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FORESTS AND DUNES

From

Point Betsie to Sleeping Bear

Benzie and Leelanau Counties, Michigan

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BEAUTIES OF FORESTS AND DUNES FROM POINT BETSIE TO SLEEPING BEAR.

The writer has already described technically a portion of this region in a paper presented before the Michigan Academy of Science, and is preparing other papers to cover the balance of the region. The present booklet is a condensation of those articles, to give the many visitors to the region an opportunity to know its real nature, and to appreciate better its many features of beauty and interest.

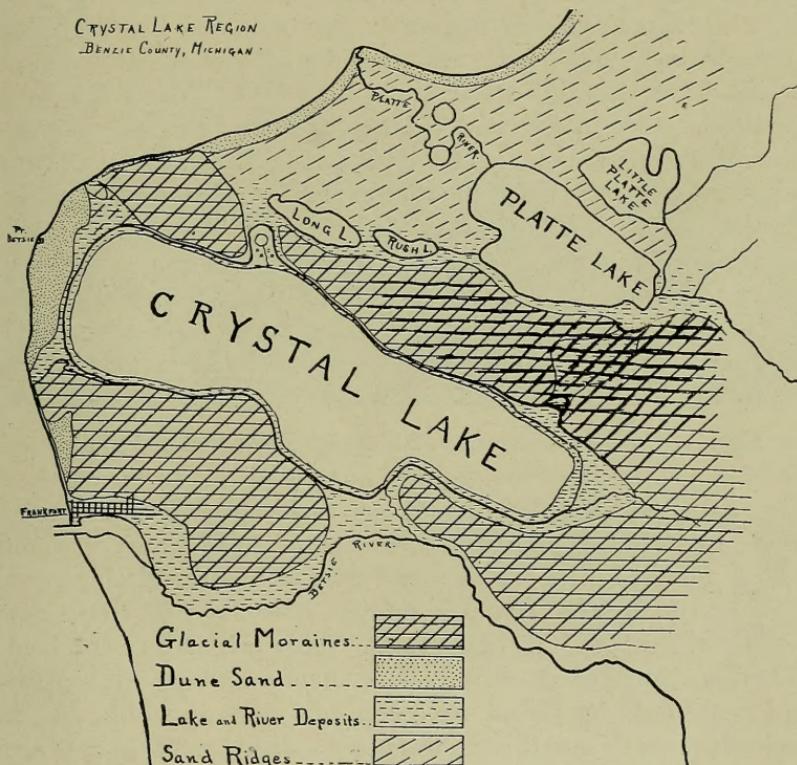


Fig. 1. Geography of N. W. corner of Benzie County, Michigan.

I. GENERAL GEOGRAPHY AND GEOLOGY.

There are three distinct divisions of the region, the Crystal Lake Bar comprising the strip of land between Crystal Lake and Lake Michigan; north of that the Platte Plains, a triangle of sand hills containing the Platte River and several lakes; and still farther north the Sleeping Bear Plateau with the valley of Glen Lake to the eastward.

To understand the geography of the region, its geological history must first be reviewed briefly. Little is known of the topography before the Glacial period, but the Crystal Lake basin at least was a deep valley, as shown by the present great depth of Crystal Lake—frequently over two hundred, and in one place six hundred feet. The chart of offshore soundings in Lake Michigan also shows a submerged valley on the lake bottom west of Crystal Lake. When the glaciers passed over Michigan, they deposited clay, gravel and sand in great parallel ridges in a general East and West direction, which now appear as rows of hills. When the glaciers finally retreated, the south end of the present Lake Michigan was uncovered, while ice still closed the straits at Mackinac, with the result that the water was ponded at the south and the level of the lake was raised until the waters flowed out through the valley now occupied by the Chicago Drainage Canal, and discharged into the Mississippi River of the day. Marks of this high water stage, known as "Lake Algonquin," may still be seen in elevated beaches and terraces, in some cases several miles from the shores of the present lake. At this time harbor bars were built across the mouths of many former river valleys, closing them and turning the flooded basins into permanent lakes. Within this especial region there are four such valleys now known as Frankfort Harbor, Crystal Lake, Empire Harbor, and Glen Lake. South of this region the Herring Lakes, Portage Lake and others farther south had a similar origin. Crystal Lake was closed by a bar about four miles long and one mile wide.

