blue-stem (<i>Andropogon scoparius</i>).	Maximilian sunflower (<i>Helianthus maximilianus</i>).
Indian grass (<i>Sorghastrum nutans</i>).	Alum root (<i>Heuchera hispida</i>).
Porcupine grass (<i>Stipa spartea</i>).	Blazing star (<i>Lacinaria pycnostachya</i> and <i>Lacinaria scariosa</i>).
Sedge (<i>Carex festucacea</i>).	Lobelia (<i>Lobelia spicata</i>).
Yarrow (<i>Achillea lanulosa</i>).	Evening primrose (<i>Merolix serrulata</i>).
Gray false indigo; Lead-plant (<i>Amorpha canescens</i>).	Slender beardtongue (<i>Pentstemon gracilis</i>).
Cylindric wind-flower (<i>Anemone cylindrica</i>).	Ground cherry (<i>Physalis lanceolata</i>).
Cut-leaved wormwood (<i>Artemisia caudata</i>).	Black-eyed susan (<i>Rudbeckia hirta</i>).
Harebell (<i>Campanula rotundifolia</i>).	Spiderwort (<i>Tradescantia bracteata</i>).
White-flowered avens (<i>Dryocallis arguta</i>).	Ironweed (<i>Vernonia fascicularis</i>).

(b) *Xerophytic, or Bouteloua, Prairie (Western Short-grass)*

Grama grass (<i>Bouteloua oligostachya</i>).	Yellow flax (<i>Linum rigidum</i>).
Buffalo grass (<i>Bulbils dactyloides</i>).	Narrow-leaved puccoon (<i>Lithospermum linearifolium</i>).
Loco plant (<i>Aragallus lambertii</i>).	Skeleton plant (<i>Lygodesmia juncea</i>).
Silver sage (<i>Artemisia frigida</i>).	Orange-red false mallow (<i>Malvastrum coccineum</i>).
Buffalo pea (<i>Astragalus crassicaepus</i>).	Yellow Indian paintbrush (<i>Orthocarpus luteus</i>).
Brown-eyed susan (<i>Brauneria angustifolia</i>).	Pale beardtongue (<i>Pentstemon albidus</i>).
Indian paintbrush (<i>Castilleja sessiliflora</i>).	Silver clover (<i>Psoralea argophylla</i>).
Golden aster (<i>Chrysopsis villosa</i>).	Groundsel, paintbrush (<i>Senecio platensis</i>).
Treacle mustard (<i>Erysimum asperum</i>).	Yellow violet (<i>Viola nuttallii</i>).
Prairie marigold (<i>Gaillardia lanceolata</i>).	
Scarlet gaura (<i>Gaura coccinea</i>).	

CROP ADAPTATIONS OF THE TRANSITION ZONE

The crop adaptations of the Transition Zone and its subdivisions make it the most important in the State because of the extent of the zone and the enormous quantity of its products. Every slight advantage in variety of grain or other crop under different climatic conditions should be utilized so far as these conditions prevail. Different crops and varieties are being constantly tested and the more resourceful farmers are quick to adopt any that offer even a slight advantage in quality, yield, or price.

Canadian Zone

The Canadian Zone, which sweeps across the continent mainly north of the United States and is generally characterized by forests of spruce, fir, hemlock, aspen, and birch, is only lightly represented in a few restricted areas in North Dakota. Its largest area lies within the Turtle Mountains, where Canadian-Zone species dominate the flora and fauna, although by no means unmixed with Transition species. Other districts with still less representation of the zone are the Pembina Hills, the Killdeer Mountains, and numerous cold slopes and cold gulches in the high bluffs and buttes along the western side of the Mouse River Valley. On many steep northeast slopes, on high buttes, and in the Badlands, where in winter drifting snows fill shaded gulches to such a depth as to remain until late in spring or to the beginning of summer, a trace of Canadian Zone species may be found.

The aspen (Pl. 4, fig. 2) is one of the most widely distributed and abundant of the Canadian Zone trees, and from its habit of reproduction from myriads of widely blown, cotton-tufted seeds, it not only fills its zone, but lodges and grows wherever climatic conditions are possible for it. For this reason it is often found in spots far from its regular range, where even such local conditions as late snowbanks, cold springs, cold underground waters, or well-shaded slopes reduce the summer temperature. Thus, the aspens, with a few other Boreal plants and animals, often form little islands far out in the Transition Zone, in places even to its lower edge, that carry Boreal species whose presence is very confusing unless the conditions are thoroughly understood and the existence of the zone recognized.

Cold slopes and gulches facing the north or northeast and missing much of the heat from the sun's rays are also important factors in carrying local traces of zones far below their real borders. Often cold gulches contain springs or streams of cold water in addition to the snow which accumulates in winter and which helps to keep their summer temperature low. In the Turtle Mountains the cold slopes and gulches are practically pure Canadian Zone, as are mainly the moist bottomlands and all but the more open slopes facing the south. Although the temperature in these hills may be no lower in winter than that of the surrounding prairies, the more important growing temperature of summer is noticeably cooler than that of the open prairies where the sun's rays are more readily absorbed by the ground and returned to the surface layer of air.