1. Moraines. On either side of Crystal Lake is a ridge of glacial material extending from the shore of Lake Michigan to the southeast. The northern or Point Betsie moraine varies from one-half mile to one mile in width, sloping to a well-marked ridge which is divided into long, rounded hilltops. About a mile from Lake Michigan, it is divided by the depression which extends from Bass Bay on Crystal Lake to the west end of Long Lake. This originally contained a round pond about a quarter of a mile in diameter which was separated from Crystal Lake by a sand bar only a few yards in width. At that time the waters of Crystal Lake were approximately fifteen feet above their present level, being held back by a sand bar across the mouth of the present outlet, and the waters of the lake apparently escaped by seeping through the sand. About 1871, certain individuals formed an ambitious plan for an inland waterway from Frankfort Harbor through the Betsie River, Crystal Lake, and Long and Platte Lakes. This would have greatly benefited the farmers as the sand roads were impassable, and a continuous waterway would have enabled them to get to Frankfort much more easily. It was claimed that a survey had been made, and that the scheme was practicable. As a first step, the

bar at the outlet was cut through and this of course rapidly lowered the water level of Crystal Lake. The sand bar between Round Pond and Crystal Lake soon gave way, and the waters flowed out until only the present remnant was left.

East of this depression the moraine widens. Its summit has been partly cleared for farms, of which the most conspicuous is the clearing of the Crystal Lake Orchards. Farther east it is crossed by a winding valley from the east end of Crystal Lake to the resorts on Platte Lake.



Fig. 2. North moraine and grass meadow near Long Lake.

The southern or Frankfort moraine is flattopped and broader than the northern, and extends from Crystal Lake to the valley of the Betsie River. Frankfort Harbor is the flooded mouth of the Betsie River, and it is almost closed by a harbor bar which was occupied by low sand hills until they were leveled off to form the site of the Frontenac Hotel.

These morainic ridges are composed mainly of sand and gravel, more or less water-washed and stratified, and they contain at least one layer of laminated clay several feet in thickness, as shown clearly by the exposure on the Lake Michigan bluffs. This layer is marked on the bluffs by a zone of vegetation, which is probably due to the seepage of water, held and brought to the surface by this clay layer. The character of the surface soils varies as different layers are exposed by erosion. This glacial deposit was apparently laid down on pre-glacial ridges, while the level areas between the ridges are due to water action at the time of the Algonquin depression.

The topography as well as the character of these deposits and the identification of Algonquin beaches, show that in Algonquin times Crystal Lake was connected with Lake Michigan toward the north by a channel passing west of Long Lake, toward the south through the valley of the present outlet, and to the west through the then unfilled valley which now contains Crystal Lake. During this time a broad harbor bar was built across this valley between the western ends of the glacial ridges. This bar, which is approximately two miles long

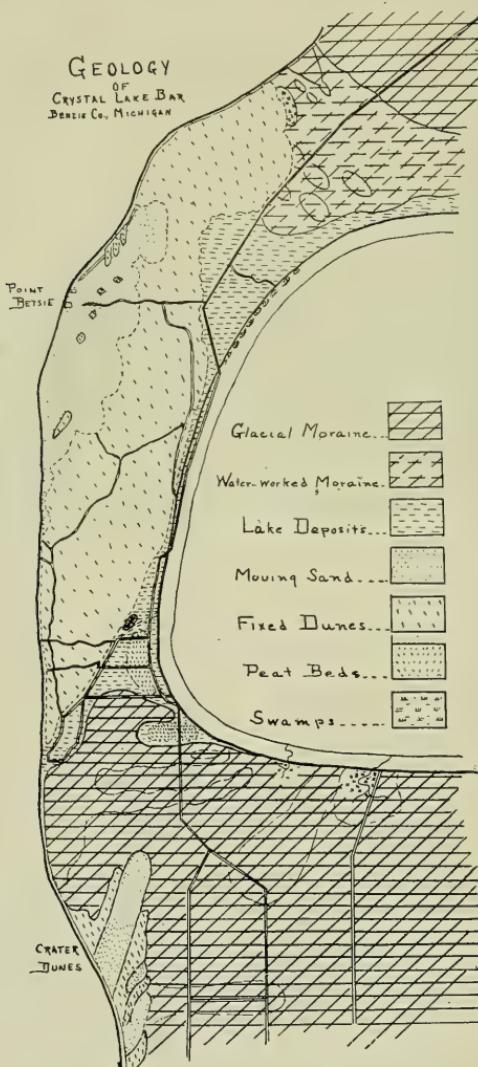


Fig. 3. Geology of Crystal Lake Bar.

and three-quarters of a mile wide, now cuts off Crystal Lake from Lake Michigan, and accounts for the name given to this region. At present the western outline of the bar is convex, but probably when first formed, the glacial ridges extended much farther into Lake Michigan, and as they have been cut back the bar assumed its present shape. The region is still being eroded, as shown by the sand and clay bluffs, and by the presence of fixed dunes the western ends of which have been entirely eroded away by lake action.



Fig. 4. Morainic bluff on Lake Michigan at mouth of Platte River.

2. Dune formation. Soon after the recession of the post-glacial lakes the wind began its work of piling up dunes, on which dune plants began to grow until they were at least partly covered by a conifer forest. These forest patches did not last long in any one spot, being blown out by the wind in some places while they were being formed in others. The dunes are found in two main localities in this region, a large complex on the Crystal Lake Bar surrounding the present Point Betsie, and a small group of perched dunes, called locally from their chief spectacular feature, the "Crater" group.

Point Betsie Complex. This group is located on Crystal Lake Bar, starting at a point on Lake Michigan at the western end of the grounds of the Congregational Summer Assembly, and spreading like a fan toward the north. It is about two miles in length and half a mile in width at its widest point. Its elevation varies from a few feet above the water level to ridges upwards of 200 feet in height. At the southern extremity of the group the dunes are fixed or covered with

vegetation, and extend from bluffs on the eroding shore to a steep lee slope on the eastern side. The contour of the fixed dunes is very uneven, showing dune ridges and outlines of blowouts. These are covered by a climax forest and have evidently been untouched for a very long time. Approaching Point Betsie the shore bluffs gradually become lower, and give place to a complex of moving sand. Great troughs lead from the shore for half a mile or more inward, to the advancing lobes of the lee front. Among these blowouts are found residual patches of the original forests. Just north of Point Betsie is a rather large patch of relic forest on three dune ridges, which extend southeastward from sand bluffs on the lake. On either side of them the sand has been blown out by both southwesterly and northwesterly winds, and a semicircular trough with a very large horse-



Fig. 5. Looking northwest through the trough of the great blowout.

shoe-shaped blowout has been formed. This is one of the largest blowouts in the whole dune region of Lake Michigan, and is unique in this locality at least, in showing the influence of winds from two directions. Beyond this blowout the dunes are higher and the steep sand bluffs begin again, and finally end about a mile north of Point Betsie with a definite lee slope just where the edges of the moraine ridge pass under the level surface of the bar. Under these dunes the moraine apparently extends some distance to the south as glacial pebbles have been found *in situ* almost to the top of the bluffs on Lake Michigan to a point within a quarter of a mile of the lighthouse.

The Crater Dunes. This small group of dunes is found half a mile north of Frankfort on the shore, forming a most interesting group of detached, perched dunes. They are only half a mile in length and one-quarter of a mile in width, and extend almost north from the shore, which at this point lies northwest and southeast. The group consists of small fixed dunes which like all the others of this region once extended much farther out into the lake. They are from 50 to 100 feet in height, but are placed on a morainic plateau, whose surface is 100 feet above the lake. These fixed dunes have been blown out through the center in a long trough, which is complex and shows traces of a number of parallel blowouts. These all end in a large steep-sided, semicircular blowout, popularly called the "Crater."