The Turtle Mountains at their highest rise less than a thousand feet above the prairie base level, and the actual altitude of the highest hills is only approximately 2,500 feet. Although their elevation is not such as to lower perceptibly the general temperature, it is sufficient to attract an unusually heavy precipitation. This, in the form of rain and snow, produces not only a cooling effect on the surface, but a heavy growth of vegetation, largely arboreal and shrubby, the only extensive openings in which are lakes and marshes. The timber is largely aspen mingled with balsam poplar, white birch, and a few oaks, elms, and boxelders. The forests have been frequently swept away by fires, which fact undoubtedly accounts for the complete absence of conifers. Even the tamarack, which would find ideal conditions in the marshes, is not known to occur in this region. The preponderance of aspens also indicates frequent fires, as these trees, more than any other in this region, quickly reforest burned areas. Owing to the fact that heavy winter snows remain late in spring on the cold slopes, and to the difficulty of clearing the brush and timber-covered soil, the settlement of the hills has lagged behind that of other parts of the State.

Though much modified, the Canadian Zone area is here of special importance and interest in carrying a comparatively well-forested area in the midst of an extensive treeless region. The forest is happily associated with numerous beautiful lakes, originally well stocked with fish. The whole region was once famous for its game and fur-bearing animals, and at present it affords a delightful resort for fishing and camping, and is steadily growing in importance as a summer recreation ground.

CHARACTERISTIC MAMMALS—CANADIAN ZONE

The principal Canadian Zone mammals of the Turtle Mountains and Pembina Hills at the present time are the red squirrel (*Sciurus hudsonicus*), northern chipmunk (*Eutamias borealis*), varying hare (*Lepus americanus*), Canada lynx (*Lynx canadensis*), Richardson shrew (*Sorex richardsoni*), and silver-haired bat (*Lasionycteris noctivagans*). Formerly there occurred also the caribou, moose, marten, fisher, and wolverene.

CHARACTERISTIC BREEDING BIRDS—CANADIAN ZONE

The typical Canadian Zone birds of this region are not strongly represented, but the white-throated sparrow (*Zonotrichia albicollis*) is a common summer songster in the Turtle Mountains, and the slate-colored junco (*Junco hyemalis*) occurs and probably breeds.

CHARACTERISTIC PLANTS—CANADIAN ZONE

The number of species of Canadian Zone plants in North Dakota is not great, but the forest is dominated by a few of them, as the aspen (poplar), balsam poplar, and white birch. The following characterize the zone in the State:

Aspen poplar (<i>Populus tremuloides</i>).	Beaked hazel (<i>Corylus rostrata</i>).
Balsam poplar (<i>Populus balsamifera</i>).	Rabbitberry (<i>Lepargyrea canadensis</i>).
White birch (<i>Betula papyrifera</i>).	Bunchberry (<i>Cornus canadensis</i>).
Shrubby birch (<i>Betula pumila glandulifera</i>).	Canadian serviceberry (<i>Amelanchier canadensis oblongifolia</i>).
Pin cherry (<i>Prunus pennsylvanica</i>).	Red currant (<i>Ribes triste</i>).
Autumn willow (<i>Salix serissima</i>).	Winter-lettuce (<i>Pyrola asarifolia</i>).
High-bush cranberry (<i>Viburnum opulus americana</i>).	Miterwort (<i>Mitella nuda</i>).

The Killdeer Mountains, lying just south of the Little Missouri River, about 30 miles directly west of its junction with the Missouri, are another group of high hills of a different type, but with only a slight trace of Canadian Zone in their cold gulches. They are about 900 feet higher than the surrounding prairie, with the main ridge about 12 miles long and from 2 to 3 miles wide. Their slopes are steep and rocky in places and at the southern end form limestone cliffs 100 feet high. The top of the ridge is a level, grassy plateau, but there are many deep gulches with springs and small streams of cold water. All the deep gulches and about half the area of the mountains are covered with a growth of deciduous trees and shrubs. The principal trees are oak, aspen, ash, elm, boxelder, white birch, and western birch; the shrubs are mainly willow, serviceberry, chokecherry, red cherry, pin cherry, plum, rose, gooseberry, wild currant, raspberry, thorn apple, cornel, beaked hazel, buffaloberry, rabbitberry, and shrubby juniper. Of these plants the aspen, white birch, pin cherry, beaked hazel, rabbitberry, and shrubby juniper are mainly Canadian Zone species. This element, however, is not sufficiently pronounced to warrant mapping the Killdeer Mountains as Canadian Zone.

Similar but even less strongly marked elements of Canadian Zone may be found in the deep gulches west of the Mouse River, and on some of the high ridges and cold slopes over the northwestern part of the State.

CROP ADAPTATIONS OF THE CANADIAN ZONE

Although pure Canadian Zone is of comparatively limited agricultural value, it has other advantages, as forest, fur, and game production. Its representation in North Dakota is so limited and so mixed with Transition-Zone conditions that most of the hardy crops of the Transition Zone thrive in it except on pronounced northerly slopes or cold bottomlands. The clearing of the land gives a slight advantage to the lower zone conditions, especially on open areas and southerly slopes. The main area of the Canadian Zone lies in the Turtle Mountains, but even the more limited spots in the Pembina Hills, the Killdeer Mountains, in the gulches, and on the cold slopes of other elevated areas may prove of special value for timber and fur production.