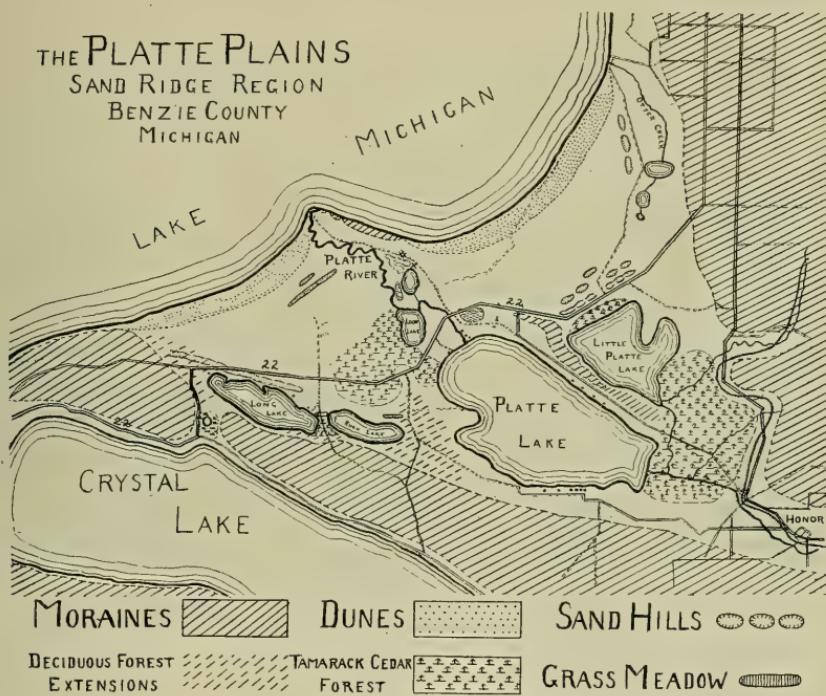


Fig. 6. Map of Platte-Plains.

3. The Platte Plains. Beyond Point Betsie there is a region which was a great bay in Lake Algonquin whose site is now occupied by a series of sand ridges with depressions between, known as the Platte Plains. This area may be described as a right triangle, the base of which extends east and west eight miles, and the east side about the same distance north and south, while the hypotenuse is formed by the coast line of Lake Michigan from the moraine

south of Empire to a point almost three miles northwest of Point Betsie. Between the sand ridges and the Algonquin bluff is a wide crescent-shaped trough of relatively slight depth containing a series of lakes or ponds more or less connected and draining into Platte River, which meanders through the sand ridges and reaches Lake Michigan about at the center of the hypotenuse of the triangle. From west to east these lakes are Long, Rush, Platte, and Little Platte. On the east three small lakes are connected to Lake Michigan by Otter Creek. There are also two small lakes, Loon and Mud, on the lower stretch of Platte River. Loon Lake is marked on the maps as Round Lake, but it is not round but crescent-shaped. Its original name was Loon Lake and as there are still icons to be found on it, it seems more appropriate to use the original name. When the glaciers were finally



Fig. 7. Looking west over Platte Plains to the Point Betsie moraine.

melting and opening the straits of Mackinac, the waters of Lake Algonquin gradually receded and formed a series of sand bars with lagoons between. On these bars, the winds built up low dunes which now form the sand ridges of the Platte Plains. The larger depressions remain as lakes, while the smaller ones have been more or less completely filled in by the growth of aquatic vegetation.

The borders of Platte Plains are formed by the remains of the shores of the post-glacial Algonquin embayment. Beginning at the south on the shore of Lake Michigan with the low foothills or hummocks of the Point Betsie moraine, they extend across the fields in a southwesterly direction up to the west bank of the Round Pond basin.

East of this basin, the old shore line begins again, but here it has been kept steep by the erosion of Long Lake. Beyond the cedar swamp, between Long and Rush Lakes, the terrace bends southward away from the lakes and runs roughly parallel with Platte Lake, until it reaches the southeast corner of the triangle, where it is trenched by the valley of Platte River entering the Platte Plains about a mile west of Honor. Northwest of Honor the terrace has been eroded into steep rounded hills for about two miles, to the vicinity of Otter Creek. Here the erosion of the creek has produced a steep bank almost bare of vegetation, and it so continues to the north corner of the triangle at the Empire moraine. The main road from Honor to Empire winds around the edge of the hills and gradually climbs to their summits, giving beautiful views to the west and southwest over Little Platte and Platte Lakes, and the mouth of Platte River valley.



Fig. 8. View over Platte Lakes from hills above Honor.

Michigan Highway 22 skirts the northwest corner of Crystal Lake to Bass Bay, then turns to the north past the remains of Round Pond, turns east again around the west end of Long Lake across the Platte Plains. About five miles east, it crosses Platte River bridge, goes through a series of blueberry hills and barrens, and climbs a long sandy hill to join the Empire road—Michigan Highway 11, from Honor. Four miles north the road descends a long serpentine hill into the Empire valley, similar to the Betsie River valley at Frankfort, but shorter and narrower. North of Empire is another high moraine forming the south border of the Glen Lake valley which is bounded by uplands on the east and south, and by the dune plateau of Sleeping

Bear on the west. In the center of the valley is a triangular morainic ridge which lies between the arms of Glen Lake. Through the swampy flat east of the ridge, Glen Lake drains into Lake Michigan near Glen Arbor.

4. The Sleeping Bear Plateau has as its core a broad morainic ridge with an average elevation of 450 feet above Lake Michigan. Its upper layers are composed of a very sandy gravel from which sand is continually being blown toward the east and north. On the east it forms a lee slope which is advancing toward Glen Lake at a rate of six feet a year, and to the north it has produced a dune complex nearly a mile square, ending in Sleeping Bear Point on which is located a Coast Guard Station. East of the point the shore line curves southeast to the town of Glen Haven, situated on a flat which extends from the central moraine to the Sleeping Bear plateau. The dune sand from Sleeping Bear is advancing on the flat and at one place has nearly reached the foot of the central moraine. Through the narrow valley thus left runs a small lumber railroad from Glen Haven to the mill on the west arm of Glen Lake.

The west edge of the plateau is being eroded by the waters of Lake Michigan, forming a steep bluff 450 feet high and two miles long. This makes a striking landmark, which is well known to every one who travels by water from Chicago to Charlevoix or Mackinac. The effect of this long level bluff is heightened by the presence of the dune from which the plateau and the point get their name. This dune is forested on its eastern slope but is being cut away with the plateau by the waters of the lake. As seen from the lake, it resembles an animal lying on its side and the Indians told the story of a mother bear and her two cubs who swam across the lake to escape a drouth and famine in Wisconsin. The mother reached the shore first and, climbing up on the bluff, lay down to wait. The cubs tired out, sank in the lake and were drowned, and the Great Spirit transformed them into the Manitou Islands. The mother bear, falling asleep, was covered with sand and became the dune which now bears her name.

II. INFLUENCE OF NATURAL CONDITIONS.

Two factors of the natural environment are of great importance in understanding the vegetation of the region, the direction and strength of the prevailing winds and the nature of the soil. The prevailing winds are from the south and their force on exposed points is the chief cause of the moving sands around Point Betsie and Sleeping Bear Point. As already described, the force of the northwest wind is shown about a mile north of Point Betsie, where its effects, combined with those of the southwest wind, have resulted in a large

crecentic blow-out, with a trough opening toward the lake on the north and also on the west.

The soil varies from clay and sandy gravel on the moraines to pure blown sand on the dunes. This dune sand constitutes one of the poorest soils for plant growth that can be found. Although it seems very dry, this is only on the surface, and underneath there is enough moisture to supply the plants which can grow there, but it is deficient in the mineral elements, which are necessary for plant growth. This accounts for the scattered position and stunted growth of most of the plants that can exist at all on the open sand. As we approach the forests the sand contains more and more dead plant material and consequently it is able to support a denser vegetation.



Fig. 9. The Climax Forest on fixed dunes.

III. VEGETATION.

A. The Climax Forest. The moraines and part of the fixed dunes were originally covered by a heavy forest known from its predominant trees as a Beech-Maple-Hemlock forest. This is best seen now on the fixed dunes north of the Congregational Summer Assembly, in spots on the moraines north of Crystal Lake and in a few forest patches around Glen Lake which have been more or less modified by scientific cutting and care. On the Point Betsie dunes it is still practically untouched at the southern tip and along the eastern edge of the dunes. The level ground of the Bar has largely been cleared, and is covered with second growth of forest trees and clearing pioneers, where not occupied by summer cottages. The climax forest is composed of

beech, maple and hemlock, with much yellow birch. Where undisturbed the trees are tall and slender with close stand and very little undergrowth. Occasional specimens of red oak (*Quercus rubra*), white pine (*Pinus Strobus*), and red or Norway pine (*Pinus resinosa*), are found. Among the shrubs the mountain maple (*Acer spicatum*), about at the southern limit of its range, the maple leaved viburnum (*Viburnum acerifolium*), and the American yew (*Taxus canadensis*), are conspicuous. Characteristic species in the undergrowth are the wild sarsaparilla (*Aralia nudicaulis*), *Streptopus roseus*, *Clintonia borealis*, *Aralia racemosa*, the wild lily-of-the-valley (*Maianthemum*



Fig. 10. *Clintonia borealis* in climax forest.

canadense), the twin-flower (*Linnaea borealis*), and the partridge berry (*Mitchella repens*), with *Aspidium spinulosum*, *Adiantum pedatum*, and *Botrychium virginianum* among the ferns.

B. The Burned Area. The northern and central portion of the forested strip has been burned on Crystal Lake Bar, in some parts repeatedly, in others not so recently. In the much burned portions the tree specimens are young and somewhat stunted. In the other portions the trees are larger and the undergrowth thicker. The species include the white birch (*Betula alba*), the chokecherry (*Prunus virginiana*), and the fire cherry (*Prunus pennsylvanica*), with the more xerophytic relics of the mesophytic undergrowth, and much bracken fern (*Pteris aquilina*), and horsetail (*Equisetum*).

C. The Conifer Belt. Where the climax forest still untouched, extends to the shore, a zone 50 to 100 yards in width, shows a very characteristic difference in species. The trees are the arborvitae

(*Thuja occidentalis*), the ironwood (*Ostrya virginiana*), the basswood (*Tilia Americana*), and the fir balsam (*Abies balsamea*), with the climbing bittersweet (*Celastrus scandens*). The line of demarcation is not sharp, but the climax trees, especially hemlock, mingle with the others almost to the edge of the cliffs. The characteristic border zone species are not found farther back in the climax forest. This belt broadens as it approaches Point Betsie, but it has been largely cut up by blowouts on the dune complex around the point. A few interesting patches still exist as relic groves in the midst of the open dunes east of the lighthouse. These apparently grew in valleys between former fixed dunes whose summits have been entirely blown away. The interiors of these patches present all the characteristics of a heavy forest, and their evaporation rate is almost as low as that of the climax forest.



Fig. 11. Patch of *Linnaea* (Twin-flower) on edge of forest.

The vegetation is characteristic of the border zone described above, containing especially *Thuja* and *Abies*, and is marked by some trees reaching two feet in diameter, but not over 30 feet in height. The undergrowth is similar to that of the climax forest, but is especially characterized by the maple-leaved viburnum (*Viburnum acerifolium*), the poison ivy (*Rhus toxicodendron*), and the wild sasaparilla (*Aralia nudicaulis*). On the edges, next to the open sand, are found the bearberry (*Arctostaphylos*), the twin flower (*Linnaea*), and the creeping juniper (*Juniperus horizontalis*). These apparently originate in the fixed area, and extend out on to the sand, forming a protective covering which frequently contains also *Juniperus* com-

munis. Buried trees and occasional graveyards are to be found all over the moving sand area. In one spot seven evergreens may be observed within a radius of a few hundred feet. These are white, red, and Jack pines, arbor vitae, fir balsam, upright juniper and creeping juniper.

D. Dune Vegetation. The moving sand on the open dunes affords very poor conditions for the development of vegetation. In fact the only plant which can grow on pure dune sand is the sand grass (*Ammophila arenaria*), known by its long, slender, creamy-white spikes. This is the true sand pioneer and some investigators have reported that it cannot live unless it is annually covered by a fresh layer of blown sand. In sand that contains an appreciable amount of humus it gradually dies out. A close second is another sand grass, the *Calamovilfa*, distinguished by its large feathery flower clusters. Along with these grasses are found the sage green tufts of the wormwood (*Artemisia canadensis*), and the silky-white sand thistle (*Cirsium Pitcheri*). On the open sand are also found the harebell (*Campanula rotundifolia*), the beach sweet pea (*Lathyrus maritima*), the yellow puccoon (*Lithospermum*) with a cluster of small trumpet-like flowers whose roots furnished a red war paint for the Indians, a slender white lily-like plant poisonous to cattle (*Zygadenus*), as well as several asters and golden rods. Among evergreens or semi-evergreens, are the creeping juniper, the bearberry, with a dark red berry and small flat leaves, and the *Hudsonia*, looking somewhat like a small juniper but having a yellow flower. In the wet depressions or pannes on the open dunes, the characteristic plants are the Baltic rush (*Juncus balticus*), and occasionally the delicate little *Utricularia* with irregular yellow flower. Among shrubs which are interesting are the sand cherry (*Prunus pumila*), several willows, the red ozier dogwood (*Cornus stolonifera*), and the evergreen upright juniper. Occasional single specimens or groups of white birch, balsam poplar, arbor vitae and fir balsam have either wandered from the edge of the forest or started in pannes. The *Linnaea* or twin-flower also wanders from the edge of the forest even on to the bare sand, but it is almost always sickly and dwarfed under those conditions.

E. Vegetation of the Crater Group. This group apparently consisted at first of fixed dunes, which were at least partly covered by the climax forest of the glacial plateau on which they are perched. At present the outer slopes of the fixed dunes, from which the center has been blown out to form the trough, are covered by a formation similar to that of the border-zone and relic patches already described. On the open sand of the trough are found the usual pioneers of the region,

with in addition a great abundance of *Anemone multifida* and the Philadelphia lily (*Lilium philadelphicum*). The sides of the earlier troughs are frequently covered with *Ammophila* and *Calamovilfa*, and in places these practically form fixed grass dunes.



Fig. 12. Lower reaches of Platte River.

F. Platte Plains Vegetation. The Platte Plains region varies from open dunes on the shore to the beginnings of the climax forest on its inner borders. The vegetation on the shore is about the same as that on the Point Betsie dunes. The open dunes lead to a row of horse-shoe-shaped blowouts. These are bordered by thickets of wild roses, grape, red ozier dogwood and juniper. Between the blowouts are occasional groves of conifers, chiefly jack pine, arborvitae and balsam. Beyond these moving dunes begins the sand ridge region now covered by a pine-oak association. These sand ridges had been burned over when the first white settlers reached this country, but they apparently were originally covered by a heavy forest of pine and oak. Many of the stumps may still be seen and a few patches in protected localities survived the fire and living trees up to two feet in diameter are still standing. The Beech-Maple-Hemlock forest originally migrated out on the edges of the Platte Plains and some hemlocks and perhaps beeches also became established in protected hollows among the ridges. No hard maples have been noticed on the Platte Plains, but an abundance of red maples took their place. At present the trees are small and consist chiefly of three oaks, white, red and ellipsoid, three pines, white (*P. Strobos*), red or Norway

(*P. resinosa*), and some Jack pine (*P. Banksiana*). There are also frequent white birches and large-toothed aspens. The shrubs are chiefly red ozier dogwood, and sumach.

The undergrowth consists in the drier portions chiefly of the bracken fern (*Pteris aquilina*), two species of blueberries, huckleberry, wintergreen, several mosses, and reindeer lichen (*Cladonia*), and occasionally selaginella. In the more sheltered portions the trailing arbutus (*Epigaea repens*), is not infrequently found and the hardier members of the Beech-Maple-Hemlock undergrowth also occur.



Fig. 13. Typical vegetation of Platte Plains.

G. Vegetation in the Glen Lake Region. Some of the best bits of climax forest still remaining are to be found on the Glen Lake moraine, but the best trees are rapidly being cut. The Day forest northwest of the Glen Lake Narrows is a very good specimen of a well-kept forest.

The eastern edge of the Sleeping Bear Plateau forms the dominant feature of the landscape looking west from the Glen Lake narrows. It is best reached from the west shore of Glen Lake, by farm roads to the bottom of the steep slope formed by sand blown from the moraine by the westerly winds. On climbing this slope the surface of the Plateau is reached. The broad expanse of this plateau is desert-like in appearance with scattered dune plants and occasional patches of cottonwood (*Populus deltoides*). The vegetation is similar to that of the Point Betsie dune complex, except that the balsam poplars (*Populus balsamifera*), of the Betsie dunes are replaced by cottonwoods on the Bear plateau. The surface of the plateau consists mostly

of blown sand on the east, but near the lake the original material of the moraine is exposed. This material is very sandy gravel, the sand from which has been blown away for centuries leaving the scattered pebbles and cobbles to form a thin layer on top. These pebbles have been subjected to the action of the blown sand for so long, that they have acquired the characteristic features of desert pebbles—the harder specimens showing the polish known as "desert biscuit," and the triangular pyramidal shape, and the softer pebbles being etched in all sorts of fantastic patterns.

The Sleeping Bear hill is a forested dune, a relic of an earlier stable condition which possibly included the whole of the plateau. At present the vegetation occupies only the sheltered eastern side of the hill, the western side showing the effects of wind and wave erosion



Fig. 14. Sleeping Bear Dune, forested on east, sloping toward the lake on the west.

and being continuous in slope with the steep lake bluff on which it stands. The presence of several large dead cedar trunks shows the size of the trees which at one time grew in this locality. The views from the edge of the bluff and from the top of the dunes are magnificent, extending from Point Betsie on the southwest to Pyramid Point on the northeast.

H. Aquatics. The display of water vegetation is very interesting and complete, ranging all the way from the more common water plants to the specialized and unusual bog flora. The depressions in the Platte Plains, the many bays along the shores of the various lakes and the river valleys furnish opportunities for the observation of all stages in the development of the water vegetation.

There is a regular order in the appearance and growth of water-loving plants which begins with plants which grow in deep water, floating unattached like the algae and some of the flowering plants. These are followed by plants that root on the bottom, but have their leaves and flowers floating on or rising above the surface, like water lilies, cat-tails and bulrushes. Next come the sedges and grasses forming a sort of meadow and then the water-loving shrubs, such as willows and alder, followed by arbor vitae or white cedar and tamarack (*Larix*), among the evergreens, and deciduous trees like the ash and elm. These plants grow in regular belts or zones determined by the depth of the water, and their remains gradually fill up the water until it becomes a mass of muck or peat on which the forest finally develops. The process is a very slow one and the vegetation may remain for a long time in certain stages. For instance, the grass stage



Fig. 15. Long Lake. Peninsula with pines, aquatic plants in the bay.

may remain as a swamp meadow or the tree stage as a cedar swamp. Under certain conditions a quaking mat is formed on the surface of ponds and in this mat, characteristic bog plants will be found. The sphagnum used by florists and during the war for surgical dressings, is found in masses in the bog mat and with it the pitcher plant (*Sarracenia purpurea*), the sundew (*Drosera rotundifolia*), and the cranberry (*Vaccinium macrocarpon*). The lady's slipper orchid, or moecasin flower (*Cypripedium*), was formerly very common, but now extremely rare. The bog shrubs are cassandra or leather-leaf (*Chamaedaphne*), bog rosemary (*Andromeda*), the swamp blueberry, and occasionally the Labrador tea (*Ledum*). All these shrubs

have thick glossy leaves with down on the under surface. The flowers and fruits resemble those of the blueberry to which family they belong.

The tamarack is the first tree to appear on the bog and the black spruce reaches the southern limit of its range in the bogs of this region. Small bogs are found in various stages from wet to dry in the depressions between the sand ridges on the Platte Plains. The largest examples are found in the Platte River valley, one rather mature and dry, on both sides of the Michigan Highway 22 just beyond the Platte River bridge, and a wet and quaking one on the west side of Loon Lake. A very large swamp or bog covered with a dense growth of small tamaracks lies between the eastern ends of



Fig. 16. *Chamaedaphne* bog—the home of the pitcher plant.

Platte and Little Platte Lakes. It is crossed by the road from Honor to the Platte Lake resorts. The flood plain of the Betsie River is bordered by dedicuous swamp trees mostly ash and elm and shrubs with occasional strips of swamp meadow.

I. Crystal Lake Beach. As a result of the lowering of the waters of Crystal Lake at the time of the inland waterway proposition, a broad under water shelf or sand terrace was laid bare. Nothing further was done with the inland waterway scheme, and the beach has remained exposed to the present. As a result of this exposure of a broad sand area, the formation of dunes began at the first point on the west end of the lake where the southwest winds could get sufficient sweep. These dunes extend for nearly a mile, and increase in size toward the north. At the beginning they are almost indistinguishable from the beach,

and at the other end have reached a height of 10 or 15 feet and a length of 50 feet. The vegetation on these dunes is scattered and consists chiefly of Ammophila. The vegetation of the beach is interesting because a definite date can be set for its beginning. At present it consists chiefly of *Junceus balticus* in the wetter portions, some species of aster, goldenrod, and stunted shrubby growths of willow, *Populus balsamifera*, and *Betula alba*. At certain points there has been a slight invasion of arbor vitae, apparently from swamps of the high water period.

At one point on the beach there can be seen four stumps of trees which apparently grew on the beach at a prehistoric period of low water similar to the present, although they may have floated there from the shore at the high water stage. These stumps are about three



Fig. 17. Bracken ferns (*Pteris*) in white birch grove.

feet in diameter, and have been identified as *Pinus Strobus*. While the water was high they were cut off level by the action of the waves working the beach gravel back and forth. Since the waters were lowered the sand has been removed from around them by wind action to a depth of approximately eight inches, and they thus give a measure of the lowering of the level of the beach by removal of sand by the wind. Their presence is interesting as indicating a possible former vegetated period for this beach. If the stumps grew in their present position, there must have been a time at which the beach was covered with a pine forest, which was killed by the slow rising of the waters due to the forming of the bar at the outlet.



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